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Experiential Learning in the Middle School Living Environment Classroom

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By

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Table of Contents

CHAPTER 1

Introduction

New researched-based methods for science education are beginning to challenge the traditional methods we are used to seeing in science classrooms. Today's society continues to put greater value on STEM careers and the skills required for such. Similarly, scientific literacy is becoming expected of citizens, especially in a world that is facing a possible environmental climate crisis. This shift has been mirrored by the new Framework created for the Next Generation Science Standards (2013) in which a variety of skills and interdisciplinary concepts are expected of students. This shift in expectations requires a shift in teaching methods (NGSS Lead States, 2013). Traditional science methods focus on a linear scientific method and highly controlled step-by-step laboratory science. This outdated method restricts learning and inquiry, and separates students from the natural environment that they are ultimately learning about (Prokop, Tuncer, & Kvasničák, 2007). In order to foster authentic learning experiences and connect science learning with the greater natural environment, science education needs to be moved out of the confinements of an artificial laboratory and into the natural setting of the outdoor world.

Experiential learning (EL) teaches students through concrete experiences, often occurring outdoors or outside of the classroom. (Scogin, Kruger, Jekkals, & Steinfeldt, 2017). Learning takes place through hands-on, active experiences that occur in context of the topic being studied (James & Williams, 2016). Multisensory experiences gained outdoors allow students to make connections between varied networks in the brain and thus create strong and specific long-term memories (Fägerstam, 2014). Students deepen their understanding of science by becoming active

in the natural world around them (Zaikowski & Lichtman, 2007). Outdoor experiential learning provides higher level thinking opportunities as well as opportunities to build a range of non-cognitive skills such as cooperation, collaboration, independence and responsibility. Additionally, EL is a key tool for creating interest in science and in connecting science contexts from the classroom to real world applications that students can experience firsthand (James & Williams, 2016). EL fosters scientific literacy by allowing for the breakdown of barriers between school and community, and between nature and humanity (Hougham, Bradley Eitel, & Miller, 2015). While advancement in science content knowledge is a main focus, the social applications of science need to be emphasized as well because the majority of students do not continue on to a career in science, but all will need to understand the social applications of science in their futures as active and informed citizens (Feierabend & Eilks, 2010). A study of over 2,000 children ages 8-18 found that they spent over 7 hours a day interacting with electronic media and only 30 minutes a week outdoors (James & Williams, 2016). This suggests that outdoor experiences and connections to nature need to be implemented in the school curriculum, or else many students may go without having them.

The review to follow aims to outline the benefits that outdoor experiential learning and similar teaching methods can have on instruction. It will describe teaching methods that include or that make up experiential learning components. It will highlight effects on science knowledge acquisition, on attitudes and interest in science and in creating positive environmental identities. It will cover benefits on the building of 21st century skills that are necessary outside of the science classroom and other benefits to fostering overall scientific literacy. Opportunities EL provides for differentiation and for addressing previous conceptions will be discussed. It will describe reviews of how to structure EL to connect it to classroom learning and get the greatest

benefits from the experience. Cons and obstacles of experiential learning models will also be reviewed.

CHAPTER 2

Literature Review

Benefits of Experiential Learning

Experiential Learning in Many Forms

Informal and non-formal science. Eshach (2007) defines non-formal learning as structured out-of-school field trip experiences such as visits to science centers and museums, and informal learning as learning that takes place spontaneously at home or otherwise not on school time. Weinberg, Basile, and Albright (2011) add that informal science learning employs less rigid structure than traditional learning, and is usually driven by interest.

In a study by Lin and Schunn (2016) the only learning experience in a comparison of traditional, non-formal and informal experiences to have an effect on science interest and values was experiences of informal science at home. This experience also had a positive association with competency beliefs for 6th graders. This is believed to stem from the highly autonomous nature of exploring science at home where there may be no knowledgeable adults to act as guides (Lin & Schunn, 2016). High autonomy was also the case for experiences in nature, which was found to be predictive of science sense-making and competency beliefs. This is supported by the tendency for nature experiences to elicit observations that result in posing questions and finding solutions autonomously.

Eshach (2007) found that non-formal learning experiences generated interest in science, a sense of wonder, enthusiasm, eagerness and motivation to learn when compared to traditional classroom learning.

Field ecology. Classroom science most regularly consists of chemistry, biology and physics with a minimal to non-existent focus on field sciences such as ecology. Field sciences like ecology differ from the traditional classroom sciences that take place in well-controlled laboratory settings. The field sciences offer a number of ideas and skills that are present to a greater extent than in traditional science disciplines such as adaptability and resourcefulness (Bowen & Roth, 2007). Ecology differs from laboratory science in the fact that changing conditions and complex ecological interactions often result in findings that cannot be replicated. Additionally, field ecology is often observational, while laboratory science is experimental in nature. Based on these differences, Bowen and Roth (2007) conclude that field ecology differs significantly from the traditional laboratory sciences and that teachers cannot claim to model science for all students if field sciences like ecology are not included in the curriculum. Authentic ecology experiences taking place in the field build skills for scientific literacy and for skills that can be applied to other disciplines and the workforce such as adaptability, ingenuity and communication.

