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THE DIVERSITY OF LIFE AT THE BELL

By

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ABSTRACT

THE DIVERSITY OF LIFE AT THE BELL

By

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A study of the diversity of organisms should be part of any high school science curriculum. Teaching this can be a very time consuming task. Looking for an efficient way to teach this topic has led to the development of a system, the anticipatory set, that has proven to be effective.

An anticipatory set at the beginning of each class period can be used to teach a great deal of content material. Taking full advantage of this instructional time, my colleagues and I developed a system to teach the diversity of life. Using videotape of common West Michigan plants and animals and an accompanying manual, our students learn to classify, identify, and justify the importance of organisms from all five kingdoms of living things within the first four minutes of class each day. Emphasis is placed on those organisms which they see every day.

Students not only gain a better understanding of their environment and their role in it, but also develop a greater appreciation for the beauty of our natural world.

ACKNOWLEDGMENTS

This project was possible due to the vision, dedication, hard work, and inspiration from my colleagues, Mr. Ron Reimink and Mr. David Bolhuis. They have both guided this project and my teaching in many ways and I view them as my mentors in much more than education. My appreciation is also extended to Dr. Merle Heidemann for her assistance since my freshman year at Michigan State and for her patience and assistance with the completion of this project.

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INTRODUCTION

Statement of the Problem

In teaching science, we often have to make difficult decisions about the content of our courses. Many of us have the tendency to try to fit too much material into the course content. We have a love of science and want to relay that information to our students as much as possible. With the considerable demands placed upon us to teach reading, writing, mental math, and other topics across the curriculum, we have to be even more selective about the content of our courses. Often a textbook ultimately determines the content, a dangerous proposition given the errors and fallacies of current texts.

Thirty seven percent of the chapters in the current text which our district uses for sophomore biology, *Biology* by Miller and Levine (1992), are dedicated to a presentation of the diversity of life. Chapter by chapter, students are presented first with prokaryotic and simple eukaryotic organisms and later with multicellular, complex organisms. The chapters are divided according to the taxonomic classification groups of the organisms. An attempt is made in every chapter to present students with the basic forms and structures associated with each group of organisms. Miller and Levine focus on particular species within each taxon and use them as

examples. Often the authors devote a section of a chapter to an explanation of how those organisms "fit into the world". A single chapter addresses the classification system of all living things. Realistically, 20 weeks of instruction would be necessary to teach all of these chapters, assuming one week is spent to teach each chapter. This translates to slightly more than one semester for material which is all but ignored by the Michigan Essential Goals and Objectives for Science Education (Michigan State Board of Education, 1991).

The MEGOSE sets forth very clear learning objectives at various grade levels in science and is the framework used for the design and content of the High School Proficiency Test (HSPT). While our science curriculum has been geared toward the MEGOSE document, we have also recognized that it does not take into account all of the learning goals which we have for our students in science. Therefore, we set out to design a method to teach the diversity of life using as little instructional time as possible. This method consists of showing students video clips of common organisms at the beginning of each period as an anticipatory set.

The need to add this content to the biology curriculum was just one of the factors which led to the development of this system of teaching. As a department we also wanted to find methods which

would allow us to utilize the full fifty-five minute class period to the maximum extent possible. Typically, chores such as taking attendance, organizing papers and materials, and calling the class to order eat away a few minutes of valuable time each class period. Over the course of a school year of185 days, 3 minutes of wasted instructional time per day adds up to over 9 hours of instructional time. The system which we developed for teaching the diversity of life within the first few minutes of class each day puts this time to valuable use.

The challenging task was to find a way to teach the diversity of life on Earth without having to limit the studies of other topics. Utilizing the first few minutes of class time each day accomplished this goal. Students are shown 30 second video clips of organisms which are common to West Michigan while they refer to a manual. When an organism appears on the video, students are to observe it and learn to identify it while at the same time reading the manual to learn the classification and justification information for the species shown. Justification refers to the importance of an organism to it's environment. After 30 seconds, the next organism listed in the manual is shown.. However simple it may seem, this system accomplishes its objectives: Teach the diversity of life in minimal time and appeal to students of various learning styles.

Literature Review

William Glasser (1993), in *The Quality School Teacher*, describes how quality teachers teach useful skills. Being able to identify, justify, and classify living organisms is seen as useful by students who begin applying what they have learned in class to their everyday experiences.

Aside from being useful, the Diversity of Life (D of L) has helped students to develop positive attitudes about nature. Students have indicated that learning the diversity of life has helped them see the value, importance, and usefulness of other living organisms.

Many educators and scholars today are implementing instructional strategies from the constructivist approach. Rooted in the ideas of Piaget, the constructivist approach centers around the organization and adaptation of information and learning (Papalia, 1986). Organization is the bringing together of the learner's knowledge into a comprehensive system or framework for learning. Adaptation is a process in which the learner takes in new information, reflects upon it, and either fits it into their organizational framework or changes their framework to fit the newly acquired knowledge. The role of the teacher and the experiences they provide for their students is critically important to this process. The D of L procedure addresses this issue since it

provides a framework for learning and requires students to fit new learning into that which they have already acquired.

As Leinhardt (1992) says, when we use the classroom "as a social arena for the public examination of ideas ... students naturally build on or refute old ideas as they are merged with new knowledge". The Diversity of Life at the Bell is well suited to this type of learning. Students come into high school with many experiences with the natural world and the common organisms of the West Michigan area. They learn a great deal about familiar organisms as well as new knowledge of species they may have never experienced as they engage in this work at the bell. Although the framework for classification is already laid out for them and they are not required to construct that knowledge, this procedure requires them to fit what they know into that system.

John Zahorik(1997) warns against allowing student's understandings to stand when they clash with the constructions of experts in the field. Educators are sometimes guilty of erring on the side of the students by allowing their constructions and understandings to go unchallenged since they may be adequate for the purposes of the lesson. Driver (1994) and his colleagues point out, "Scientific entities and ideas, which are constructed, validated, and communicated through the cultural institutions of science, are

unlikely to be discovered by individuals through their own empirical enquiry". On the other hand, educators may err on the side of scholars whereby student constructions are dismissed as unimportant and trivial. According to Von Glaserfeld (1995), "Concepts cannot simply be transferred from teacher to students - they must be conceived". By implementing the D of L procedure, I hope to balance the two approaches. Students will construct new knowledge about familiar and unfamiliar organisms as well as fit their knowledge into the accepted classification framework that has been constructed and accepted by the scientific community.

Much has been said of learning styles in educational research in past years. It has been noted that some students are visual learners while others are auditory, kinesthetic, or others. Regardless of the modality of learning, it is important for educators as well as students to understand how each individual learns best and utilize all available tools to take advantage of this knowledge. Cynthia Tobias (1996) states, "Always remember that each child is a complex and wonderful mixture of learning style strengths - and that there's a little bit of all styles in every one of us".

The teaching methods utilized by The Diversity of Life at the Bell accommodates students of various learning style strengths due to the auditory instruction on the first day of each set, the visual

images used to teach identification, the manual for linguistics, and the classical music soundtrack which accompanies the videotape. Appealing to numerous learning styles is part of what makes this project and its method of teaching so popular with students.

The D of L procedure also addresses motivational and organizational factors within the classroom. Many students are motivated by video. The use of video alone has been shown to have an effect upon student performance in the classroom. Drost, Loubser, and Swanepoel (1983) were able to demonstrate a mean increase of six percentage points in the test scores of a classroom in which video programs were used for math, biology, and physical science. Although not backed by hard statistics, the view that the increase was due to greater motivation and concentration by students was shared by the researchers. Also, it is important to expect students to be on time to class and to start the lesson immediately to establish a sense of seriousness of purpose that is lost in a " ragged start" (Evertson et al, 1984). By using the Diversity video as an anticipatory set to begin each class period this goal is also accomplished.

The content of The Diversity of Life at the Bell is supported by David Hershey (1993) who states that " Too often real world connections of plant biology are missed in biology education".

Nearly half of the 180 organisms which are covered by the program are plants of West Michigan. Students learn not only the classification, and therefore structural characteristics of the plants, but many of their uses in industry, agriculture, and medicine. This may be one of the greatest assets of the program; it's ability to connect what is taught in the classroom to the world outside of the school.

Demographics

This procedure was implemented in a suburban high school in West Michigan. The majority of our students come from middle income homes within newly developed subdivisions of a rapidly growing area. The town has two high schools, a Christian school and a public school, with a very strong Christian Reformed Church influence. Our public high school houses grades 10-12 with a population of 818. The student body is lacking in racial diversity with a mere 3% of the students being classified as minorities. Sixty two students, or 7.5%, are in the Special Education program. Parental support is strong with 65% attendance at parent-teacher conferences for sophomores while slipping to 50% for seniors. This data is from the fall conferences in 1998. There is usually a modest decrease in attendance during the spring conferences.

IMPLEMENTATION

Background

The initial phases of the development of this project goes back further than my teaching career. I take no credit for this system or the idea behind it. When I began teaching within the science department at Hudsonville, a similar system of teaching biodiversity was already in place. Mr. David Bolhuis and Mr. Ron Reimink had collaborated on the project which used photographic slides to introduce students to common West Michigan plants and animals.

Students viewed a set of 10 organisms per day. As soon as the clock clicked to the minute that class was supposed to start, one student would turn off the lights and another would turn on and run the slide projector. The projector operator would wait for approximately thirty seconds before switching to the next organism. This gave all of the students the opportunity to view the organism at hand as well as read the classification and justification information from papers handed out when the study of a particular set began. Sets were organized on the basis of their classification. For example, there was one set of amphibians, another of reptiles, and three sets of birds due to their large number and interesting varieties. Although all of these belong to Kingdom Animalia,

Phylum Chordata, Subphylum Vertebrata they are all separate classes and therefore separate sets.

At this stage in the progression of this system, the master list of the organisms included was determined by the organisms of which we had good photographs. Mr. Reimink is an accomplished photographer and had taken many of the slides during the summer prior to my hiring. The organisms he photographed were the organisms we taught to our students.

The justification and classification information was printed out on individual sheets. Each biology instructor made his own sheets. They included the Kingdom, Phylum, Subphylum, and Class of all of the organisms in a particular set. The justification was indicated by writing how that plant or animal makes a living, how they are useful or harmful to the environment and humans, or simply interesting facts about that organism. The idea behind this aspect was so that upon the completion of the year long D of L procedure, students would be able to intelligently discuss a particular species. When walking along a country road in the summertime they will not just be able to identify the Orange Day-lily but also know that each flower lasts only a single day and the flower buds can be cooked and eaten like green beans (Peterson, 1990).

Development

The slides were a great way to start the class each day while teaching biodiversity. Students really did see this activity as useful, but it needed to be improved. Mr. Bolhuis initiated an improvement by using a video camera to film common organisms. It was obvious that it would be a great improvement in the activity to get videotape of different organisms. Some organisms, like maple trees, are fairly easy to catch on film and are readily accessible. Microscopic, nocturnal, underwater, and seasonal organisms provide greater challenges. After seeing Mr. Bolhuis' first attempts at videotape it was hard not to be excited about the possibilities of using this medium. Students would no longer see static images but have better opportunities to judge size, characteristics, movement, and behaviors of the organisms under study. We knew that the time required to film all of the organisms we needed would be considerable.

Mr. Reimink, Mr. Bolhuis, and I sat down to put together our ideas about the video. We wanted the tape to be something which we all could use. We agreed that classical music playing in the background would be a nice touch. We also agreed that we should put the classification and justification information together in a booklet (see Appendix A).

Organism Selection

Choosing the organisms to include in the list was the next task. Our goal was to select organisms that our students would encounter on a regular basis. We approached the list from the standpoint of classification. We wanted to be sure that representatives of all of the major groups were included. The formal 5 Kingdom classification system was used. The role of the individuals were also considered snd we included organisms which have especially interesting uses or habits.

Initially our list was far too large so we had to pare it down into a number which would be managable for students to learn. We then grouped organisms into sets of 6 to 10. It is quite manageable for students to learn a set of 10 organisms in 8 or 9 class days.

This fact gives a great deal of flexibility to the teacher regarding the timing of quizzes. If a lab happens to fall on the eighth day of a ten organism set, adjusting the quiz for the seventh or ninth day is very easy and does not put undo strain on the students. We also try to build in time for review of organisms at the end of the semester and at the end of the year for final exams. We accomplished this in a period of two weeks, 10 class days, covering one or two sets of organisms each day. The advantage to having this part of the curriculum on videotape is that students who wish to

have more review time can simply come in before or after school to watch the tapes which are always in the VCR in the classrooms.

Development of the Manual

Mr. Reimink took on the task of developing the manual to accompany the video. Instead of each individual teacher developing their own handouts with the classification and justification of the organisms, he developed this information for each of the 180 organisms on the final list. Using numerous Peterson Field Guides, he attempted to capture in a sentence or two the role and importance that each organism has to its environment. Many organisms are of economic value to our region which was, of course, noted. Not all of the descriptions were so concrete. For example, part of the justification of the Trillium was that it "adds beauty to spring hikes in the woods" (See Appendix A). Being a conservationist and sportsman, Mr. Reimink also mentioned when or if a particular species could be eaten as well as the quality of the taste.

The idea of including the justification segment was to encourage students to attach value to the organisms they were studying. In an age when senseless killing sometimes seems rampant, it is important to teach the value and importance of living things. Perhaps the famous line by Rachel Carson (1967) in her book

Silent Spring sums it up best, "We only grieve for what we know".

Included in the booklet is a list of the 180 organisms which we chose for this procedure, a Greek and Latin Root Index for terminology (an extension of one of the goals of the English Department at our school), an outline of the five kingdom classification system with examples (Miller and Levine, 1993), and a descriptive listing of the identification and justification of the organisms.

The manual turned out to be a terrific piece from which I still learn as we move through the list each year. The quantity of information contained in the manual is vast. Therefore many students keep theirs at the conclusion of the course for reference. Each year we have new copies made for all sophomores enrolled in biology. They are printed on very colorful paper, a different color for each Kingdom, three hole punched, and bound with a plastic spiral binder with a thick paper cover. We encourage students to keep this manual inside a three ring binder since they will be using it every day for the entire school year.

Development of the Video

The development of the video has been a painstaking and often frustrating process. Countless hours have been spent crawling

through the weeds and woods to capture on tape all 180 organisms. Mr. Bolhuis spent one summer with the camera the science department had purchased for our Summer Science program. It is a Sony Handheld 8mm camera with a color viewfinder. Although a lot of good footage was recorded, we still did not have video clips of all of the organisms.