Sustainability education. Sustainability education utilizes science-based projects that include global involvement and community action. Students who participated in a sustainability research project with development of a community action model with Gleason, Ause, and Hein (2013) learned about their own impact on the world and took matters into their own hands by learning how to make changes in their own lifestyles. Most students reported that they voluntarily went through with making these changes in their lives after completing the project. Gleason et al. (2013) claimed that the project allowed them to grow both as students and as citizens, and the lifestyle changes students made are evidence that completing this project has driven students towards becoming more environmentally literate citizens. Students said that they

learned that individuals are capable of making contributions to global crisis, and that even a few students can make a difference in a community with a little determination (Gleason et al., 2013). This project spanned the course of a year and was highly involved, with weekly time dedicated to research and then to developing and implementing a solution in the community. Projects that require deep involvement in an issue create a connection between the student and the content, which can be seen in the motivation displayed by these students as well as their willingness to make changes to their own lifestyles as a result (Gleason et al., 2013).

Citizen science and community action. Citizen science describes experiences where members of a community collect real data to contribute to a research project (Cohnstaedt, Ladner, Campbell, Busch, & Barrera, 2016). Students involved in citizen science are important resources for making observations, collecting data and submitting analyses of the areas they live in, which scientists can compile to measure larger patterns and create solutions (Zaikowski & Lichtman, 2007). Cohnstaedt et al. (2016) believe that providing students with firsthand data collection experience in the field is an important skill and that citizen science opportunities allow students to understand the importance of field research and its implication for the community. These opportunities also benefit students by creating connections to organizations and scientists in their community. Though some experiences are remote from the work of the leading scientist, some experiences like the one by Zaikowski and Lichtman (2007) allow for students to meet and present side by side with the leading scientists. Involving students in these opportunities is engaging because they get the satisfaction of seeing their data be used for a cause, and they become involved in something that can help their local community or the greater science community (Cohnstaedt et al., 2016). Citizen science provides an opportunity for students to apply the biological and environmental concepts that they've learned in class. It also allows

students to see science as a way to address the health of people and of animals in their community (Cohnstaedt et al., 2016).

Mueller, Tippins, and Bryan (2012) emphasize the benefits of including other realms of the community in citizen science and avoiding the tendency to focus solely on cold science. Ethics, history, politics, spirituality, and cultural traditions should all be considered and included in citizen science projects. When community involvement is included, all aspects of community need to be in there, not just the science aspect (Mueller et al., 2012).

Outdoor learning on school grounds. Outdoor learning on school grounds requires fewer obstacles and less risk than fieldwork or outdoor adventure education that takes place at remote locations (Fägerstam, 2014). In addition, it allows for opportunities to increase knowledge of the local area. Fägerstam (2014) found that collaboration with peers during outdoor activities allowed students to explore real contexts that are less abstract than what they would encounter in the classroom. Therefore, learning outdoors could be more efficient than traditional indoor classroom learning. Teachers in this study reported that student participation increased and that student-to-student interactions improved (Fägerstam, 2014).

Expeditionary learning. Expeditionary learning describes interdisciplinary learning experiences in which students participate in non-content specific learning expeditions that incorporate content knowledge and skills acquisitions along with building of non-cognitive and character skills. Most often the expeditions lead to a culminating activity or a creation of a product or presentation that summarizes the connections between the multifaceted learning experience (Bell, Daniels, & Lawless, 2011). Bell et al. (2011) argue that the ability of expeditionary learning experiences to take students outside of their comfort zone allows for

learning to take place and for students to link that learning with their everyday lives. They observed that the activities often began with frustration, but quickly became motivating challenges that drove the students to build relationships and work on communication skills (Bell et al., 2011). They found that these holistic learning experiences provided opportunities for students to make deeper connections and ask higher thinking questions when their comfort zones and previous ideas were challenged, in an environment in which they felt supported by their peers (Bell et al., 2011).

Place-based education. Place-based education refers to learning that occurs in and with relation to a specific location, often but not always the student's native local area. Place-based education allows students to build their own meanings and understandings from their prior knowledge in the context of their own environment (Nichols, Howson, Mulrey, Ackerman, & Gately, 2016). Zimmerman and Land (2014) found that place-based learning is a way to design curriculum to make school-based learning more relevant to the lives of students by relating science to social issues. Hougham, Bradley Eitel, & Miller (2015) used place- based learning to provide students with opportunities to look at real-world problems and find solutions by applying them to their local neighborhoods. Engagement with the local area and community through these activities allows students to create deeper meanings of what they are learning and to transform abstract knowledge to concrete and local knowledge (Zimmerman & Land 2014).

Students in a study with Watt and Bautista (2016) learned about carbon footprints, calculated theirs, and then took a field trip to a local company to investigate their carbon footprint and make suggestions to improve it. They found that students were more engaged and motivated in this task than they had been in science in the past. They came up with novel ideas and worked diligently throughout the study. They saw improvements to quality of work and

behavior. Motivation to give final presentations was high and students spent a lot of time practicing and voluntarily dressed up for their presentations. A post-assessment found that students gained a lot of knowledge on the topic over the course of the study through a place-based learning experience (Watt & Bautista, 2016). Nichols et al., (2016) argue that students must learn about the environment they live in, the ecosystem they are a part of and what they can do to live within these areas in harmony. A sense of belonging is developed through place-based learning, and with that comes a desire to protect and conserve an area or a resource (Nichols et al., 2016).

Montessori approach. Montessori learning is similar to experiential learning in the sense that both highlight direct interaction with the learning environment, students work both individually and collaboratively, students become deeply engaged, concentrated and invested and find enjoyment in their own work. While experiential learning is a new idea in many classrooms, Montessori learning, though similar, is already a well-established method of instruction.

Both EL and Montessori learning stem from a constructivist approach to learning and provide students with opportunities to build new knowledge and incorporate new ideas into their pre-existing beliefs of the world. Both techniques rely on creating relevance of science to real life. Though separate from an authentic natural environment, students in the Montessori classroom in a study by Rinke, Gimbel, and Haskell (2013) had various scientific resources (microscopes, plants, live animals and various tools for collecting data) at their disposal for making observations and conducting experiments. Older students mentored younger students and helped them formulate their observations into scientific understandings (Rinke et al., 2013). Both methods use an interdisciplinary approach, incorporating science with social sciences. Human interactions with society and the greater environment as well as moral obligations to society are

made a part of the curriculum (Rinke et al., 2013). While EL is considered a new teaching method that may encounter resistance, Montessori learning is a well-established and widely accepted method that focuses on many of the same methods, ideas and goals.

Garden-based learning. A meta-analysis by Williams and Dixon (2013) found a number of positive outcomes across 48 studies on garden-based learning from 1990 to 2010. 14 out of 15 studies that looked at outcomes on science achievement saw positive outcomes. Other disciplines saw positive academic achievement increases as well, especially in math and language arts (Williams & Dixon, 2013). The authors found 100% positive outcomes in other academic areas such as in curiosity and wonder, life skills, problem solving, motivation and attitude towards academics. They also found positive outcomes in a number of the studies on social development, nutrition knowledge, school bonding and self-concept. Non-academic outcomes saw positive effects as well, such as attitudes towards gardening and towards nutrition, environmental empathy, healthy eating and ideas about growing food (Williams & Dixon, 2013). These studies covered grade levels from kindergarten through 12th grade, but the majority took place in 3rd through 5th grade.

Effects on Knowledge Acquisition

An EL study by Prokop et al. (2007) found that students saw an increase in biology knowledge from involvement in EL that was statistically significant. Both the control (a traditional education experience) and experimental groups scored around a 50% on the pre-test of biology knowledge, but the experimental group received scores as high at 90% on the post-test. The control group did not significantly increase in score (Prokop et al., 2007). Hiller and Kitsantas (2014) found that academic achievement and anxiety had a negative relationship,

inferring that anxiety decreased as students gained content knowledge on a topic. After completing the project, the EL experimental group in their study had significantly higher scores that the traditional control group (Hiller & Kitsantas, 2014). To-im et al. (2010) saw a significant increase in content knowledge over the course of an EL program. The percentage of increased correct answers on each of their administered test items ranged from 10% to 80%. (To-im et al., 2010).

Effects on Standardized tests

Due to the time investment that experiential learning lessons require, teachers are often afraid that it will detract from time spent on content that will appear on standardized tests. Both Scogin et al. (2017) and James and Williams (2016) express concerns about the negative consequences that high stakes testing is having on school curricula due to the increased weight of test scores on teacher and school reviews, and that teachers often choose to narrow the curriculum in order to reserve time for test preparation over experiential learning opportunities and other research-based instructional practices. However Scogin et al. (2017) found that standardized test scores did not differ significantly between an EL group involved in an experience called STREAM and the traditional group. Students in the STREAM program gained significant increases in all standardized test scores except reading (which was not taught in STREAM) between the beginning and end of the program (Scogin et al., 2017). This indicates that experiential learning is an effective way for students to learn. James and Williams (2016) argue that test preparation only utilizes lower level thinking skills, and that EL would offer opportunities for learning and using higher level skills.

Effects on Attitudes towards Science and the Environment

EL has been shown to result in positive attitude changes towards the subject of science in general and towards the natural environment. James and Williams (2016) conducted a study in which students participated in an overnight outdoor learning experience with their teachers. Afterwards 79% of students stated that this experience was worthwhile. Students expressed enjoying the hands-on activities that they participated in, their ability to see data being collected instead of working with hypothetical worksheets, and the chance to step out of their comfort zones (James & Williams, 2016). Scogin et al. (2017) found that students in their EL program STREAM were excited about STREAM and looked forward to STREAM classes. They reported that the program made them enjoy going to school, that they took on more responsibility than they would in their normal classes and that it taught them how science was used in the real world (Scogin et al., 2017). In comparing pre-and post- surveys of students' attitudes toward science, Prokop et al. (2007) found that the EL group raised their attitude towards the natural environment from neutral to positive. To-im et al. (2010) gave students involved in an EL program a test to measure their awareness toward their local water resources. Every item on the test saw a significant increase in correct responses after participation in the EL program.