This is where the bulk of my work on this project began. I decided to use the time allotted to me for research to update, improve, and finish our videotapes. I estimated that the time allotted would be insufficient to film and edit the video for all 180 organisms, yet that remained my goal. I did not get all of the organisms on tape during the first summer, however I came close. I filmed numerous hours worth of tape to capture 163 of the 180 organisms on videotape. However, only154 of those made the final tape since Mr. Bolhuis had previously captured video clips of 9 organisms which turned out to be better than those that I had filmed. The remaining organisms had to be filmed from guide books and still photographs in magazines, a poor substitute for live video.

A knowledge of basic photography would have saved many hours that were spent refilming numerous organisms. I learned as I worked that summer and while some mistakes were made, I feel that it was very productive.

There were also numerous challenges that were not foreseen but had to be dealt with. Seasonal organisms like morel mushrooms and trout lilies needed to be accounted for. If someone decides to replicate this work for their region and they don't start filming until summer vacation there is no way to have a complete video for the following fall. This is definitely an ongoing project. In fact, I continue to carry a video camera around with me hoping to get shots of organisms which we are still missing, like the striped skunk, or improve on existing footage.

Time in the field and luck must play a part in getting quality footage. To leave the house in search of a particular organism is usually futile. The most successful method seemed to be to charge up the batteries, grab the camera and tripod, and take a walk. You must be ready for the unexpected, close-up encounters. If you are not, you'll leave for home knowing that you blew the "shot of the day". A prime example is the day that, while filming the ever-elusive duckweed, a muskrat came swimming by, turned a couple of circles to mock me, then submerged beneath the water before I could even get the camera off the tripod. Given the fact that muskrats are not often encountered makes this kind of occurrence all the more frustrating.

Capturing video of microscopic organisms was relatively easy. An Olympus CH 30 microscope and a Flex-Cam connected to a VCR were used. Most protists can be found in a sample of pond water. It is important to have a mechanical stage to aid in keeping the organisms within the field of view. Monerans were filmed using prepared slides. Although they provide a clear and distinct view of these organisms it is a throw-back to using the still photographs and will be changed in the future.

Plants were relatively easy to film, provided their flowers were in season. To shoot them from a distance and then quickly zoom in on key identifying characteristics seemed best suited for our purposes. It was important to keep in mind which key characteristics were mentioned in the manual when filming the plants. For example, Black Cherry trees are described in the manual as having bark similar to "burnt potato chips". Without a close-up of the bark, this descriptor would be relatively meaningless to students. A color viewfinder is absolutely essential when filming plants. Through a black and white eyepiece they tend to blend in with surrounding foliage, making it difficult for the photographer to determine whether they are getting the shot they want. I had to refilm numerous plants since they blended in with the background in many of the distance shots. Large trees also pose a challenge since

filming against a bright sky closes the aperture on the camera and tree leaves appear blackened instead of green during playback. I might have known much of this beforehand had I taken even a basic photography course prior to filming. Instead, most of my experience was gained by trial and error. I would highly recommend that someone take a photography course prior to filming. Considerable time and effort was wasted due to lack of ability and experience on my part.

Naturally the animal kingdom was the most entertaining and challenging to film. Most of the animal footage was taken while walking out in the field looking for plants. You need to rely on chance occurrences and take advantage of them. Being mobile, animals do not give you the luxury of a good angle and all the time it takes to set up the tripod and compose the picture, you just aim and shoot.

Numerous trips were taken to Kellogg Biological Station near Kalamazoo, MI. At KBS, I filmed Mute Swans, Mayflies, Eastern Tent Caterpillars, Groundhogs, Spotted Salamanders, and Cardinals among many others. Blandford Nature Center in Grand Rapids, MI as well as all of my childhood stomping grounds throughout Michigan's Barry County provided opportunities for filming countless birds, plants, and insects.

Living in a large city should not be a deterrent to anyone who is considering adopting this format for teaching biodiversity. Remember, the objective was to teach those organisms which are common to the area and which students may encounter. Youth in large urban areas may not need to see video of a whitetail deer, but they could definitely benefit by learning the difference between a fox squirrel and a chipmunk.

Other filming locations included Gillette Nature Center near Muskegon, MI, Shedd Aquarium in Chicago,IL for some fish, as well as my back yard bird feeders. Filming the organisms was the most enjoyable aspect of this project for me since it afforded me the opportunity to spend hours each day in the field experiencing what I hope students will in some way experience, a love of nature and enjoyment of being outdoors.

Editing the video was nearly as time consuming as filming and was a substantial part of my involvement in this project. Fortunately, our district had recently purchased editing equipment. It was intended to be used by the teaching staff, but wound up being used much more often by coaches and school group sponsors. Two SuperVHS VCRs were linked to two monitors and the Videonics Editing Suite. We decided to stay with the thirty second per organism format of the previous teaching system, however it was

now possible to use multiple clips and views of each of the organisms. In most cases, at least one to two minutes of footage of each organism had been recorded on Hi-8 tapes using the video camera. This footage had to be dubbed to VHS tapes and indexed for timing references. Once this was complete it was much easier for me to find the desired footage amidst hours of videotape.

After recording title clips and credits, the process of piecing together the master tape began. The order in which the organisms appeared on the tape had to coincide with the sequence used for the manual, so that students could read about each organism as they saw the video clips. A title screen with a blue background was recorded at the beginning of each set indicating the group of organisms to be seen as well as their reference numbers from the master list. Thirty seconds of selected footage was then recorded for each of the organisms. At the end of each set the blue screen was recorded again to indicate the end of the set. Most sets were determined by the number of organisms in any one group. For example, we included seven protists in the master list which comprised one set. Fish, on the other hand, were too numerous to be included in only one set so they were divided into two groups to make two sets of seven fish each for the students to view.

After the video editing was complete, I added the musical

soundtrack on another track of the tape. Mr. Bolhuis is a fan of classical music and had numerous recordings on compact disc. Once I determined the playback time for each set of organisms, classical selections of nearly the same length were chosen by Mr. Bolhuis. Obviously, most of the music was chosen on the basis of its appeal and not only the length of the composition. The editing equipment used to produce the video track did not have the ability to lay audio tracks over the existing video. A local cable television station, WCET, is housed within our high school and has a full production and recording studio. Enlisting the help of Todd Bialas of WCET, Mr. Bolhuis and I recorded the audio on top of the video. A listing of the names of the compositions and the composers of each of the pieces was then written to be distributed to the students.

Plans for using portions of the video as part of semester and final exams made it necessary to also produce exam tapes. The first semester exam tape included clips of organisms from the first half of the list with numbers 1 - 20 superimposed in the bottom corner of the picture. The numbers corresponding to the number of test questions for the exam. This tape was produced by simply editing from the completed master tape. That way students would see the same clips on the exam that they had studied throughout the semester. Since the music was also recorded, it provided a nice

prompt to students during the exam to look up from their papers to see the next organism since the music changed every time a new organism appeared. The final exam tape was prepared in the same manner but included organisms from the entire list and was numbered 1 - 40.

Daily Classroom Procedure

Once the video and corresponding manual were in place the majority of the work was complete. The day to day implementation of this teaching procedure can be accomplished through the use of two student volunteers per class. Once they have established the routine of how to run "D of L" as I call it, the four minutes or so at the beginning of the class period becomes a time to record attendance and arrange papers and/or materials for the hour. The tasks performed by the volunteers does not interfere with their ability to learn as well as the rest of the class but gives them an important role to fill in the classroom, something which can be very valuable for some students. On more than one occasion I have hand picked students who have had difficulty settling in once class is supposed to start and gave them one of these simple tasks. I have noticed that it helps them to focus their attention on the video procedure.

Once the clock clicks to the appropriate start time for the hour the class has exactly one minute to have their manuals open, the lights off, the video playing, and absolutely no talking. One student has the simple job of turning off the lights in the classroom and making sure that the lights in the lab area of the room are on so that it is not completely dark. Actually this serves more than the purpose of eliminating glare on the TV screens. The semi-darkness along with the classical music of the video tends to calm and relax a restless group. At times, I have resorted to keeping the lights on in my first hour classes to keep them awake and having the lights off before my fifth and sixth hour classes even enter the room to calm them. There is a lot to be said for classroom environment and behavior even at the high school level.

When the lights are off and all students have their manuals out with no talking, the second volunteer may start the video. This person needs to be somewhat of a leader in the classroom since they determine when the video starts. If too much talking is taking place they need to quiet the class before they may start. It is interesting to see the different styles some students use to accomplish this. I've seen kids quietly ask the class to be quiet, start the video and then pause until all talking stops, or yell until the rest of the class heeds the warning. Obviously I avoid the last option by explaining to

the class that if they do not start within the first minute, they will remain after class to make up the minute missed with the exception of the student volunteer trying to quiet them. This usually occurs once or twice within the first week or two of school but they quickly catch on that I am serious about my expectations and will not let anything slip. If a student does begin talking during the video I take appropriate action immediately. Before long the prompt start of class using the video becomes second nature and I no longer need to keep a watchful eye on them every day.

As stated previously, a typical set consists of 8 to 10 organisms which requires four to five minutes of playing time per day. At the conclusion of a set the blue screen appears which is the clue for the volunteer to hit the rewind button on the remote control. Once the video has been returned to its original starting position, it is ready for the next hour to view it. The lights are then turned back on and I am ready to start the day's lesson.

This procedure continues every day for approximately eight or nine class days so that students have ample opportunity to learn to identify, classify, and justify all of the organisms in the set. Since I walk them through the first day of each set and say a few words about each of the organisms and point out their key identifying characteristics, most students have learned to identify them all

within just a couple of days. Classification and justification can be a bit more difficult, and students use the remaining time to learn these aspects of each organism. After learning to identify them, some students will use the time each day to practice writing the names of the organisms as they appear in the video, since I ask all of the common names of the organisms to be written completely and correctly. They usually groan about this at first, but it too becomes second nature in short order.

After eight to nine days a quiz over the set will be given in place of watching the video and is the bell work for that day. The quizzes are given orally and consist of ten questions. Three questions deal with classification, three are identification, and three questions are about the justification of the organisms. The tenth question is either the name of the composer of the music for the set or the name of the composition itself. Most students look at the last question as the "gimme question" since it is basically a free point to anyone who is paying attention.

Diversity of Life quiz scores account for twenty percent of a student's grade in biology. This is standard for all biology teachers in our school. Grades are typically higher in this category than the class average for other parts of the course, such as test grades and homework grades. This is intentional as our biology course is a

college prep program and standards are set quite high. We make numerous provisions for students with learning difficulties and D of L scores can really help out a student's grade if they are willing to do the work necessary during that four to five minute time frame each day.

At the end of the semester a comprehensive test targeting all organisms viewed to that point is administered. It is given in addition to the regular exam for the course and counts for twenty percent of the exam grade. It is broken into three sections, Identification, Classification, and Justification. The identification exam is on video and has thirty second clips of twenty organisms with numbers superimposed in the corner of the screen. Students use the master list from the D of L manual as their answer sheet and simply fill in the number on the screen in front of the organism's name on that list. They are always very thankful that they are not required to write the names correctly on the exam, as they do during oral quizzes! The justification portion is on paper and is nothing more than the justification information of twenty organisms from the manual rewritten into a test. Again, students use the master list as an answer sheet and write the number of the justification in front of the organism's name on the list. The classification portion consists of a photocopy of pages 2-5 of the manual (see Appendix A)

with classification names missing and replaced by a number. Students are given an answer key which contains a word bank from which they must choose the appropriate name to fill the space left blank. This portion consists of ten questions and has proven to be the most difficult of the three for the majority of students. I believe that this is due to the fact that students are more interested in identification and justification than they are classification. This method of assessment is valid since it addresses all aspects of the D of L procedure.

The final exam at the end of the year follows the format of the semester exam described above but has twice as many questions and covers the entire manual and organism list (See Appendix A). Students were thankful that this was part of their exam grade since many score very high on this portion of the exam.

EVALUATION

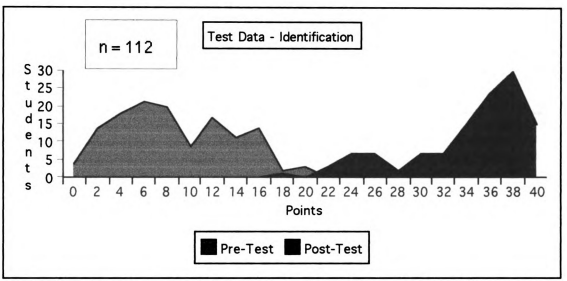
Test Data Analysis

To evaluate the effectiveness of The Diversity of Life at the Bell, a pre-test, post-test, and a student evaluation was administered. In addition to gathering raw scores before and after the year long program, information regarding student's attitudes and enjoyment of nature was collected. It is difficult to measure values, attitudes, and enjoyment scientifically. Rather, an attempt was made to standardize student responses on a survey by carefully describing the rating scale used and the significance of each score. Test scores and survey information were collected from my students only, although all members of the biology department used the D of L procedure.

A pre-test was given at the beginning of the school year to test student knowledge regarding identification, justification, and classification of common West Michigan organisms. Over the course of two days students were given a three part exam, the same exam which was to be given to them at the conclusion of the year. Obviously, I did not advertise this fact as the final exam would be a part of their grade, unlike the pre-test. As described earlier (See Classroom Procedure), the identification exam consisted of forty 30 second video clips of the organisms from the master list. Students

were asked to identify as many as possible by marking the number of the clip next to the name of the organism on the answer sheet. The following graph illustrates both the pre-test scores as well as the post-test scores from the same exam given at the end of the year.

Figure 1 - Pre-Test vs. Post-Test Identification Scores

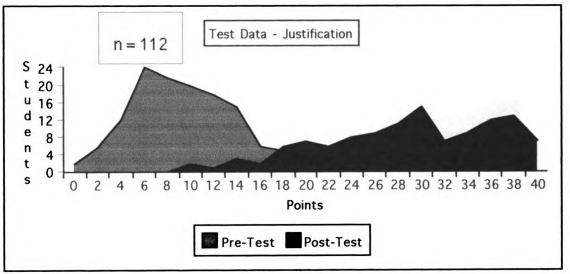


Pre-test scores are shown in gray, while post-test scores are shown in black. Pre-test scores on Identification had a median score of 10 out of 40 with a standard deviation of 4.5. Post-test scores on Identification had a median score of 30 out of 40 with a standard deviation of 7.5. This shows a significant increase in student knowledge regarding Identification.

Student knowledge of Justification, or the role an organism

plays in the environment, was also measured using the pre-test and post-test. Students were asked to read the justification of an organism (copied from the manual) and write the number of the justification description next to the name of the organism on an answer sheet. The following graph illustrates pre-test and post-test scores on the Justification portion of the test. Please note that a different scale is used on the y-axis from the previous graph.

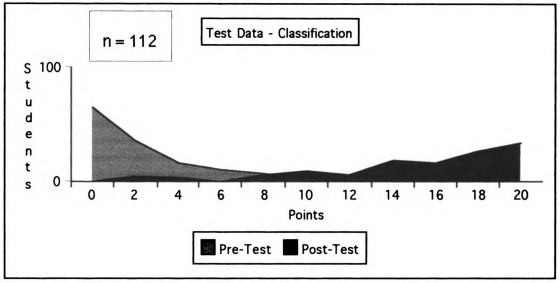
Figure 2 - Pre-Test vs. Post-Test Justification Scores



Pre-test Justification scores had a median score of 8 out of 40 with a standard deviation of 5.1. Post-Test Justification scores had a median score of 36 out of 40 with a standard deviation of 5.1 also. Again, its easy to see the significant increase in student knowledge.

Pre-test and post-test Classification scores were also collected using photocopies of pages 2-5 of the manual with select terms whited out. Students had to select from a word bank the appropriate term(s) to fill the gap. The following graph illustrates the test results for Classification. Please note the different scales on both axis from previous graphs.

Figure 3 - Pre-Test vs. Post-Test Classification Scores



Pre-test Classification scores had a median score of 2 out of 20 with a standard deviation of 2.5. Post-test Classification scores had a median score of 18 out of 20 with a standard deviation of 4.5. This category seems to show that students are most lacking in their knowledge of the classification of common organisms when they enter sophomore biology. This makes sense, since those students

who spend a lot of time outdoors and love nature tend to be able to identify and justify some organisms while they can classify very few. It is not knowledge which one obtains first hand in the field, but learns through reading and study in the life sciences.

Student Evaluations (Survey Results)

At the conclusion of the year, students were also asked to complete a survey indicating their views of the knowledge they gained as a direct result of the D of L procedure (See Appendix C). The survey consisted of two parts. In the first part, students were asked to rate their knowledge on a scale of 1 - 10 in each category (Identification, Justification, and Classification) prior to participation in the D of L procedure and after participation. The following three graphs illustrate the results of the first part of the survey.

Figure 4 - Survey Results for Identification

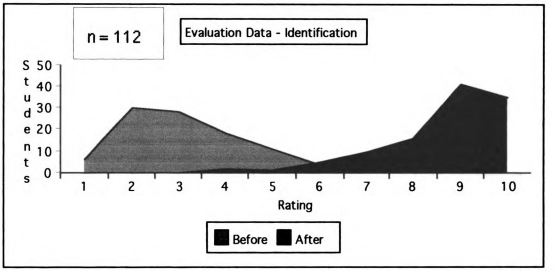


Figure 5 - Survey Results for Justification

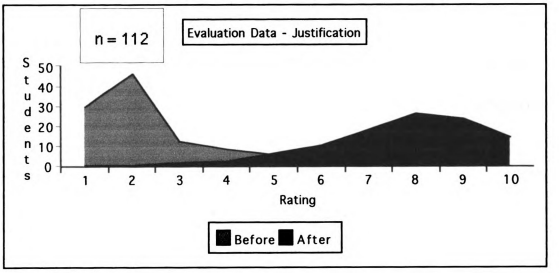
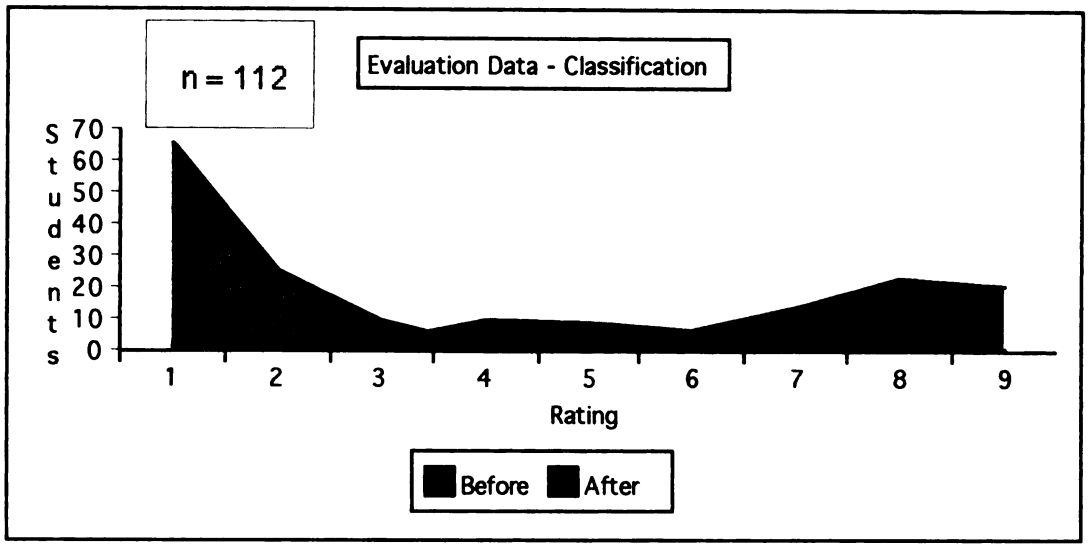


Figure 6 - Survey Results for Classification



An interesting comparison can be made between the graphs generated from the test data and the graphs generated from student responses to the survey. When Figure 1 is compared to Figure 4 (See Figure 7) you can see how closely student responses tracked the actual pre-test and post-test data. There is very little difference between the two graphs, indicating to me that students were completing the survey honestly and accurately. Students, therefore, do have an accurate perception of their learning and can identify those areas where they are strongest and those areas where they have weaknesses. The same result is obtained when Figure 2 is compared to Figure 5 (See Figure 8) or Figure 3 is compared to Figure 6 (See Figure 9). When comparing the graphs, please note that the

scales are not identical.

Figure 7 - Identification Comparison : Survey to Pre/Post Test Data

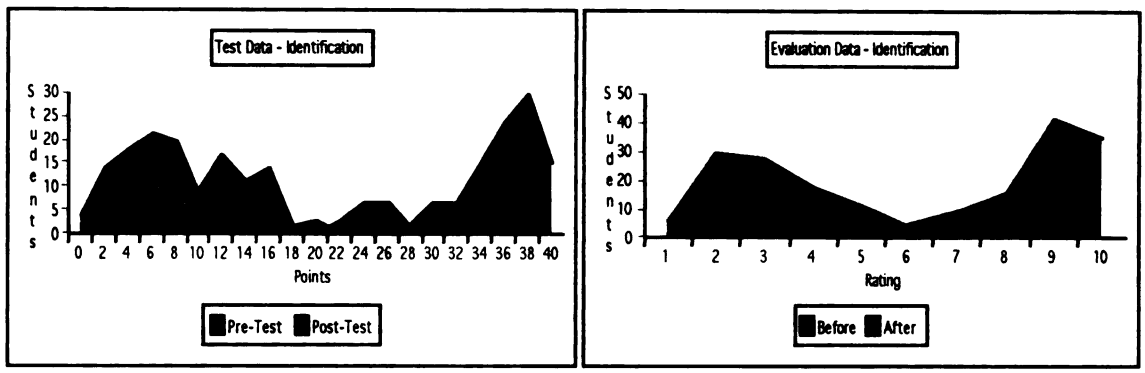


Figure 8 - Justification Comparison : Survey to Pre/Post Test Data

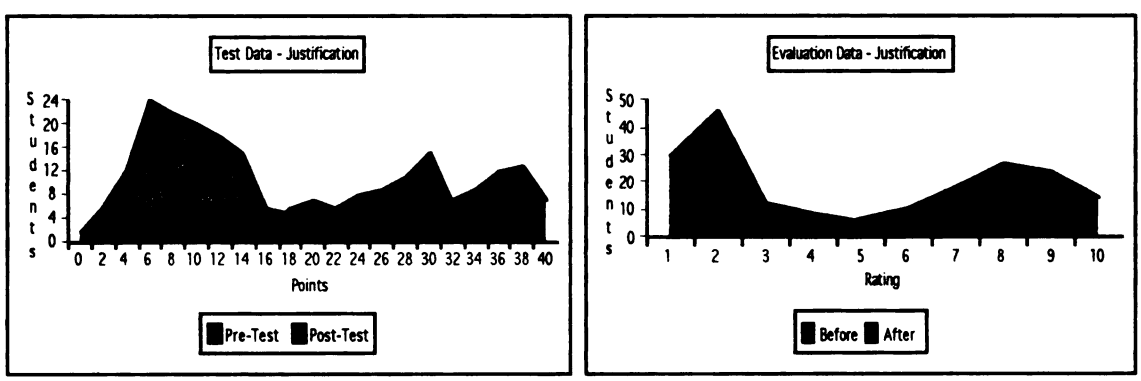
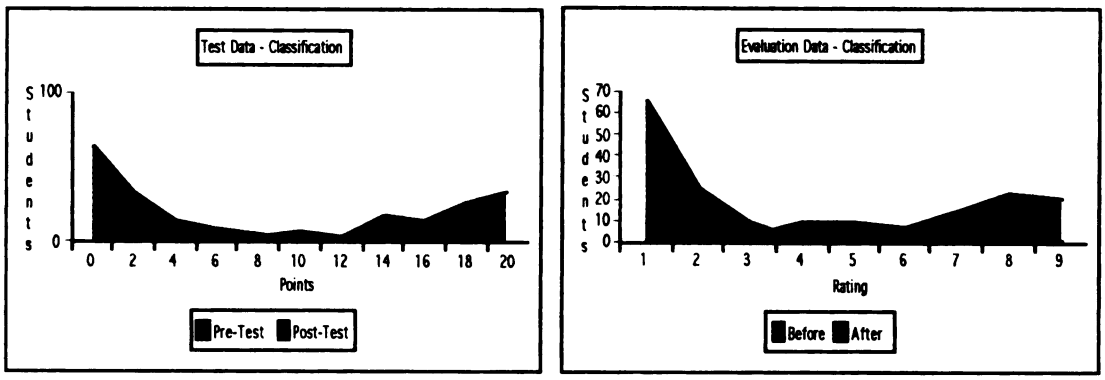


Figure 9 - Classification Comparison : Survey to Pre/Post Test Data



The second part of the survey consisted of two questions. Students were asked to rate the effect D of L had upon their view of nature and/or specific organisms as well as its effect upon their enjoyment of nature and being outdoors. They were also given room to write additional comments after each question. To encourage consistency, each number rating was carefully described. For example, a rating of 1 on the View of Nature was to indicate that D of L had no impact at all on a student's opinion of the usefulness or importance of any organism on the list while a rating of 10 would indicate that D of L had a significant impact on a student's view toward all of the organisms. Figure 10 illustrates the results of this part of the survey.

Regarding the Enjoyment of Nature rating, a student response of 1 was to indicate that D of L did not increase their enjoyment of

or interest in being outdoors while a rating of 10 would indicate that D of L was directly responsible for dramatically increasing their enjoyment. Figure 11 illustrates the resulting student ratings.

Figure 10 - Survey Results: View of Nature Rating

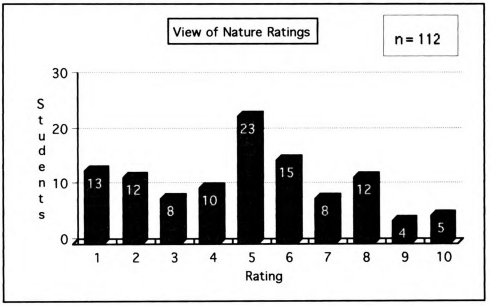
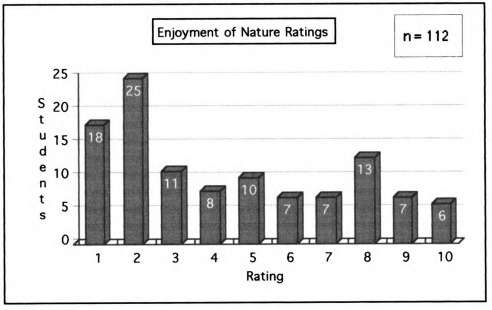


Figure 11 - Survey Results: Enjoyment of Nature Ratings



The results do not show that students had a dramatic increase in their enjoyment of nature or a drastic change in their views toward living things. However, in the space given to comment on their rating, many students stated that they already loved being outdoors and did not see D of L as being the reason. Many also stated that they have what they consider to be positive views toward living things and D of L really did not change their views a great deal. Numerous students expressed gratitude for the D of L procedure by making statements like, "Now I know what I'm looking at when we go for walks" or my favorite, "It's given me more to talk to my Dad about." However, some students take a different view and comment, "I like it because it helped my grade, but I don't know how I'll ever use it." My hope is that, in time, they will.

While not overwhelming, the survey results did indicate that the D of L procedure had some impact on student's enjoyment of nature and being outdoors. Thomas Lickona (1991) states that teaching values such as these is an important part of building character through education. As educators we have a certain responsibility to teach values but Lickona warns that we should carefully scrutinize which or whose values are emphasized. I think that anyone would agree that learning the value and importance of the natural world as a means of establishing a connectedness to

nature is not threatening to the values or morals of any race, religion, or otherwise defined group.

DISCUSSION AND CONCLUSIONS

Effective Aspects

While I will not take credit for the idea behind this project, the work that I have put into it has been very rewarding. Every hour that was spent in the field filming organisms or in the studio editing footage has translated into something positive in my classroom. Often educators are put in the position of making curricular changes or modifying their teaching practices for the sake of an administrator or curriculum director which may have little impact on students. Not that all change in education is bad; many good things often come out of those types of school wide improvement plans, but few result in the kind of change in classroom atmosphere and whole class enjoyment as has this D of L project.

The most effective aspects of D of L are that it teaches a great deal of content that would otherwise be overlooked with great efficiency. Students enjoy and learn while participating in the procedure each day. They develop a sense of responsibility since the learning is student driven. The teacher merely puts the process in motion and students run with it from there. It involves learning about something that is already familiar to them and expands upon it. D of L also engages some students who are normally not too

interested in biology but enjoy wildflowers or hunting and fishing, for example. They connect what we are doing in the classroom to the world outside of the room. I refer to organisms in the D of L video consistently throughout the course of the year and students are able to make those connections.

Other effective aspects of this program are centered around the teacher. Having your class begin precisely on time every day without having to lift a finger is tremendously beneficial. Of course the first few weeks of the course takes a lot of guidance, but after you've established the routine, problems are minimal. Time to record attendance or arrange papers and materials no longer takes place at the expense of the students. Students expect class time to be used wisely; this procedure ensures that the first few minutes are productive. They begin learning immediately, which sets the tone for the rest of the hour. I find the classical music and darkened room at the beginning of the hour relaxing and it helps me to forget about frustrations from previous hours and allows me to focus on the upcoming class and lesson for the day.