After participating in an EL event, Zoldosovoa and Prokop (2006) asked students to draw a picture of their ideal science learning environment. . Twenty-nine percent of students in the experimental (EL) group included images of nature in their learning environments opposed to less than 2% of the control (traditional learning) group. Similarly, 34% of the experimental group included aspects of a science laboratory in their drawing, while less than 5% of the control group did. Fifty- four percent of the experimental group drew the class in a non-traditional setting, while only 35.8% of the control group did the same (Zoldosovoa & Prokop, 2006). This suggests

that students who participated in EL had a new view of how science can be taught based on their new experiences learning hands-on science.

Effects on Interest in Science and Science Careers

Many studies have found that EL and other hands-on science opportunities increase students' interest in science and desire to pursue science careers. Weinberg et al. (2011) found that 85% of students said that participating in an EL program increased their level of interest in science. Eighty-four percent said the program changed their understanding of what scientists do. Eighty-five percent of respondents said that the program increased their level of interest in science (Weinberg et al., 2011). Prokop et al. (2007) found that students who participated in their EL program increased their attitudes on future work in science from negative to neutral. A positive influence on goals relating to career choice resulted from an EL program in the study by Hiller and Kitsantas (2014).

Effects on Environmental Identity

In order to foster a student's environmental identity, their current identities need to be recognized, and then connections must be made to the environment based on personal attachment and social experiences that affect the relationship between themselves and the environment.

In response to an activity in a study by Blatt (2014) where students calculated their ecological footprint, one student cried over the impact that her lifestyle has on the environment. Others stated that they feel bad for the materialistic decisions that they've made and want to think twice before they make purchases in the future. By raising student awareness on the environmental effects of their lifestyles, their materialistic consumer identities were disconfirmed, and those who expressed willingness to change their behavior affirmed their

environmental identity (Blatt, 2014). Blatt (2014) suggests a method of coupling activities that disconfirm an identity- despite the distress it may cause- with a positive follow up activity that will build positive characteristics of a new identity, like higher self-efficacy and a desire to personally make a difference. To-im et al. (2010) found that their study was able to teach students to respect our Earth and of the obligations of citizenship, thus creating scientifically and environmentally-minded individuals through creating a connection to the land.

Effects on 21st Century Skills

The new NGSS standards emphasize the need for students to build what they refer to as 21st century skills, or skills that are needed to join society and the workforce in the 21st Century. Experiential learning with its holistic, collaborative and interdisciplinary approach has the potential to teach many of these non-cognitive 21st century skills. Scogin et al. (2017) found that students in their study improved a number of skills that have been reported as lacking in recently hired employees such as communication, collaboration, critical thinking, problem solving, and adaptability. Collaboration was a main focus of the program, and the authors conclude that the student-centered atmosphere and applicability of information were key factors in fostering collaboration. Students showed heightened levels of maturity and began to recognize the benefits of collaborating with peers when they saw that each individual brought different skills and perspectives to the table (Scogin et al., 2017). Gleason et al. (2013) also found that their Sustainability Action Project increased students' scientific literacy and global skills, while building 21st century skills in communication, problem solving and collaboration.

Opportunities for Differentiation

Experiential learning offers a flexible atmosphere that can be easily differentiated in

countless ways for general education or inclusive education classes. Fägerstam (2014) found that being outdoors challenged the boundaries between high and low achieving students by switching up the environment so that students were unable to fall into the same roles they were used to. Teachers in this study also found that they were able to provide assistance to students more discreetly and efficiently in the outdoor setting than in the classroom. James and Williams (2016) observed that students who struggle with reading and writing and therefore do not usually demonstrate higher levels of thinking in the classroom are able to demonstrate their understanding better through hands-on and discussion opportunities in experiential learning settings. Remmen & Frøyland (2014) saw that EL had the ability to drive quiet students to initiate interactions in the field due to heightened engagement, which resulted in deeper engagement in the field. Watt and Bautista (2016) found that EL programs resonated very positively with students who struggled academically because the immersion into a program like EL made students realize they are a part of a greater community and they could use their knowledge to make improvements in the community or help people and the environment.

Opportunities to Correct Previous Conceptions

As discussed above, alternative conceptions exist with all students, and addressing those conceptions in learning has proven a successful tactic in increasing knowledge acquisition, at least in the short term. EL provides an opportunity for students to explore the environment and voice their previous conceptions, allowing teachers to address them. Bell et al. (2011) saw that throughout their expedition, students continually came across misconceptions that they had on the environment, on community or on working and communicating with others. These misconceptions were addressed and ideas that students previously held were challenged in order for new learning to take place based on the new experiences that they had. To-im et al. (2010)

stated that students held misconceptions on why industries were located near the river and that these were corrected via the EL program.