Ineffective Aspects

Along with the effective aspects there are, of course, some aspects that need improvement. There are still some organisms which I have

not caught on tape; the striped skunk, smallmouth bass, starnosed mole, and the opossum for example. Whenever we get to these organisms students see a still photograph in place of live video. I often hear groans of disappointment when this happens. I've noticed that students tend to ignore the TV when no live video is available.

The fact that students see only one example of some organisms is also a problem. Instead of learning how to identify the organism by its distinguishing characteristics, they memorize its name on the basis of where the organism is filmed, its size on the screen, what is in the background, etc.. For example, many students have learned to identify the Eastern White Cedar by the fact that a girl can be seen walking on the sidewalk in the background.

Future Challenges

More time needs to be spent in the field to complete the video. Numerous organisms are videotaped from a distance and closer views are required. This is something which simply requires more time and some degree of luck. Identification test tapes for each set could be made containing different views of organisms than students see during class. This would force them to study the distinguishing characteristics of each organism instead of merely memorizing the video clips. Bird songs could be added when appropriate to further

enhance the video of birds. As it is, the music soundtrack covers any sounds recorded while filming. The overall quality of the videotape can be improved by cleaner editing and better photography. It is my expectation that in future summers I'll have the time and the experience necessary to rectify some of these problems.

Other teachers and departments in our school have adopted the format of D of L to teach varying content in other courses. Our Earth Science teachers are in the process of producing a similar project teaching land formations. Instead of video clips of Chicory and Brown Headed Cowbirds, their students will see clips of Devil's Tower and the front range of the Rocky Mountains. Social Studies teachers have also developed the system to teach ancient Greek architecture and other sites of historic significance. I see these adaptations as an endorsement of the effectiveness of The Diversity of Life at the Bell. Another challenge will be to help other biology teachers institute similar programs into their curriculum.

The content of The Diversity of Life at the Bell addresses areas which are commonly overlooked in science education. The topics are important since they help our students develop connections and values toward nature and the out of doors in a very unique way. The use of video is exciting and educational for students. The daily procedure provides a consistant framework in

which students can construct new knowledge as well as alter their misconceptions. D of L also addresses different learning styles than conventional lessons and procedures. It is for these reasons that I believe that The Diversity of Life at the Bell should be a part of the life science curriculum in all schools.

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APPENDIX A

The Diversity of Life Manual

Biology Organism Checklist

1_____Rhinovirus
2_____HIV
3_____Bacillus Bacteria
4_____Coccus Bacteria
5_____Spirillum Bacteria
6_____Paramecium
7_____Didinium
8_____Vorticella
9_____Amoeba
10____Euglena
11____Volvox
12____Diatoms
13____Black Bread Mold
14____Morel Mushroom
15____Yeast
16____Powdery Mildew
17____Common Puffball
18____Shelf Fungus
19____Corn Smut
20____Amanita Mushroom
21____Athlete's Foot Fungus
22____Crustose Lichen
23____Foliose Lichen
24____Fruticose Lichen
25____Forgspit Algae
26____Moss
27____Liverwort
28____Horsetail
29____Brachen Fern
30____White Spruce
31____Eastern White Pine
32____Red Pine
33____Northern White Cedar
34____Eastern Red Cedar
35____Eastern Hemlock
36____Common Cat-Tail
37____Timothy
38____Smooth Crabgrass
39____Reed Canary Grass
40____Duckweed
41____Orange Day-Lily
42____Trillum
43____Trout Lily
44____Field Garlic
45____Sassafras
46____Eastern Cottonwood
47____Weeping Willow
48____Black Cherry
49____Sugar Maple
50____Silver Maple
51____White Birch
52____American Elm
53____American Beech
54____White Oak
55____Red Oak
56____White Ash
57____Sycamore
58____Staghorn Sumac
59____Poison Ivy
60____Queen Anne's Lace
61____Common Milkweed
62____Common Ragweed
63____Chicory
64____Bull Thistle
65____Hawkweed
66____Goldenrod
67____Common Dandelion
68____White Clover
69____Common Plantain
70____English Plantain
71____Common Mullein
72____Purple Loosestrife
73____Bouncing Bet
74____Bladder Campion
75____Spotted Knapweed
76____Spotted Touch-Me-Not
77____Teasel
78____Common Blue Violet
79____Planaria
80____Schistosome
81____Tapeworm
82____Roundworm
83____Zebra Mussel
84____Pond Snail
85____Earthworm
86____Eastern Daddy-Long-Legs
87____Common Garden Spider
88____Crayfish
89____Mayfly
90____Dragonfly
91____Damselfly
92____Grasshopper
93____Cricket
94____Water Strider
95____Earwig
96____Cicada
97____Spittlebug
98____Beetles
99___Tiger Swallowtail Butterfly
100___White Butterfly
101___Sulfur Butterfly
102___Monarch Butterfly
103___Gypsy Moth
104___Eastern Tent Caterpillar
105___Crane Fly
106___Mosquito
107___House Fly
108___Deer Fly
109___Bald-Faced Hornet
110___Carpenter Ant
111___Formicid Ant
112___Honey Bee
113___Bumble Bee
114___Rainbow Trout
115___Northern Pike
116___Carp
117___White Sucker
118___Brown Bullhead
119___Channel Catfish
120___Smallmouth Bass
121____Largemouth Bass
122____Pumpkinseed Sunfish
123____Bluegill
124____Rockbass
125_____Crappie
126____Walleye
127____Yellow Perch
128____American Toad
129____Green Frog
130____Northern Leopard Frog
131____Spotted Salamander
132____Common Snapping Turtle
133____Eastern Box Turtle
134____Eastern Painted Turtle
135____Eartern Garter Snake
136____Mute Swan
137____Canada Goose
138____Mallard
139____Wood Duck
140____Red Tailed Hawk
141____American Kestrel
142____Great Horned Owl
143____Great Blue Heron
144____Downy Woodpecker
145____Killdeer
146____Ring-Billed Gull
147____Rock Dove
148____Mourning Dove
149____Wild Turkey
150____Tree Swallow
151____Blue Jay
152____Common Crow
153____Black-Capped Chickadee
154____American Robin
155____Starling
156____House Sparrow
157____Red -Winged Blackbird
158____Common Grackle
159____Brown-Headed Cowbird
160____Cardinal
161____American Goldfinch
162____Purple Finch
163____White Breated Nuthatch
164____Slate Colored Junco
165____Tufted Titmouse
166____Opossum
167____Starnose Mole
168____Eastern Mole
169____Brown Bat
170____Raccoon
171____Striped Skunk
172____Woodchuck
173____13-Lined Ground Squirrel
174____Eastern Chipmunk
175____Eastern Fox Squirrel
176____Red Squirrel
177____Muskrat
178____House Mouse
179____Eastern Cottontail Rabbit
180____Whitetail Deer

Table Of Contents

Greek and Latin Root Index for Words Used in Classification

1.	amphi	both	38.	mama	breast
2.	anggeion	vessel	39.	molluscus	soft
3.	annulus	ring	40.	monos	single
4.	arthron	joint	41.	multus	many
5.	askos	bag	42.	mykes	fungus
6.	autos	self	43.	nema	thread
7.	avis	bird	44.	opsis	appearance
8.	basis	base	45.	osteon	bone
9.	bios	life	46.	para	beside
10.	bryon	moss	47.	pelekys	hatchet
11.	cestus	girdle	48.	phos	light
12.	cheilos	lip	49.	phyton	plant
13.	chele	claw	50.	platys	flat
14.	chloros	grass green	51.	pous	foot
15.	chorde	string	52.	pro	before, first
16.	chrysos	gold	53.	pteris	fern
17.	cilium	eyelid	54.	repere	to crawl
18.	conus	cone	55.	sar	flesh
19.	crusta	shell	56.	schisto	split
20.	deuteros	second	57.	soma	body
21.	di	two	58.	sphen	wedge
22.	dia	through	59.	sperma	seed
23.	diploos	double	60.	synthesis	put together
24.	eidos (toda, lida)	form	61.	temnein (tom)	to cut
25.	eu	well	62.	trachia	wind pipe
26.	ferre	to bear	63.	trematodes	having holes
27.	flagellum	whip	64.	trophe	nourishment
28.	fungus	mushroom	65.	turbellae	stir, row
29.	gaster	stomach	66.	unus	one
30.	glene	eyeball	67.	vertebra	vertebra
31.	gymnos	uncovered, naked	68.	zygos	yoke
32.	helmins	worm			
33.	heteros	other			
34.	ichthys	fish			
35.	karyon	nucleus			
36.	keras	horn			
37.	kotyledon	cup-shaped hollow			

Kingdom Monera

prokaryotic; unicellular; autotrophic or heterotrophic organisms
(see reference pg. 16 in "Biology" by Miller & Levine)
example: bacteria

Kingdom Protista

eukaryotic; usually unicellular; autotrophic or heterotrophic organisms
(see reference pg. 16 in "Biology" by Miller & Levine)

I. Phylum Ciliophora = ciliates
example: paramecium

II. Phylum Zoomastigina = animal like flagellates
example: volvox

III. Phylum Sarcodina
example: amoeba

IV. Phylum Euglenophyta = flagellates
example: euglena

V. Phylum Chrysophyta = golden algae
example: diatom

Kingdom Fungi

eukaryotic; unicellular or multicellular; mostly decomposers
(see reference pg. 16 in "Biology" by Miller & Levine)

I. Phylum Zygomycota = conjugation fungi
example: black bread mold

II. Phylum Ascomycota = sac fungi
example: morels

III. Phylum Basidiomycota = club fungi
example: puffballs

IV. Phylum Deuteromycota = imperfect fungi
example: athlete's foot fungus

Kingdom Plantae

eukaryotic; multicellular; photosynthetic; autotrophs
(see reference pg. 16 in "Biology" by Miller & Levine)

I. Phylum Chlorophyta = green algae
   example: spirogyra

II. Phylum Bryophyta = bryophytes
   example: moss

III. Phylum Tracheophyta = vascular plants

   A. Subphylum Sphenopsida = horsetails
      example: horsetail

   B. Subphylum Pteropsida = ferns
      example: brachen fern

   C. Subphylum Spermopsida = seed plants

      1. Class Coniferae = conifers
         (called Gymnosperms = with "naked" seeds)
         example: eastern white pine

      2. Class Angiospermae = with "covered" seeds
         (called Angiosperms)

         a. Subclass Monocotyledonae = monocots
            example: grass

         b. Subclass Dicotyledonae = dicots
            example: sugar maple

Kingdom Animalia

eukaryotic; multicellular; typical heterotrophs
(see reference pg. 16 in "Biology" by Miller & Levine)

I. Phylum Platyhelminthes = flatworms

   A. Class Turbellaria
      example: planarian

   B. Class Trematoda = flukes
      example: schistosome

   C. Class Cestoda = tapeworms
      example: tapeworm

II. Phylum Nematoda = roundworms
   example: hookworm

III. Phylum Mollusca = mollusks

   A. Class Pelecypoda = bivalves
      example: clam

   B. Class Gastropoda = gastropods
      example: snail

IV. Phylum Annelida = segmented worms
   example: earthworm

V. Phylum Arthopoda = arthopods

   A. Subphylum Chelicerata = chelicerates
      example: spider

   B. Subphylum Crustacea = crustaceans
      example: crayfish

C. Subphylum Uniramia

1. Class Insecta = insects
   example: grasshopper

VI. Phylum Chordata = chordates

A. Subphylum Vertebrata = vertebrates

1. Class Osteichthyes = bony fishes
   example: bluegill

2. Class Amphibia = amphibians
   example: leopard frog

3. Class Reptilia = reptiles
   example: garter snake

4. Class Aves = birds
   example: cardinal

5. Class Mammalia = mammals
   example: whitetail deer

Monerans

Classification: Kingdom Monera

1. **Rhinovirus**
   Identification: Up to one half of all colds are caused by this group of viruses. "Rhino" refers to the nose, the entrance place into the body for cold viruses. Many rhinoviruses look like a soccer ball in shape. These parasitic, noncellular particles consist of a protein coat (capsid) that surrounds a core of nucleic acid (genetic material). Viruses, in general, infect a host cell by (a) taking over the protein-making machinery of the cell causing the cell to make thousands of copies of the virus (lytic infection) or (b) by incorporating their DNA into the cell DNA (lysogenic infection). In the latter case they may lay dormant for years. Experts disagree as to whether viruses are alive.
   Justification: This group of viruses has caused incredible annoyance to humans. Chances are at least one of you is sniffling and sneezing right now and most of you have had at least one cold in the past year. More debilitating viruses cause human diseases such as smallpox, polio, measles, AIDS, and influenza (flu). They have also been linked to cancer in animals. Antibiotics don't affect them, possibly because they aren't alive?!?

2. **Human Immunodeficiency Virus (HIV)**
   Identification: This well-studied lentivirus is round with many projections of protein sticking out from its surface. "Lenti" means "slow" which describes how slowly this virus works. It eventually destroys a key part of the immune system which leaves a person susceptible to some other killing disease resulting in AIDS (acquired immunodeficiency syndrome). Outside a host cell HIV is called a virion, which consists of a capsid surrounding two strands of RNA.
   Justification: Only the future will tell how great the impact this virus will have on the human population. The prevention of AIDS of HIV infection is simple. There is no need for anyone, except in rare cases, to contact them.

3. **Bacillus bacteria**
   Identification: Bacillus bacteria are rod-shaped, prokaryotic cells that can be arranged singly (mono), in pairs (diplo), in groups (staphlo) or in chains (strepto).
   Justification: Escherichia coli is a single bacillus bacterium found in large numbers in the large intestine of humans where it takes some vitamins we can't produce on our own.

4. **Coccus bacteria**
   Identification: Coccus bacteria are spherical-shaped, prokaryotic cells that can be arranged single (mono), in pairs (diplo), in groups (staphlo) or in chains (strepto).
   Justification: Streptococcus pneumoniae causes pneumonia while Streptococcus pyogenes causes strep throat. Neisseria gonorrhea causes gonorrhea.

5. **Spirillum bacteria**
   Identification: Spirillum bacteria are spiral-shaped, prokaryotic cells that can be arranged single (mono), in pairs (diplo), in groups (staphlo) or in chains (strepto).
   Justification: Treponema pallidum causes syphilis.

Protists

Classification: Kingdom Protista
Phylum Ciliophora

6. **Paramecium** sp..
Identification: Paramecium are large, microscopic organisms shaped like a slipper with rows of cilia used for propulsion and gathering food. Most species have both macronuclei and micronuclei and are found in most freshwater ecosystems.
Justification: These large protists are an important link in a balanced aquatic ecosystem serving as a food source for larger invertebrates while preying upon smaller ones.

7. **Didinium** sp..
Identification: This ciliate has an oval-shaped body with two ciliary bands. It has a mouth on one end.
Justification: A few of these protists can eliminate an entire population of paramecia in a few days and play a role as predator for such organisms. They also serve as prey for larger organisms in aquatic environments.

8. **Vorticella** sp..
Identification: Although over 100 species of this genus exist, a typical organism is often stalked with a funnel-shaped body at one end. A row or two of cilia on top look as if they are rotating.
Justification: This organism preys upon other microorganisms and also is preyed upon. Some species are commonly attached to fish in a symbiotic relationship.

Classification: Kingdom Protista
Phylum Sarcodina

9. **Amoeba** sp..
Identification: This is an ammorphous protist which lacks cilia or flagella but moves by means of pseudopods or "false feet". The ameboid movement is used to engulf food particles which it then digests. These protists are common in most freshwater habitats.
Justification: Amoeba are important protists for making a diverse microscopic ecosystem, which in turn directly affects the health of the entire ecosystem.

Classification: Kingdom Protista
Phylum Euglenophyta

10. **Euglena** sp..
Identification: This long, microscopic protist has two unequal flagella. It appears green due to its chloroplasts which allow it to be a photosynthetic autotroph. A red eye spot near the base of the flagellum is often noticeable. They are found in most freshwater ecosystems.
Justification: Being a producer makes this protist important in forming the base for microscopic aquatic ecosystems.

Classification: Kingdom Protista
Phylum Zoomastigina

11. **Volvox** sp..
Identification: Organisms in this genus are colonial, often forming a cylindrical colony which moves around like a slowing spinning ball. Chloroplasts make this protist look green.
Justification: These organisms will often occur in such large numbers in lakes that the water takes on a green appearance.

Classification: Kingdom Protista
Phylum Chrysophyta

12. **Diatoms**
Identification: This group of protists is extremely diverse but most have intricate cell walls made mostly of silicon (the main ingredient in glass). The walls are shaped like two sides of a petri dish. They are photosynthetic and found mostly in aquatic habitats.
Justification: Diatoms are responsible for producing a large portion of the available oxygen in our atmosphere and form an important base in any aquatic food web.

Fungi

Classification: Kingdom Fungi
Phylum Zygomycota

13. **Black bread mold**
Identification: This fungus is often seen as a fuzzy mass of delicate hyphae consisting of rhizoids which anchor the fungus and stolons which spread the fungus out. Black sporangia, round spore-producing structures, are usually visible.
Justification: Although valuable as a decomposer, this fungus was once a source of cortisone and other medicines.

Classification: Kingdom Fungi
Phylum Ascomycota

14. **Morel mushroom**
Identification: The honeycombed head of this mushroom is attached directly to a whitish stalk in most species and can be confused with the "false" morel which has a head not directly fused to the stem. They are found here in early May in moist, wooded environments.
Justification: Morels are the most sought after mushroom in the U.S. because of their excellent taste and provide recreation for thousands of people in our state.

15. **Yeast**
Identification: This round, colorless, single-celled fungus is microscopic and occurs naturally in the nectar of flowers and on fruits and leaves.
Justification: Yeast are extremely valuable for baking and brewing alcoholic beverages and have become invaluable for a variety of uses in genetic engineering.

16. **Powdery Mildew**
Identification: These fungi take their name from the white, powdery appearance on different parts of common plants such as grass, fruit trees, and vegetables.
Justification: Mildews cause extensive damage to crops because their hyphae penetrate the plant causing decreased production and death.

Classification: Kingdom Fungi
Phylum Basidiomycota

17. **Common puffball**
Identification: The oval, white cap of this fungus has a surface that feels like fine felt when it is growing but turns brown when mature with spores exiting through a hole in the top like a puff of smoke. It is most commonly found in open woods, meadows, and pastures.
Justification: This fungus serves as a decomposer. A close relative of the species, the giant puffball, provides excellent eating when young, usually sauteed or batter fried.

18. **Shelf fungus**
Identification: Although a great variety of shelf or bracket fungi exist, most appear as layered, leathery caps which form a shelf attached to sticks, stumps and logs of hardwood trees.
Justification: This is one of the most common groups of fungi in North America and important in the forest ecosystem as a decomposer of trees.

19. **Corn smut**
Identification: This fungus is easily observed on all parts of mature corn plants. It first appears as a glistening, greenish to silver-white enlarged area but later looks like a black, greasy or powdery mass - thus the name "smut".
Justification: Corn smut will decrease corn production up to 10% and is difficult to control. Most promise in combating this fungus is with developing smut resistant corn.

20. **Amanita Mushroom**
Identification: This group of fungi contains individuals that are often brightly colored. They have a secondary veil below the cap and often a swollen base.
Justification: These mushrooms are the most poisonous in our area. Some species, with common names like "destroying angel" and "panther fungus", can be fatal even if only a little ingested.

Classification: Kingdom Fungi
Phylum Deuteromycota

21. **Athlete's foot fungus and ringworm**
Identification: This fungus is identified by observing its effects on humans as the fungus grows in the outer layers of the skin. The fungus causes red, open sores when growing between the toes (athlete's foot) and a raised, red, circular area on the scalp (ringworm).
Justification: This fungus causes discomfort to many people but can be killed using any of a variety of fungicides.

Lichens

Classification: Lichens are composed of two organisms from two kingdoms - an algae and a fungus - living in a mutualistic relationship. The alga is often green and the fungus is typically an Ascomycete. They are grouped according to appearance.

22. **Crustose**
Identification: This form is flat and crust like.
Justification: All lichens are pioneer organisms which are valuable in breaking down rock to form soil. Some are used in tanning and dyeing processes, in the perfume industry and for making litmus used as an acid/base indicator in chemistry.

23. **Foliose**
Identification: This form is leaf like.
Justification: All lichens are pioneer organisms which are valuable in breaking down rock to form soil. Some are used in tanning and dyeing processes, in the perfume industry and for making litmus used as an acid/base indicator in chemistry.

24. **Fruticose**
Identification: This form is shrublike and grows upright. British Soldier Lichen is a striking example of this type.
Justification: All lichens are pioneer organisms which are valuable in breaking down rock to form soil. Some are used in tanning and dyeing processes, in the perfume industry and for making litmus used as an acid/base indicator in chemistry.

Plants I

(non-vascular & spore-producing vascular)

Classification: Kingdom Plantae
Phylum Chlorophyta

25. **Frogspit algae**
Identification: The most common "frogspit" alga in our area, Spirogyra sp., is filamentous with spiraling chloroplasts and forms dense mats, usually in stagnant water. The oxygen produced gives the mat a foaming appearance, thus its common name.
Justification: This alga provides cover and food for invertebrates and, being a producer, is important in aquatic ecosystems.

Classification: Kingdom Plantae
Phylum Bryophyta

26. **Moss**
Identification: Lacking vascular tissue, these plants must remain short so all cells can obtain water and minerals. They are often velvety in appearance and found growing in cool, damp places on soil, rocks, and trees.
Justification: This producer helps hold the soil thereby preventing erosion and also plays a role in the decaying process. It is used as a decorative plant in landscaping and as a soil enhancer for gardens.

27. **Liverwort**
Identification: Most of these bryophytes closely resemble mosses. Most look like little green leaves growing close to the ground in areas that are constantly wet. The major difference is how they are attached to the stem. Marchantia sp. has large air-filled leaves giving them a spongy appearance.
Justification: Although not as common as moss, liverworts act as ground cover in wet environments.

Classification: Kingdom Plantae
Phylum Tracheophyta
Subphylum Sphenopsida

28. **Horsetail**
Identification: This hollow, green-stemmed plant has whorls of branches giving it a bushy appearance in some species or a snakelike appearance in others. It prefers a moist habitat and is one of the most common plants in the Northern Hemisphere.
Justification: This producer was once used as a scouring material for pots and pans because of its rough texture. It is poisonous to livestock.

Classification: Kingdom Plantae
Phylum Tracheophyta
Subphylum Pteropsida

29. **Brachen Fern**
Identification: The large blades of this spore-producing plant always divide into thirds making it easy to identify. It is found most commonly in woods and clearings and is one of the most common plant species in the world.
Justification: Because of its soft, dry texture in the fall of the year this plant makes an excellent substitute for toilet paper! It is also an important producer in most forest ecosystems.

Plants II
(gymnosperms)

Classification: Kingdom Plantae
Phylum Tracheophyta
Subphylum Spermopsida
Class Coniferae

30. **White Spruce**
Identification: The .5-.75 in. needles of this evergreen have whitish lateral lines and are arranged mainly on the upper side of the twig. They have a skunk-like odor when crushed and are common in poor soil areas.
Justification: This is the most important tree species in Canada with the wood being used for construction and musical instruments. Deer, rabbits, and grouse browse this producer in the winter.

31. **Eastern White Pine**
Identification: The needles of this conifer are 3-5 in. long and are in bundles of 5. The needles are soft and flexible and the bark has rectangular plates. The tree grows away from the prevailing wind giving a windswept appearance and is common in many soils.
Justification: This pine was the major lumber tree in Michigan from 1850-1900 and is still valuable for its wood. It is the state tree of Michigan.

32. **Red Pine**
Identification: This gymnosperm has needles in bundles of 2 which are 4-6 in. long and break readily when doubled. The bark has irregular plates and the tree prefers sandy soil.
Justification: This is the most extensively planted tree in Michigan because the wood is very useful in general construction and for poles.

33. **Northern White Cedar**
Identification: This evergreen has flattened branchlets with aromatic scales, shreddy bark and prefers poorly drained soil.
Justification: The wood is used for posts, shingles, and log cabins. This is the most important winter food for deer in the north and also is a popular ornamental species.

34. **Eastern Red Cedar**
Identification: The leaves of this evergreen are scale-like with some being sharp, others flat. The tree is narrow pyramidal in shape and prefers well-drained soils.
Justification: Red cedar wood is very fragrant and used in cedar chests. The tree is planted extensively as an ornamental.

35. **Eastern Hemlock**
Identification: Hemlock leaves are flat, round tipped, and spirally arranged around the stem. Two whitish bands are found on the underside of each leaf. They live in poorly drained soils, are highly shade tolerant and often live 600 or more years.
Justification: The bark of a hemlock was a source of tannin used in the leather industry. Trees are now planted as ornamentals and the wood is important as lumber.

Plants III
(angiosperms)

Classification: Kingdom Plantae
Phylum Tracheophyta
Subphylum Spermopsida
Class Angiospermae
Subclass Monocotyledonae

36. **Common Cat-tail**
Identification: This tail monocot has flat, sword-like leaves with a club-shaped spike of yellow/brown flowers at the end of a round stalk and are common in ditches and marshes.
Justification: The roots, stems and flower heads of this plant can be eaten by humans. Large stands are important for red-winged blackbirds, muskrats, and waterfowl.

37. **Timothy**
Identification: This grass has a dense grouping of flowers (panicle) which is spikelike and stiff. It appears bristly because each spikelet is fringed with short hairs. It is common throughout the United States.
Justification: Timothy is an important hay meadow grass.

38. **Smooth Crabgrass**
Identification: This monocot has forked, finger-like stalks which lack hairs. The narrow leaves are 2 to 6 inches long and 1/4 of an inch wide. It rapidly takes over any bare soil and can be found in lawns, ditches and disturbed areas.
Justification: Most people desire to destroy this lawn weed yet the seeds of this producer are very valuable for songbirds.

39 **Reed Canary Grass**
Identification: This grass is tall with broad leaves. Its panicle is dense and cylindrical or thimble-shaped. This species forms dense colonies in marshes and along ditches.
Justification: This grass is planted for erosion control on farm waterways. Some forms are planted as ornamentals.

40. **Duckweed**
Identification: This small, single-leafed plant is found floating in masses on ponds, lakes, and ditches. A single root hangs down about an inch into the water.
Justification: This monocot is an important food source for waterfowl.

41. **Orange Day-lily**
Identification: The large, orange, funnel-shaped flowers found on a leafless stalk make this monocot easy to identify. Each flower lasts for only one day. They grow from 2 to 4 feet high and are found most commonly in wet ditches.
Justification: Along with beautifying the countryside the flower buds can also be cooked and eaten like green beans.

42. **Trillium**
Identification: These large, showy, woodland flowers are easily recognized because they have three large petals of various colors, although our most common species is white to pink.
Justification: Trilliums signify spring and provide beauty to the woods. Although protected now, Native Americans used this plant as a food source.

43. **Trout-lily**
Identification: This woodland plant is easily recognized in the spring because of its characteristic mottled leaves. Although very common in the spring, by mid-summer there will be no above ground trace of this plant because the leaves wither soon after it flowers in May.
Justification: This is another plant that adds beauty to spring hikes in the woods. The plant has also been used as a food source.

44. **Field Garlic**
Identification: This monocot has dark green, tubular leaves that grow skyward. Crushing a leaf reveals the strong onion odor which distinguishes it from a similar looking species.
Justification: Although very strong, the leaves and root of this plant have been eaten to add the onion flavor to food.

Plants IV
(angiosperms-dicots)

Classification: Kingdom Plantae
Phylum Tracheophyta
Subphylum Spermopsida
Class Angiospermae
Subclass Dicotyledonae

45. **Sassafras**
Identification: Some leaves of this tree are unlobed, some 2-lobed and some 3-lobed, all of which turn brilliant colors in the fall. The roots, stems, and leaves are spicy aromatic and the limbs look like they bend and reach for the sky. It is most commonly found along fence rows, old fields and roadsides.
Justification: Oil from this producer has been used to flavor medicines, candy, root beer, tobacco, and soap.

46. **Eastern Cottonwood**
Identification: The leaves are triangular in shape with coarse teeth and are dark green on top and pale green below. They are often found along banks of streams and shed "cotton" in the spring.
Justification: The wood from this tree is not highly valued and used mostly for pulpwood. Young trees, however, provide valuable habitat for many animals.

47. **Weeping Willow**
Identification: The long, slender, and finely-toothed leaves of this tree are shed with the branchlets which makes it an undesirable plant for landscaping. It prefers open sunlight with wet soil and can be identified from a distance because of the distinctive drooping branches which gives it a "weeping" form.
Justification: Although the wood i s not valuable, this tree is often planted as an ornamental in parks.

48. **Black Cherry**
Identification: Black cherry leaves are oval with fine teeth and have a small red gland near the base. The bark has a texture of burnt potato chips and the twigs have a bitter almond smell when crushed. It is common on disturbed, sandy sites.
Justification: This tree is poisonous to browsing livestock but the wood is highly valued for furniture and gunstocks.

49. **Sugar Maple**
Identification: The leaves are opposite, not alternate, like most trees and are 5-lobed with smooth edges. The fruit is paired "helicopter" and the leaves turn bright colors in the fall.
Justification: This tree is the principal source of maple syrup and the wood is used for furniture, flooring, and musical instruments.