Comparison to Virtual Field Trips

Due to travel restraints that some classrooms may experience, there has been some speculation as to whether authentic EL trips could be replaced with virtual EL "field trips". Puhek, Perše, and Šorgo (2012) led an EL study that compared an authentic EL field trip with a virtual EL field trip. They found that overall students' knowledge improved in both groups from before the study to after. However the authentic field trip group gained more knowledge in exercises that involved observing real objects in nature, such as the activities referring to dendrology and identifying trees based on characteristics of leaves and bark. They found that the virtual field trip group gained more knowledge in exercises where detailed explanations of complex processes could be explained through computer use (Puhek et al., 2012).This suggests that virtual field trips may be just as beneficial as real remote field trips to learning certain types of knowledge, especially more complex, detailed knowledge rather than knowledge build from collecting observations (Puhek et al., 2012). Though many of the skills present in authentic EL learning will not be acquired through virtual EL programs, some of the same knowledge can be acquired in cases where students may not have the option of embarking on an authentic EL trip.

Hougham et al. (2015) conducted a study using "Adventure Learning @," a program allowing students to remotely partake in virtual place-based learning experiences. Students were able to conduct remote atmospheric research in one of the modules using tools that were located thousands of miles away. Though not directly interactive with the natural world, this opportunity

did allow students to build their climate and science literacy skills through remotely learning about weather and climate change (Hougham et al., 2015).

How to Structure Experiential Learning

Bridging In and Out Of School Learning

While experiential learning opportunities may appear exciting and fun to students, teachers need to be sure to structure EL trips so that students understand that work is expected of them and that classroom rules still apply. The Novelty Phenomenon as coined by Eshach (2007) describes an over-anxious or over-excited response from students when placed in a non-formal science experience due to the new environment or new tasks involved. Students may become off-task and distracted by the new opportunities, causing them to fail to partake in science learning. To alleviate these effects, out-of-school science experiences must be explicitly connected to classroom learning. Teachers must inform students of the purpose of the trip and their expectations during the trip and upon returning to the classroom. Teachers should provide students with structure and an agenda for their field trip (Eshach, 2007)

Relevant activities should be introduced before the trip so that students have the background information necessary to understand what they will encounter as well as the skills they will need to interact with the environment and carry out tasks. Teachers should always assign a task for students to complete at the non-formal site in order to guide their learning and keep them on task, while still allowing some aspect of choice. Museums and some other popular field-trip destinations have a tendency to supply mainly factual information, so these assignments should involve open-ended and higher level thinking questions relating to the content.

Morris (2012) suggests providing students with a limited choice activity to complete on the trip, where they have some flexibility in the assignment but the expectations are well structured and clear. Morris (2012) provided an example of a well-structured EL trip where the teacher began preparing students three days before the trip. She begins by defining the term "expedition" with students, and sharing the goals of the trip. Students pick a topic of interest and develop their own research questions that can be explored at the museum they will be visiting. Question development is modeled for the class, and students engage in metacognition of their questions. Together the class discusses a theme for the trip, as well as previous knowledge regarding the exhibit they will be visiting. As a class, they look at the museum website to get ideas of what to expect during their visit. The day before the trip, students share questions that each will be researching. During the field trip, students make observations and take notes. Students are engaged and focused during these well-structured field trip experiences. After the field trip, students are excited to share their findings, demonstrating their engagement in the experience (Morris, 2012). These ideas support findings by Remmen and Frøyland (2014) that suggest that students need to be prepared with information on cognitive, geographic and psychological aspects of the field trip. They also suggest limited choice activities similar to the activity by Morris (2012) where students work in small groups and have some choice as to how they will complete the task, given the goals to be reached. Research has shown that preparation and follow up (discussed below) of any field trip need to be included in order for field work to be effective (Remmen & Frøyland, 2014).

Supplementing EL Trips with Technology

With increasing mobile technology making its way into the classroom, opportunities are arising to implement the use of technology in EL programs. Zimmerman and Land (2014) used

mobile computers on an EL trip to increase location awareness in ways that accentuated physical aspects of the setting of the outdoor informal environment where learning was taking place. Fictional scenarios were added to these locations through the use of computers, which the authors referred to as "participatory simulations" in which problems or narratives were given to the students (Zimmerman & Land, 2014). Throughout the outdoor area QR codes labeled trees and flowering plants with information on the species and characteristics. Animals were also included in the computer simulation portion, as they would be associated with many of these plants but were not expected to be visible at the location or time of visit (Zimmerman & Land, 2014).

Allowing for Reflection

While field work in itself is a positive experience in learning, it is most efficient when paired with reflection and metacognition on the activity, which is shown to deepen understanding and expand students' concept of themselves as thinkers and learners (Ballantyne, Anderson, & Packer, 2010).

After a day of field work, students in the Ballantyne et al. (2010) study met the second day to solve a hypothetical environmental problem using the experiences they had in the field to support their solution. This discussion was video recorded, and on the third day, students watched the recording and talked through reflecting on what they learned. Students reported enjoying the discussion activity, and felt that they learned a lot from it.

Students recognized that group discussion deepened their learning. They also believed that they learned more at camp through fieldwork and discussion than they learned in the

classroom. They had a chance to describe their method of coming up with ideas and sharing them, something they had not done before (Ballantyne et al., 2010).

Self-evaluation allowed students to see how they think and the styles in which they learn (Ballantyne et al., 2010). Students noticed that this experience utilized interdisciplinary connections, and they learned much more than biology. Their reflection helped them see how what they learned in biology was a part of the real world and how all of these different parts of their previous education could be connected to real life events.

Obstacles in EL

While EL offers a multitude of benefits and opportunities for gaining knowledge and building skills, there are some obstacles that may be encountered when implementing EL trips and programs. Some research has already been done on overcoming these obstacles while in other cases more research needs to be done.

In Fägerstam's (2014) study, some teachers did find that the first couple of months of occasionally moving classes outdoors proved difficult in keeping students on task in the new setting. However those teachers who continued this approach found that student behavior improved once working outdoors became a regular part of the schedule (Fägerstam, 2014). In time, teachers noticed a more relaxed atmosphere than indoor teaching, and a change in the classroom hierarchy that they enjoyed.

In one of the classes that Remmen and Frøyland (2014) studied, they noticed that when students who were participating in an EL trip encountered a challenge in the field, they quickly gave up, instead of thinking deeper and asking questions as expected by their teachers. With the teacher out of sight, these students did not have the motivation to think deeper and instead gave

up. However in another class that Remmen and Frøyland (2014) observed, they found talk that reflected deeper engagement in the preparation and field work phases of the lesson. They did not see this same engagement in the follow up phase, however. The follow-up product was a report, and students were often disengaged during the researching and drafting of the reports. To avoid this, Remmen and Frøyland (2014) suggest more verbal interaction with peers and the teacher with higher level questioning in the follow up phase, instead of assigning an individual research report.

Scogin et al., (2017) observed off-task behavior and occasional frustration with group members that was a detractor from engagement and collaboration at times. However in their experience, these situations tended to sort themselves out without being detrimental to the EL experience.

Puhek et al. (2012) noted that some trips are very costly to schools, sometimes safety is an issue, and some trips are difficult to differentiate or modify for students with disabilities. In these situations solutions could be made from findings on technology in their study or in Hougham et al.'s (2015) study on technology to create virtual EL experiences. Fägerstam's (2014) study on outdoor learning on school grounds could also offer solutions.

Mueller et al. (2012) mentioned one downfall of citizen science is that many projects only ask students to collect menial data, and do not allow them to become a deeper part of the research. Often students are not involved in the developing of ideas, asking of questions and constructing of analysis that the scientists behind the project are involved in. Mueller et al., (2012) suggest that teachers take responsibility for creating inquiry scenarios in these situations.

Lastly, Nichols et al. (2016) found that students of young ages cannot be introduced to environmental topics in a negative light, as is often done in problem-solving EL tasks. They found that doing so pushed them away from the topic. Older students can handle this introduction better and will work towards solving the problem.

Middle School Critical Period for Science Interest and Skill Development

Researchers such as Lin and Schunn (2016) claim that interest and motivation for learning science in the middle school years acts as a predictor for future interest in science careers. Studies have found that the images children create before age 12 are highly significant to their future career choices and their beliefs about science throughout their life (Eshach, 2007). Additionally, non-cognitive skills such as communication, collaboration, critical thinking, problem solving, and adaptability are best introduced to students during middle school years (Scogin et al., 2017).

CHAPTER 3

Steps for Implementing Experiential Learning in Your Classroom

While an efficient and beneficial experiential learning experience is more complex than a typical field trip, we can simplify the planning process by following a basic template. As described in the review above, a key difference in structure between an average field trip and an experiential learning trip is the continuity between classroom learning and learning that takes place in the field. To accomplish this, there must be ample preparation of students for the setting, skills and content that will be addressed in the field, as well as discussion, explanation and extension that will bring the field experience back into the classroom afterwards and integrate it with further classroom learning.

The template below offers a suggested structure for experiential learning lessons, and was used in each of the example modules provided in the following chapter. The items in red are included to organize what will be taught and how the lessons align with standards and fit in the curriculum. The lesson planning template begins with general questions such as content area and grade, unit, and main questions to be addressed in the lesson to get a main idea of what the lesson will cover. Next, including the standards that apply to the topic and main questions allows the teacher to align with the curriculum and helps narrow down the learning objectives, which come after. Note that in the examples that follow, the standards listed are from the Living Environment section of the New York State Intermediate Level Science Core Curriculum (link in references). Topics and ideas that students should already be familiar with can be listed as prior knowledge, which helps to set a starting point for where the new learning objectives will pick up. It also it beneficial to review expected prior knowledge so that the teacher can fill in any gaps or

review any ideas that students will need before moving on to the ideas presented in the experiential learning lesson.