50. **Silver Maple**
Identification: The leaves are opposite and toothed,having 5 lobes but with deeper cuts than a sugar maple. They are green on top with a characteristic silver color below. The twigs break readily and smell rank.
Justification: The wood from this producer is used for boxes and crates.

51. **White Birch**
Identification: The oval leaves of this tree are finely toothed and found on long shoots or in groups of 3's on short shoots. This tree is most easily identified by the white, peeling bark.
Justification: White birch are often planted as ornamentals and the wood is used for plywood.

52. **American Elm**
Identification: The leaves are doubly toothed and rough on top with veins that are unforked. The trunk often divides into a few large branches 10-15 feet above the ground.
Justification: Elm wood is commonly used for barrel and furniture making.

53. **American Beech**
Identification: The toothed,oval leaves have an unbranching vein ending at each tooth. Kids often carve initials in the gray, smooth bark. The nut has a brisly husk and the tree is common in upland forests.
Justification: Beech nuts make excellent eating and the wood is used for tool handles and furniture.

54. **White Oak**
Identification: The leaves of this tree have rounded tips with deep cuts. Limbs appear gnarled and twisted in old trees and the sweetish acorn has a large cup. Trees are common in sandy upland areas.
Justification: The acorns of this producer provide important food for squirrels, birds, deer, and other wildlife. The wood is very hard and valued for furniture and flooring.

55. **Red Oak**
Identification: The dull green leaves have pointed tips and the bitter acorn has a shallower cup than the white oak.
Justification: Red oak wood is hard and used for furniture and floors and the tree is sometimes used in landscaping.

56. **White Ash**
Identification: This tree has compound leaves which are opposite with leaflets being pale or whitish on the under surface. I t does not grow well in wet soils.
Justification: The wood of ash is very strong and is used for making various sporting goods and tool handles.

57. **Sycamore**
Identification: This is the largest deciduous hardwood tree in North America and is easily distinguished by its characteristic light, scaly, mottled bark. Seeds are clustered in hanging balls which persist through the winter. It prefers wet, open areas.
Justification: Sycamores are easily transplanted and are planted as ornamentals. The wood is a butcher's first choice for a meat block.

58. **Staghorn Sumac**
Identification: The compound leaves of this shrub-like plant are alternate with the leaflets being dark green on top. Because the twigs and petioles are velvety hairy and the trunks are twisted, it has an "antlered" appearance - thus its name. The fruit is reddish-brown and covered with hairs. It prefers sandy soil.
Justification: The fruit is an important food for songbirds and game birds and can be made into a sweet drink.

59. **Poison Ivy**
Identification: This plant is seen as ground cover or as a vine. The compound leaves have three leaflets of irregular shape which turn red in the fall.
Justification: Poison ivy contains an oil that may cause severe skin inflammation. The fruit of this producer, however, is eaten by many songbirds and game birds.

60. **Queen Anne's Lace**
Identification: Lacy white flowers form a flat flower head in this plant. The leaves are fern-like and it is found in fields and waste places everywhere.
Justification: Although considered a troublesome "weed" by some, the taproot can be cooked and eaten and is also called "wild carrot".

61. **Common Milkweed**
Identification: The purple-pink flower clusters which eventually give way to rough-textured green pods filled with seeds covered with silkhair are characteristic of this plant. The stems exude a white, milky juice when injured as described in its common name. Milkweed is found in fields and waste places.
Justification: This plant is the sole food source for the monarch butterfly larvae.

62. **Common Ragweed**
Identification: This plant has a coarse, hairy stem with highly dissected leaves. The flowers are small, yellow/green and are found in long clusters. Ragweed is very common in fields and waste places.
Justification: Pollen from this plant is the major cause of "hay fever" , a common and annoying allergy.

63. **Chicory**
Identification: Flowers of this common roadside plant are stemless, blue and square-tipped and last for only one day.
Justification: Root s of this producer can be roasted and ground as a coffee substitute, a practice common in Europe.

64. **Bull Thistle**
Identification: This prickly plant has pink-purple flowers and is found most commonly in pastures and waste places.
Justification: Because the flowers are rich in nectar they are important for bees and butterflies and the seeds are a preferred food of goldfinches.

65. **Hawkweed: Yellow or Orange**
Identification: Both hawkweeds have a hairy, leafless stem with either orange or yellow dandelion-like flowerheads at the end. They are both found commonly in fields and clearings.
Justification: There was an ancient folk belief that hawks ate this plant to aid their vision.

66. **Goldenrod**
Identification: Goldenrod flowers are in clusters of small yellow flowerheads found near the end of long stalks. These plants are common in fields and thickets.
Justification: Insects form galls in the stem of this plant and the grubs in the galls are used as bait by ice fishermen. Some plant parts can also be used to make tea.

67. **Common Dandelion**
Identification: This plant has a stalk which bears a solitary yellow flower head with many ray flowers. The stem juice is milky and the name refers to the likeness of the leaf teeth to those of a lion.
Justification: Dandelion greens are used in salads and the roots contain a drug once used in liver treatment.

68. **White Clover**
Identification: This common lawn plant has white or pinkish spherical flower heads and three-part leaves (sometimes 4).
Justification: Superstitious types believe good fortune comes with finding a "four-leafed" clover.

69. **Common Plantain**
Identification: The greenish spike of small flowers is long and narrow on common plantain and the broad leaves are strongly ribbed. It is found as a "weed" in lawns and waste places.
Justification: The leaves of this producer are used in salads or for making tea and may provide relief from insect bites when crushed and applied to the wound.

70. **English Plantain**
Identification: Unlike its relative, the tiny greenish flowers of this plant are arranged in a cylinder-shaped head at the end of the stalk and it has more narrow leaves.
Justification: Although considered a lawn "weed", the seeds from this plant are sought by songbirds and are a favorite of rabbits.

71. **Common Mullein**
Identification: The large woolly stem with tightly packed yellow flowers of this plant makes it identifiable from a distance. It has thick, velvety leaves and is found in fields and waste places.
Justification: The leaves can be applied to skin to soothe sunburn or used for insulation in footwear.

72. **Purple Loosestrife**
Identification: Loosestrife stems have a spike of beautiful purple flowers easily recognized from a distance. It thrives in wetlands.
Justification: This recently introduced plant is aggressive and crowds out other species more valuable to wildlife. For this reason it is being actively researched in hopes of finding a method of control.

73. **Bouncing Bet**
Identification: This leafy plant has clusters of white or pinkish fragrant flowers and is found along roads and in disturbed areas.
Justification: Bouncing bet contains poisonous saponins which are soap-like substances, and the name bouncing bet is an old-fashioned name for washer woman.

74. **Bladder Campion**
Identification: The white flowers of this producer have deeply notched petals and are found in loose clusters. This plant is common in fields and along roadsides.
Justification: This plant was introduced from Europe near the turn of the century and now is a very common "weed".

75. **Spotted Knapweed**
Identification: This highly branched, wiry-stemmed plant with lavender flower heads is commonly found in fields and waste places.
Justification: This species is considered a troublesome "weed" by many people.

76. **Spotted Touch-me-not**
Identification: This familiar plant has bright orange flowers with dark spots and grows in dense stands in wet areas. The ripe seed heads explosively propel the seeds out away from the plant when touched.
Justification: Spotted touch-me-not, also called jewelweed, can be used medicinally and as a food source. The ripe seed heads are a favorite with children.

77. **Teasel**
Identification: The small lavender flowers of this dicot are clustered in a n egg-shaped group on a prickly stem. It is found in old fields and along roadsides.
Justification: The dried flower heads of teasel were once used to raise the nap, or tease the cloth in wool production - thus its common name.

78. **Common Blue Violet**
Identification: The flowers and leaves of this smooth, low plant are on separate stalks. The flowers can be blue to white with purple veins, very showy.
Justification: Violets are high in vitamins A and C and have been used in salads or cooked as greens. The flowers can be made into candies and jellies.

Animals I
(flatworms and roundworms)

Classification: Kingdom Animalia
Phylum Platyhelminthes
Class Turbellaria

79. **Planarian**
Identification: This small, flat worm has a definite anterior and posterior end. Anterior eyespots are clearly visible when viewed with a microscope giving the worm a cross-eyed appearance. Planaria are found in most aquatic ecosystems.
Justification: These free-living flatworms eat microscopic plants and animals and are eaten by larger organisms in aquatic ecosystems.

Classification: Kingdom Animalia
Phylum Platyhelminthes
Class Trematoda

80. **Schistosome**
Identification: Schistosomes found in Michigan are most easily recognized by the effect they have on human skin in the form of swimmer's itch. This parasitic flatworm burrows into the skin of a swimmer leaving a raised red spot which itches intensely for several days.
Justification: This flatworm has a negative impact on tourism in Michigan. A relative of the Michigan schistosome is more deadly in other parts of the world where it kills hundreds of thousands of people every year from a condition known as schistosomiasis.

Classification: Kingdom Animalia
Phylum Platyhelminthes
Class Cestoda

81. **Tapeworm**
Identification: These long, white parasitic worms are made up of a head or scolex and many body sections. Usually only segments are seen as they exit with feces from your pet. Evidence of these worms is seen when your pet tries to relieve rectal itching.
Justification: Although these worms rarely kill their host they do absorb nutrients from food which can make the host weak. Humans can obtain tapeworms from eating uncooked food.

Classification: Kingdom Animalia
Phylum Nematoda

82. **Roundworm**
Identification: Roundworms are usually white or clear and threadlike in appearance. Both ends typically taper to a point.
Justification: Roundworms are one of the most numerous animals on the earth. Most are free-living in soil or water yet the parasitic ones cause horrible conditions such as trichinosis, elephantiasis and river blindness.

Animals II
(mollusk through crayfish)

Classification: Kingdom Animalia
Phylum Mollusca
Class Pelecypoda

83. **Zebra mussel**
Identification: These small, light-colored clams are most easily recognized by the zebra-like marking on the shell. Like all bivalves they have two halves to their shell which are hinged and protect soft body parts inside. They are commonly found attached to structure in Lake Michigan and nearby lakes.
Justification: This invader from Europe was first discovered in the U.S. in 1988 and has since proliferated throughout the Great Lakes and in some inland lakes. They are completely changing the aquatic ecosystems they invade because of their great water filtering capacity and are of real concern.

Classification: Kingdom Animalia
Phylum Mollusca
Class Gastropoda

84. **Pond snail**
Identification: This gastropod has a single, spiraling, black shell that covers all but the "foot" of the snail body. They are common in most aquatic ecosystems and are found attached to rocks, sticks, and plants.
Justification: Snails are invaluable for keeping lake bottoms clean of algae and decaying matter. They also provide food for birds, fish and other animals, including humans.

Classification: Kingdom Animalia
Phylum Annelida

85. **Earthworm**
Identification: These reddish-brown segmented worms are common in soil and leaf litter. They have a protective mucus around their body and an easily identified clitellum.
Justification: Earthworms play a vital role in terrestrial ecosystems in aerating and conditioning the soil by constantly passing large amounts through their digestive system.

Classification: Kingdom Animalia
Phylum Arthropoda
Subphylum Chelicerata

86. **Eastern daddy-long legs**
Identification: Although not technically a spider, this common arachnid has spider-like features such as two body segments,four pair of legs and no antennae. It is yellowish to greenish-brown with a blackish stripe along its midline and has long thin legs.
Justification: Being nocturnal carnivores they eat insects and other invertebrates and are eaten by many vertebrates.

87. **Common garden spider**
Identification: This common spider is brightly colored,often black and yellow or black and red. It is found in grassy or weedy areas. Its large, vertical web is conspicuous and the spider rests head downward in the center.
Justification: Garden spiders eat other insects and serve as prey for larger animals.

Classification: Kingdom Animalia
Phylum Arthropoda
Subphylum Crustacea

88. **Crayfish**
Identification: This aquatic invertebrate is not a fish but an arthropod with a hard exoskeleton, two pair of antennae and powerful claws for catching and holding food. It is brown in color and found in most ponds, lakes and rivers.
Justification: Crayfish serve as food for many vertebrates including fish, birds, and humans.

Animals III
(Insects)

Classification: Kingdom Animalia
Phylum Arthropoda
Subphylum Uniramia
Class Insecta

89. **Mayfly**
Identification: Adults have a very soft body with large, triangular, many-veined wings which are held together above the body at rest. Two or three hairlike "tails" are obvious. Some species swarm and move up and down in unison while flying over water.
Justification: This insect is important in the aquatic food chain providing food for fish, birds, amphibians and other insects.

90. **Dragonfly**
Identification: Two pair of long, narrow wings held out horizontally at rest distinguish this large insect from others. It also has a long, slender abdomen and large compound eyes. It is usually brightly colored and found around water.
Justification: Because of their strong flying ability, dragonflies help control mosquito and other small insect populations, catching their prey in flight. They also provide food for fish, birds and other animals.

91. **Damselfly**
Identification: Damselflies are very similar to dragonflies except the wings are held close to the abdomen at rest. They are not strong flyers and rest often on plants near water.
Justification: They provide food for fish, birds and other animals.

92. **Grasshopper**
Identification: This insect is usually brown or green with a front wing thickened and folded over the hind wing at rest. The large hind legs are used for jumping and so they rarely fly any distance. They "sing" by rubbing body parts together to attract the opposite sex and are most commonly found in fields.
Justification: Some species swarm to great numbers with reports of 100 million covering 2000 square miles. In such cases they cause extensive crop damage yet provide important food for birds, snakes and mammals.

93. **Cricket**
Identification: Crickets are similar in appearance to grasshoppers but generally smaller and often black in color. They are found in fields, woods, and around dwellings.
Justification: The "singing" of some species can be used to estimate temperature because the chirp rate decreases with temperature drop.

94. **Water Strider**
Identification: This familiar insect is often misnamed as a spider because of its spider-like appearance. It is adapted to walking on water where it is commonly seen.
Justification: Water striders are carnivores, eating other insects that fall on the water and serve as prey for other animals.

95. **Earwig**
Identification: Forceps-like pinchers out the rear of the abdomen make this insect easy to identify. They are dark in color and rarely fly. Being nocturnal they spend days in cracks and under rocks and debris.
Justification: Because they feed mainly on dead, decaying matter earwigs are beneficial in the decomposition of plant matter. Their name comes from the folk belief that they crawled into the ears of sleeping persons. They don't bite but may pinch hard.

96. **Cicada**
Identification: This large,stout-bodied insect with membranous wings is most easily located and identified by the loud buzzing noise produced by males. They are found most commonly in trees.
Justification: This insect occurs in very large numbers in certain year cycles (13 or 17 year are common) and can do extensive damage to trees at that time.