The green items in the template allow the teacher to be prepared for the trip that they will be leaving the classroom for. It includes “Location Attributes”, where all of the information about the site to be visited can be recorded. This can include anything from parking and accessibility to organizing what the encounter will hold and what can be learned from or experienced at this site. This section can include ecological and historical information and history, admission requirements or costs, and maps to assist in planning and navigating. Under “Materials Needed”, the teacher can list anything and everything that they will need for the lesson overall, and what needs to be included and taken on the trip.

The template includes information needed to bridge the experience to the classroom in purple. Notice that this bridging takes place before *and* after the experience. It will include the part of the lesson that will take place in the classroom that relates to the field portion of the learning experience. Before the lesson, students must be prepared for the trip on three fronts: on the topic, on the location, and on what behavior is expected of them. Introducing the topic and concepts to be explored before going on the trip allows for students to have sufficient understanding of what they will be learning about so that they can make the necessary connections between their experience and the science content. We want to introduce aspects of the location beforehand as well, so that there is less of a “Novelty Phenomena” effect -coined by Eshach (2007)- in which students are so excited and overwhelmed by a new experience that they cannot focus on learning. This also helps to maximize efficient use of time once on the trip, because students will know all about what they will encounter and where they should be completing their activities. Sharing “Rules and Expectations” with students before the trip is

important both for their learning and their safety. They must understand how to conduct themselves and know of any safety precautions to take.

Following the trip, their learning is extended via sharing their findings and experiences, taking those ideas and moving forward to more complex concepts, and reflecting back on the experience. Students should reflect not only on what they learned, but also on the skills they used and their applications, and what the experience meant to them. An assessment at the end of the lesson not only summarizes all of the learning that took place, but can also be used as further extension of what was learned as we will see in the examples that follow.

The blue section of the template below represents what will actually be taking place during the experiential learning trip. It includes a timeline of events so that time can be used most efficiently and everyone involved will be on the same page. It is especially important to have a pre-planned schedule if students (and chaperones) are dispersed throughout a forest and need to catch the bus at a particular time. This also allows for very specific planning of the trip, which will make everything go more smoothly during the experience. Beneath that you will see "Details of Competing Activities" which is where all of the details of the experiential learning trips' activities can be laid out. All of the worksheets can be copied or linked into this section, and all of the directions to be given to students can be written out. This allows for everything to be completed on the trip to be planned out and saved in one place.

This template is only one way to organize the important aspects of planning an experiential learning trip that I have described. It can easily be modified to fit any specific needs of the teacher while they plan, or to include specific needs of a class and other information that a teacher may find useful to include.

Template

Content Area/ Grade Level:

Unit:

Main Question:

Standards:

Prior Knowledge:

Learning Objectives:

Location Attributes:

Materials Needed:

Pre-trip Preparation:

Introducing the topic-

Introducing the location-

Rules and expectations-

On Location Student Activities:

Timeline of events for the trip-

Details of completing activities-

Post- Trip Extension:

Sharing findings-

Extending ideas-

Metacognitive Reflection-

Assessment:

The chapter to follow includes six different examples of experiential learning trips and accompanying lessons laid out following this template. The example lessons take place in Rochester, NY and surrounding suburban areas.

CHAPTER 4

Example Lessons

Module 1: Ecosystem Exploration in Corbett's Glen

Grade Level/ Content Area: 7th grade Living Environment

Unit: Ecosystems

Main Question: How do organisms interact and transfer energy through the ecosystem?

NYS Intermediate Level Science Standards:

1.1 Compare and contrast the parts of plants, animals, and one-celled organisms.

> 1.1h Living things are classified by shared characteristics on the cellular and organism level. In classifying organisms, biologists consider details of internal and external structures. Biological classification systems are arranged from general (kingdom) to specific (species).

5.1 Compare the way a variety of living specimens carry out basic life functions and maintain dynamic equilibrium

> 5.1a Animals and plants have a great variety of body plans and internal structures that contribute to their ability to maintain a balanced condition.
>
> 5.1d The methods for obtaining nutrients vary among organisms. Producers, such as green plants, use light energy to make their food. Consumers, such as animals, take in energy-rich foods.
>
> 5.1e Herbivores obtain energy from plants. Carnivores obtain energy from animals. Omnivores obtain energy from both plants and animals. Decomposers, such as bacteria and fungi, obtain energy by consuming wastes and/or dead organisms.

6.1 Describe the flow of energy and matter through food chains and food webs.

> 6.1a Energy flows through ecosystems in one direction, usually from the Sun, through producers to consumers and then to decomposers. This process may be visualized with food chains or energy pyramids.
>
> 6.1b Food webs identify feeding relationships among producers, consumers, and decomposers in an ecosystem.
>
> 6.1c Matter is transferred from one organism to another and between organisms and their physical environment. Water, nitrogen, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environment.