97. **Spittlebug**
Identification: This small brown or gray hopping insect is most commonly located by the "spittle" produced in a plant it inhabits. The spittle is a secretion from the anus which keeps the larvae moist.
Justification: Spittle bugs can cause serious stunting of plants, especially clover.

98. **Beetles**
Identification: The great variety of beetles makes identification difficult yet most have thickened front wings covering the hind wings at rest. They are found virtually everywhere in a variety of colors and size. This is the largest order of insects.
Justification: Many species cause serious agricultural problems for humans because they are plant eaters.

99. **Tiger Swallowtail Butterfly**
Identification: This large butterfly has yellow wings with black stripes and obvious tail-like projections on its hind wings. They are found in fields during early summer.
Justification: The larvae feed on cherry, birch, poplar, and other trees but not in big enough numbers to do great damage. The adults feed on plant nectar and act as pollinators.

100. **White Butterfly**
Identification: White butterflies are small to medium size with black markings on white wings. They often congregate around puddles near fields and along roadsides.
Justification: The larvae do great damage to cabbage and related plants.

101. **Sulfur Butterfly**
Identification: This butterfly is smaller in size and markings to white butterflies except for yellow wings. They are found around puddles and in fields and may be seen migrating in masses.
Justification: The larvae are a serious pest of clover crops.

102. **Monarch Butterfly**
Identification: This common field butterfly is large, has orange wings with black markings and 2 rows of small white spots on the black wing band. It can be easily confused with a mimic - the Viceroy Butterfly. Monarchs migrate in masses to California, Mexico and the Gulf States providing a mystery of navigation because the offspring will often return to the exact summer location of their parents!
Justification: Because the larvae feed on milkweed which contains toxic chemicals, the adults are distasteful to predators. The adults feed on nectar and serve as pollinators.

103. **Gypsy Moth**
Identification: Gypsy moths are medium-sized, white or gray with black markings, and have a hairy appearance typical of many moths. They are weak flyers and are often found on tree trunks.
Justification: The larvae cause extensive damage by defoliating mature trees, especially oak.

104. **Eastern Tent Caterpillar**
Identification: The larvae of this insect are most easily recognized because of the tent like nest of silk they build for protection. The larvae are black, somewhat hairy, with a yellow stripe down the middle of their back.
Justification: The larvae cause extensive damage by defoliating mature trees, especially black cherry.

105. **Crane Fly**
Identification: This often misidentified insect is mosquito-like in appearance with very long legs that easily break off. The knob-like modification of the hind wings is obvious. It is commonly found in moist areas.
Justification: The larvae play a role in aquatic food webs. Unlike mosquitoes, the adults don't bite.

106. **Mosquito**
Identification: This small, slow-flying insect has soft body parts. The males are distinguished from females by their feathery antennae. Mosquitoes need water to breed and are found most commonly in such areas.
Justification: Males are nectar feeders and, therefore, pollinators and don't bite. Females can drink their own weight in blood in a single feeding and are major vectors of serious diseases such as yellow fever, malaria and encephalitis.

107. **House Fly**
Identification: This common insect is dark-colored, has only two wings yet is a fast flyer. It breeds in manure and decaying matter and so is commonly found in great numbers in these areas.
Justification: House flies transmit diseases such as typhoid fever, dysentary, and cholera. They are unwelcome guests in households because they regurgitate their food.

108. **Deer Fly**
Identification: This fly is about the size of a house fly and has a stout body with characteristic light and dark variegated wings.
Justification: These flies bite hard and can be annoying when out in the field. Some species transmit serious diseases in other parts of the world.

109. **Bald-faced Hornet**
Identification: This medium-sized hornet is black with yellowish-white markings and is most easily identified by the large, papery nest it builds in trees.
Justification: They capture and feed other insects to the developing larvae and so play a role in the terrestrial food web. Hornets can inflict a painful sting to humans.

110. **Carpenter Ant**
Identification: Carpenter ants are large and black with the characteristic "bump" on the front part of the abdomen. They are found most commonly in moist, wooded areas.
Justification: These ants are serious pests in homes because they excavate their nests in wood. Although they don't eat wood like the termite, they can cause structural damage.

111. **Formicid Ant**
Identification: There are many closely related species of this common ant. Some are commonly found making small mounds of sand in driveway and sidewalk cracks. They are small and brown and eat a variety of food.
Justification: These ants play an important role in terrestrial ecosystems by scavenging food and transporting seeds. They taste like lemon when eaten due to the formic acid in their body.

112. **Honey Bee**
Identification: This easily recognized bee has golden-brown coloration and a characteristic humpbacked shape. It is found in fields and orchards near flowering plants.
Justification: The honey bee is extremely valuable for honey, beeswax and especially as pollinators.

113. **Bumble Bee**
Identification: Bumble bees are much larger than honey bees with a robust shape and black and yellow coloration. They nest in the ground and are found around flowering plants.
Justification: They are important pollinators, especially for certain kinds of clover.

Animals IV
(fish)

Classification: Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Osteichthyes

114. **Rainbow Trout**
Identification: This trout has many dark spots on a light background with a broad reddish-orangeish band along its side. It has a slightly forked tail and a characteristic adipose fin. Rainbows tolerate slightly warmer water than other trout.
Note: The steelhead trout is a rainbow that has spent several years in Lake Michigan and migrates back up the river to spawn. At this time it has a characteristic steel gray color and can be fairly large.
Justification: They feed on a variety of aquatic life and provide a valuable fishery throughout the state.

115. **Northern Pike**
Identification: This large, long, torpedo-shaped fish has light patterning on a green background and a duckbill-shaped snout. Its mouth is lined with needle sharp teeth and is found in lakes and streams with good weed growth.
Justification: Pike are important large predator fish in many inland lakes for maintaining population sizes of smaller fish. They also provide an important sport fishery in most areas.

116. **Carp**
Identification: Carp are large, bronze-colored fish with large scales and look very much like goldfish. They are found in soft-bottomed lakes and can tolerate warm water and pollution.
Justification: They aggressively uproot plants in shallow water which muddies the water destroying spawning areas for more desirable fish. Carp are considered a "trash" fish by many.

117. **White Sucker**
Identification: This long, round, slate-colored fish has a round mouth pointing downward. It is found in lakes and river bottoms feeding on insects.
Justification: Suckers tolerate warm, polluted water and move up rivers and creeks to spawn in the spring where they are sometimes speared at night.

118. **Brown Bullhead**
Identification: This small catfish is usually less than 12 inches in length and has a dark mottled back, a light belly and "slimy" skin. Large barbules (whiskers) are obvious. It has an unnotched tail and an adipose fin. Bullhead are found in soft-bottomed lakes feeding on the bottom.
Justification: These fish feed on plant and animal matter on the bottom of lakes and are not highly sought by fishermen.

119. **Channel Catfish**
Identification: Catfish are similar in appearance to bullhead but are generally larger, have a deeply forked tail and are common in moving water.
Justification: Catfish are bottom feeders most active at night. They feed on just about anything and provide an important fishery in certain areas.

120. **Smallmouth Bass**
Identification: This fish ranges in size form 10-20 inches, is olive green in color and lacks a prominent lateral line. The upper jaw does not extend past the eye. It is common in cool lakes and rivers.
Justification: This species is a major predator fish in many lakes helping to control the population size of smaller fish. It is highly sought after as a game fish with tournaments held for this trophy.

121. **Largemouth Bass**
Identification: Largemouth bass range in size from 10-24 inches, are olive brown in color and have a prominent lateral line. They have a very large mouth with the upper jaw extending past the eye. They are found in warm water lakes and rivers near weeds.
Justification: This major predator fish feeds on insects, fish, crayfish, frogs, and small mammals and is one of the most popular game fish in the country. Numerous tournaments are held for this trophy.

122. **Pumpkinseed Sunfish**
Identification: This small, round-bodied fish has an orange tip on the gill cover and strong orange and blue stripes on the cheeks. It is found in most inland lakes.
Justification: This sunfish feeds heavily on snails and insects and is a prey for larger fish. It is an excellent tasting panfish and important game fish in Michigan.

123. **Bluegill**
Identification: Bluegill are similar to pumpkinseed sunfish but have a dark blue tip on the gill cover and are less brightly colored. They are found in most inland lakes but are often stunted due to overpopulation.
Justification: They feed primarily on insects and are prey for larger fish. Like the pumpkinseed they are an excellent tasting panfish and important game fish.

124. **Rockbass**
Identification: Rock bass are usually larger and more elongate than bluegill and typically have a greenish-olive color with dark brown mottlings, although they can change color to match their surroundings. They have a combination of 6 anal fin spines and 12 dorsal fin spines. They are common in most lakes and ponds.
Justification: This sunfish provides fun fishing for many people and is easily caught on simple tackle.

125. **Crappie**
Identification: This is one of the largest of the sunfish with some individuals up to 14 inches in length. It is silver-colored with a longer body than the bluegill and without a dark gill covering. It is found in most inland lakes.
Justification: Crappie feed on insects and minnows and are very prolific, laying 10,000-180,000 eggs per fish which hatch in 3 days. It is an important game fish.

126. **Walleye**
Identification: This medium-sized, long, slender-bodied fish has a characteristic black spot on the rear of the dorsal fin. It has enlarged teeth, an opaque eye color ("walleyed"), and is found in many inland lakes and rivers.
Justification: Walleye feed on insects and minnows at night and are a highly sought after game fish because of their excellent taste.

127. **Yellow Perch**
Identification: Most perch are small in size, greenish yellow in color with strong vertical banding on the side. They have a slender body and are found in most inland lakes and in Lake Michigan.
Justification: They feed on insects and minnows during the day and are an important prey species for larger fish. Like the walleye they are highly sought after because of their excellent taste. They are called "jumbo" perch when taken from Lake Michigan.

Animals V
(amphibians & reptiles)

Classification: Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Amphibia

128. **American Toad**
Identification: This 2-3 inch toad has olive-colored skin, a spotted chest and large warts that are really secretory glands. It breeds in shallow water but the adults live on land.
Justification: Toads eat many slugs and insects and serve as prey in terrestrial ecosystems. They are easily tamed as pets.

129. **Green Frog**
Identification: This frog is similar in size to the American toad but has green skin with numerous blotches. The males have a yellowish throat. The voice sounds like a low banjo string "tung". It is found in lakes and ponds with vegetation.
Justification: Frogs eat many aquatic insects and serve as prey to snakes, fish, birds, and mammals. This species is often used in dissection labs in science class.

130. **Northern Leopard Frog**
Identification: This common frog is 2-4 inches in length with green spots surrounded by light colors. It makes a sound like a gruff chuckling noise which lasts up to 5 seconds. This frog prefers wet grassy meadows. Like all amphibians, it breeds in water.
Justification: This frog eats mostly insects and serves as prey for many animals. It is also used commonly for dissection labs in science class.

131. **Spotted Salamander**
Identification: This large salamander is blue-gray with two rows of yellow spots. It is found in moist wooded areas.
Justification: Salamanders are secretive animals that are most active at night when they come out from under logs and leaf cover to prey upon invertebrates.

Classification: Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Reptilia

132. **Common Snapping Turtle**
Identification: This is a large turtle often weighing 25 pounds or more. It has a large head and a long neck. The back edge of its shell and tail are sharply toothed and the shell is usually covered with algae. They rarely bask in the sun and are found in quiet ponds and lakes.
Justification: They eat vegetable matter, invertebrates, birds, and carrion. Snappers are rarely offensive underwater but attack repeatedly on land. They are used for making soups and stews.

133. **Eastern Box Turtle**
Identification: This small turtle has a smooth, dome-shaped shell which is dark olive or black with yellowish lines or large spots. Males have red eyes and females have brown. They prefer moist open woods or swamps.
Justification: They eat insects, earthworms, snails, fruit and berries and are the most popular turtle pet in the Midwest. Some individuals may live up to 80 years.

134. **Eastern Painted Turtle**
Identification: This small, brightly colored turtle has a smooth, flattened shell with yellow cross bands and red and black markings around the edges. They are commonly found basking on logs by ponds.
Justification: This reptile feeds on insects and water plants. If kept as a pet it must be fed in water. It will attack fish put in the same aquarium.

135. **Eastern Garter Snake**
Identification: This small to medium-sized snake has 2-4 rows of light colored lateral stripes on its dark body. It is found almost everywhere but prefers moist areas.
Justification: Garter snakes eat worms, insects, frogs and toads. It is the most common snake in Michigan and therefore plays a role in many ecosystems. It derives its name from the striping which is like that of a fancy gentlemen's sock garter. Some individuals may bite.

Animals VI
(birds)

Classification: Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Aves

136. **Mute Swan**
Identification: Mute swans are large, white birds who hold their long necks in a graceful S-curve. They have an orange bill with black knob and are usually silent. They are easily domesticated and are found in parks and resort areas.
Justification: This species was introduced from Europe and now is a nuisance in parts of Michigan because of its aggressive nature toward indigenous species, fouling of water, and lawns with its excrement, and uprooting plants in shallow water.

137. **Canada Goose**
Identification: This goose is large, has a black head and neck with a white cheek patch, and gives a characteristic musical honking call. It migrates in a V formation and is found on ponds, lakes, and rivers or feeding in the fields.
Justification: Canada geese have become a nuisance in southern Michigan because they foul the water and lawns with excrement. They do provide hunting opportunities and food for humans and large predators.

138. **Mallard**
Identification: Males of this species have a green head, white neckband and chestnut chest while females are a dull mottled brown. The female call is a simple "quack". They are found in most ponds, lakes and rivers and are easily domesticated. This large duck is the most common in Michigan.
Justification: Mallards feed mainly on plants and insects, serve as prey for large predators and provide hunting opportunities and meat for humans.

139. **Wood Duck**
Identification: This duck is smaller than a mallard. The male is very showy and considered one of the most beautiful in North America. It is found most commonly in marshes and flooded woodlands and nests in hollow trees.
Justification: Wood ducks were nearly eliminated in our area a few decades ago until massive efforts with nest boxes brought them back in good numbers. They provide hunting opportunities and good eating.

140. **Red-tailed Hawk**
Identification: This mallard-sized hawk has a whitish breast, a broad rusty-colored tail, and a high pitched descending scream as its call. It is often seen soaring or perched in trees and on poles.
Justification: This raptor feeds mainly on rodents, rabbits and small birds and plays an important role as a predator in terrestrial ecosystems.

141. **American Kestrel**
Identification: This robin-sized falcon is most commonly found on telephone wires where it perches.
Justification: The kestrel, also called a sparrow hawk, preys upon large insects and small birds such as house sparrows. The male brings food to the young.

142. **Great Horned Owl**
Identification: This is a common long "eared" owl and one of the largest in our area. They are common in rural areas but, being nocturnal, are seldom seen.
Justification: This owl is large enough to prey upon other large birds and mammals and is accused of decreasing the ring-necked pheasant population.

143. **Great Blue Heron**
Identification: This goose-sized water bird has a whitish head, greyish body and yellowish bill. It folds its neck while flying and has a call that sounds like a gutteral squawk (4x for alarm). It is often seen stalking prey in shallow water.
Justification: This is a major predator in aquatic ecosystems feeding on fish, frogs, small mammals, reptiles and birds.

144. **Downy Woodpecker**
Identification: This woodpecker looks very similar to the hairy woodpecker only smaller. It is black and white and the males have a red patch on the back of their head.
Justification: This is the most common woodpecker in our area and will readily come to feeders.

145. **Killdeer**
Identification: Killdeer are robin-sized birds with brown on top, white below and two black neck bands (one for young birds). Its call sounds like its name "kill DEEEEE, kill DEEEEE", etc. and is common in fields.
Justification: This bird serves as a prey species for hawks and larger mammals. It will fake a broken wing to draw predators away from its nest when threatened.

146. **Ring-billed Gull**
Identification: This pigeon-sized gull has a black ring around the end of its bill, webbed feet, long pointed wings, and a characteristic white and gray coloring. It is found by lakes and rivers but can often be seen in large flocks feeding at dumps and in fields. Its call is a high-pitched, loud, raucous, mewing cry.
Justification: Being a fish eater and scavenger this gull is valuable for cleaning carcasses off beaches.

147. **Rock Dove**
Identification: Many color varieties exist in rock doves but they commonly have two black wing bands, a broad black tail band and a white rump. They are commonly found in city parks and on farms. Their call is a soft cooing.
Justification: Rock doves are often a nuisance in the city because of their messy droppings and disease carrying ability.

148. **Mourning Dove**
Identification: This dove is smaller than a rock dove, has a sandy buff color and a long pointed tail. They are found nearly everywhere. Doves feed mostly on grains and have a low, mournful "coo-ah, coo, coo, coo" call.
Justification: This bird is the most widely hunted game bird in the U.S. providing hunting opportunity for millions. It is a popular bird at feeders and therefore is protected from hunting in some states.

149. **Wild Turkey**
Identification: This large bird is dark colored with a head lacking many feathers. The males have a "beard", a group of feathers on its chest which grow s with age. They are found in flocks in wooded farmland.
Justification: Wild turkey populations have made a tremendous comeback in recent years due to reintroduction efforts and now are common. They provide hunting opportunities and food for humans.

150. **Tree Swallow**
Identification: This sparrow-sized bird has a metallic blue-green black and white underside and a deeply forked tail. They nest in cavities and are often seen perched on wires. The call is a series of liquid notes.
Justification: Tree swallows eat insects and are valuable in controlling their populations. They are disliked by some because they take nesting sites away from the more desired bluebird.

151. **Blue Jay**
Identification: Blue jays are robin-sized with bright blue and white feathers and a prominent crest. They are commonly found in pine and oak woods feeding on seeds. Their call varies from loud and raucous to musical.
Justification: Blue jays often bury seeds and therefore act as tree planters. They drive other birds from feeders and so are often disliked by bird watchers.

152. **Common Crow**
Identification: Crows are easily identified as being totally black and are often seen eating dead animals along the roadside. They have a distinctive call and are often heard while attacking owls and hawks.
Justification: This bird is valuable as a scavenger but is disliked by many because it eats many eggs and chicks of songbirds.

153. **Black-capped Chickadee**
Identification: This sparrow-sized songbird has distinctive black and white feathers on the head. It is not fearful of man and is commonly seen at feeders. It says its name in its call, "chickadee-dee-dee".
Justification: This bird is a favorite of bird watchers in winter.

154. **American Robin**
Identification: This favorite summer resident is common on lawns while searching for earthworms. It has a red breast and slate-colored back with a call that sounds like "cheer-up, cheerily, cheerily, cheerily".
Justification: This bird is regarded as the "herald of spring" and eagerly anticipated every year. It is the state bird of Michigan.

155. **Starling**
Identification: This robin-sized bird is dusky black, has a short tail and yellow bill. Its call often imitates other birds. Being a cavity nester it is often found around old buildings. Unlike many birds, it does not migrate.
Justification: The entire U.S. population is the result of 100 birds being released in Central Park, New York City in 1890. They are now considered pests around dwellings.

156. **House Sparrow**
Identification: This bird is very common around dwellings and farms. Males have a black chest; females are mottled brown. The song is a series of monotonous chirps.
Justification: This sparrow is often a nuisance and always associated with humans. The entire North American flock came from a few birds released in Central Park, New York City in 1850. It is also called the English Sparrow.

157. **Red-winged Blackbird**
Identification: This robin-sized bird is found in marshes and wet areas. The male has bright red shoulder patches; the females are mottled brown. Their call sounds like "O-ka-leeeeeee!".
Justification: This bird is very aggressive when defending the nest and plays an important role in wetland ecosystems.

158. **Common Grackle**
Identification: This robin-sized blackbird is abundant on farmland. It is metallic black-purple in color and nests in evergreens.
Justification: Grackles are a nuisance when flocking in large numbers because they can destroy fruit crops. They are destroyed in mass by poisons.

159. **Brown-headed Cowbird**
Identification: This robin-sized blackbird is most commonly seen in pastures. The male is black with a brown head while females are dull black.
Justification: Cowbirds are social parasites in that they never nest but lay their eggs in other birds nests. For this reason they are scorned by most bird watchers.

160. **Cardinal**
Identification: Cardinals are also robin-sized songbirds with a characteristic bright red plumage (the female is less colorful). They are common at feeders and have a clear song that sounds like "what-cheer, cheer, cheer, purty-purty-purty".
Justification: This bird is a favorite of bird watchers and is named after the red robes worn by Roman Catholic cardinals.

161. **American Goldfinch**
Identification: This sparrow-sized bird is found in weedy fields and is especially fond of thistle and sunflowers. It has bright yellow and black markings (the female is less colorful) and a distinctive song that sounds like "potato-chips".
Justification: The American goldfinch is highly desired by those who feed birds and special feeders are maintained for these birds.

162. **Purple Finch**
Identification: The purple finch is sparrow-sized with the males having a reddish head and back.
Justification: This is a very common bird at winter feeders.

163. **White-breasted Nuthatch**
Identification: This small creeping bird is slate colored on top and white underneath. The male has a black cap. They are common in evergreen forests.
Justification: This nuthatch is another common bird at feeders.

164. **Slate-colored Junco**
Identification: This junco is small and drab-colored being mostly gray except for a white underside.
Justification: This bird will be seen frequently at feeders with the finches and nuthatches.

165. **Tufted Titmouse**
Identification: This bird is almost robin-sized, light gray and white in color, and has a characteristic tuft of feathers on top of its head.
Justification: Although not as common, this bird shows up frequently at feeding stations.

Animals VII
(mammals)

Classification: Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
ClassMammalia

166. **Opossum**
Identification: This mammal is the size of a house cat, has white fur, a long snout and a rat-like tail. It is often seen in the beam of a car headlight or dead along the road. It is nocturnal and found on farmland and woodlands near streams.
Justification: Opossum eat plants and small animals. They may feign death or "play 'possum" when cornered.

167. **Starnose Mole**
Identification: This small mammal is five inches long, dark brown or black with nose of fingerlike, fleshy projections in the appearance of a star. It makes a mound of black dirt above ground with tunnels not visible.
Justification: Because of its appetite for worms and insects it can do great damage to lawns and golf courses. Surprisingly the fur is of some value.

168. **Eastern Mole**
Identification: This mole is also five inches long, has broad front feet that turn outward and is a dark slate color. It makes tunnels jus t below ground yet visible from above.
Justification: The eastern mole prefers to eat insects and worms in lawns, golf courses, etc. and is considered a real pest in most areas.

169. **Brown Bat**
Identification: These mammals are most commonly seen feeding on the wing at night. They are glossy brown in color and eat numerous insects, especially mosquitoes.
Justification: Bats are invaluable because they control mosquito populations around dwellings.

170. **Raccoon**
Identification: Full grown raccoons are the size of a small dog and are often seen dead along the roadway. They appear to have a black mask over their eyes with yellow and black rings on their tail. They prefer to be near streams and lakes where they feed at night.
Justification: The meat of this mammal is edible but is mostly sought after for the fur. They are a carrier of rabies and should be avoided for this reason.

171. **Striped Skunk**
Identification: This mammal is the size of a small cat and also is often seen dead along the road. It has a black body with a white stripe and well-developed scent glands. It is found most commonly in mixed woods and farmland. It is nocturnal and feeds on most anything.
Justification: Surprisingly the skunk is one of our most valuable fur animals but it also carries rabies.

172. **Woodchuck**
Identification: This heavy-bodied, short-legged brown mammal is commonly seen in fields and along roadsides. It is a diurnal herbivore.
Justification: The woodchuck is considered a pest because it can do considerable damage to crops and create hazardous holes in farmers' fields.

173. **Thirteen-lined Ground Squirrel**
Identification: This light brown mammal has 13 whitish stripes. It is found in yards and on golf courses seeking seeds and insects.
Justification: Ground squirrels are considered pests because they make burrows in landscaped terrain.

174. **Eastern Chipmunk**
Identification: Chipmunks run with their bushy tail straight up. They have facial stripes, a reddish side and rump and are found in forests and brushy areas.
Justification: Being primarily seed eaters, chipmunks can be easily enticed to food piles and eventually domesticated.

175. **Eastern Fox Squirrel**
Identification: This common mammal is found wherever there are nut trees. It is rusty yellow with a bushy tail and nests in cavities or leaf/twig nests.
Justification: Fox squirrels are important game animals and are also important as tree planters because of their seed-burying habits.

176. **Red Squirrel**
Identification: This noisy little squirrel has a ratchet-like call, is reddish yellow, and is found in pine or spruce forests. They actively eat and store seeds throughout the year.
Justification: These squirrels may do damage to cabins left unattended.

177. **Muskrat**
Identification: Muskrats have a dense, rich brown fur with a silver belly and a naked, flattened tail. They build easily identified cone houses in marshes near ponds, lakes and streams. They eat mostly plants.
Justification: This is one of our most valuable fur animals and is heavily trapped for this purpose.

178. **House Mouse**
Identification: This greyish-brown mouse has a scaly tail which is the same color above and below. It is commonly found in buildings with humans where it breeds year round. It will eat almost anything.
Justification: The house mouse is an unwelcome pest in homes. It contaminates food and is a carrier of disease.

179. **Eastern Cottontail Rabbit**
Identification: This common mammal has a brownish-gray body and a cottony white tail. It is found in heavy brush, swamps and weed patches. It is a nocturnal herbivore although is commonly seen during the day.
Justification: This rabbit can do damage to garden crops. It is Michigan's most important small game animal.

180. **Whitetail Deer**

Identification: This large mammal has a reddish brown coat with a white undertail which is displayed when alarmed. It is found near most types of cover eating a variety of plants. Evidence of deer include scrapes and rubs.

Justification: The whitetail deer is the most important big game animal in Michigan. In heavily populated areas it can do extensive crop damage.

APPENDIX B

Final Exam

(Given as Pre-Test and Post-Test)

(SAMPLE)

Justification Final Exam

1. The fruit is an important food for songbirds and game birds and can be made into a sweet drink.

2. They feed on insects and minnows during the day and are an important prey species for larger fish. Like the walleye they are highly sought after because of their excellent taste. They are called "jumbo" when taken from Lake Michigan.

3. The "singing" of some species can be used to estimate temperature because the chirp rate decreases with temperature drop.

4. They are responsible for producing a large portion of the available oxygen in our atmosphere and form an important base in any aquatic food web.

5. This bird is regarded as the "herald of spring" and eagerly anticipated every year. It is the state bird of Michigan.

6. Roots of this producer can be roasted and ground as a coffee substitute, a practice common in Europe.

7. This is an unwelcome pest in homes. It contaminates food and is a carrier of disease.

8. Because of its soft, dry texture in the fall of the year this plant makes an excellent substitute for toilet paper! It is also an important producer in most forest ecosystems.

9. These insects are serious pests in homes because they excavate their nests in wood. Although they don't eat wood like the termite, they can cause structural damage.

10. These organisms are the most poisonous in our area. Some species, with common names like "destroying angel" and "panther fungus", can be fatal even if only a little is ingested.

11. This bird serves as a prey species for hawks and larger mammals. It will fake a broken wing to draw predators away from its nest when threatened.

12. This plant contains poisonous saponins which are soap-like substances, and the name is an old-fashion name for washer woman.

13. These birds have become a nuisance in southern Michigan because they foul the water and lawns with excrement. They do provide hunting opportunities and food for humans and large predators.

14. Altough very strong, the leaves and root of this plant have been eaten to add the onion flavor to food.

15. This mammal is the most important big game animal in Michigan. In heavily populated areas it can do extensive crop damage.

(Sample)

Classification Final Exam

Directions: Select the best answer for each of the numbers below and darken the corresponding letter on your answer sheet using the word bank.

Kingdom Monera

#1 ; unicellular; autotrophic; or heterotrophic organisms

example = bacteria

Kingdom **#2**

eukaryotic; usually unicellular; autotrophic or heterotrophic organisms

I. Phylum Ciliophora = ciliates
example = **#3**

II. Phylum Zoomastigina = animal like flagellates
example = volvox

III. Phylum Sarcodina
example = amoeba

IV. Phylum Euglenophyta = flagellates
example = euglena

V. Phylum **#4** = golden algae
example = diatom

Kingdom #5

#6 ; unicellular or multicellular; mostly decomposers

I. Phylum Zygomycota = conjugation fungi
example = black bread mold

II. Phylum **#7** = sac fungi
example = morels

APPENDIX C

Student Evaluation/Survey

Diversity of Life

Evaluation Form

Please rate each of the following items on a scale from 1 to 10 as indicated.

How many organisms could you **identify before** this unit? _____
(1 = none 10 = all)

How many organisms could you **classify before** this unit? _____
(1 = none 10 = all)

How many organisms could you **justify before** this unit? _____
(1 = none 10 = all)

How many organisms could you **identify after** this unit? _____
(1 = none 10 = all)

How many organisms could you **classify after** this unit? _____
(1 = none 10 = all)

How many organisms could you **justify after** this unit? _____
(1 = none 10 = all)

To what degree has this unit changed your view of
West Michigan's plants and wildlife? _____
(1 = not at all 10 = dramatically)

Comment on why your views have or have not changed.

Has this unit increased your enjoyment of nature and being outdoors? _____
(1 = not at all 10 = dramatically)

Comment on why your enjoyment has or has not changed.