6.2 Provide evidence that green plants make food and explain the significance of this process to other organisms.

6.2b The major source of atmospheric oxygen is photosynthesis. Carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.

6.2c Green plants are the producers of food which is used directly or indirectly by consumers.

7.1 Describe how living things, including humans, depend upon the living and nonliving environment for their survival

7.2 Describe the effects of environmental changes on humans and other populations.

7.2a In ecosystems, balance is the result of interactions between community members and their environment.

7.2b The environment may be altered through the activities of organisms. Alterations are sometimes abrupt. Some species may replace others over time, resulting in long term gradual changes (ecological succession)

Prior Knowledge:

Photosynthesis and its function in creating food for energy in plants

Students understand the steps of photosynthesis, most importantly what materials are used and what result, and that this is the process that makes food for the plant cell, so it can then make energy.

All organisms need energy to power their cells.

Students understand the basic idea of homeostasis and that all organisms are made up of cells that need a constant supply of energy to keep them alive, otherwise the cells and whole organism will die.

Learning Objectives:

Students will be able to identify organisms as producers/consumers/decomposers.

Students will be able to organize the organisms in an ecosystem into a food or energy web/pyramid based on their roles as producers/consumers/decomposers.

Students will identify ways that organisms in an ecosystem interact and depend on one another

Students will be able to recognize and predict ways that humans change ecosystems and what the effects will be.

Location Attributes:

Location: Corbett's Glen is a Nature Park located in Brighton/Penfield, NY just off of the 490 expressway and about 10 minutes from the city of Rochester. The park encompasses 52 acres and includes a section of Allens Creek complete with small waterfalls. For being surrounded by urban area, the park is exceptionally natural in comparison. GPS Coordinates: 43.129780, -77.520994

Amenities: Parking is limited, meaning busses may have to drop off and return at pick up depending on available space. A well maintained trail and boardwalks run throughout the park. No bathrooms are located on site.

Ecology: The Allens Creek Valley was carved by glaciers and is an environmentally sensitive ecosystem that is home to a lot of wildlife and native plants. It contains four distinct plant communities:

- successional northers hardwoods
- successional shrub lands
- successional old fields
- shallow emergent marshes.

Additionally, 15 invasive species have been identified in the park.

History:

Native Americans lived and traded from the Allens Creek valley before the City of Rochester was established.

Gun powder mills using the creek as a power source were built in the park in 1823 and operated until being moved to a more remote location in 1870. They exploded a number of times, often with fatalities.

The railroad was built in the early 1850s as the first in the area and later the bridge over the creek (as well as the powder mills) had to be guarded during the Civil War.

These railroad tracks were used to bring Abraham Lincoln's body back to Illinois for his funeral in 1865.

A man named Patrick Corbett bought the property in 1889 and developed his own unique irrigation system to bring water from the creek to his farmlands.

In the 1920s people began using the Glen as a park and visiting it in their free time.

The 490 expressway was built in the 1960s and work on the sewer lines during that time resulted in heavy pollution of the waters in Allens Creek at the Glen.

Flooding from Hurricane Agnes in 1972 damaged the area and railroad bridge.

A Pure Waters project in 1980 cleaned up the water in the Glen to its original state.

Iroquois chiefs visited the Glen in the 90s to help fight to preserve the park.

Materials Needed:

Appropriate outdoors clothing for the season: Footwear for walking/ hiking outdoors. Hip boots/ waders or other water shoes if planning to go into the stream.
Clipboards and writing utensils
Worksheets
Cameras
Identification pocket guides

Pre-trip Preparation:

Topics to be covered before the trip:

Producer/ consumer/decomposer roles

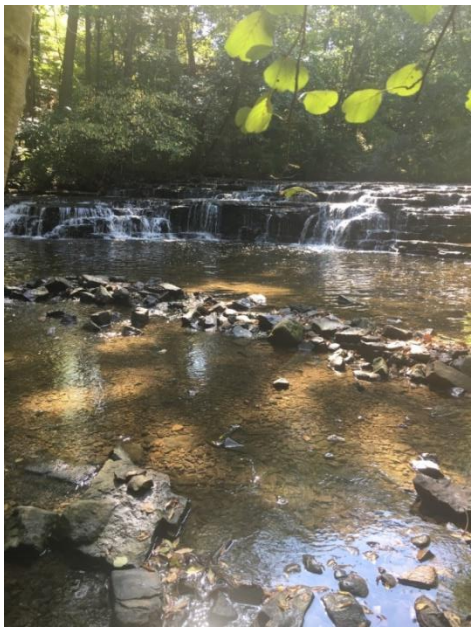
Riparian zones and their importance on life in the creek

Interactions between organisms

Flow of energy and webs

Introducing the location:

Begin by sharing a picture from the park and asking students where they think the picture was taken. Choose an image (such as the following) that looks wild and pristine. Students will be surprised to find that these natural images were taken in such close proximity to the city of Rochester.



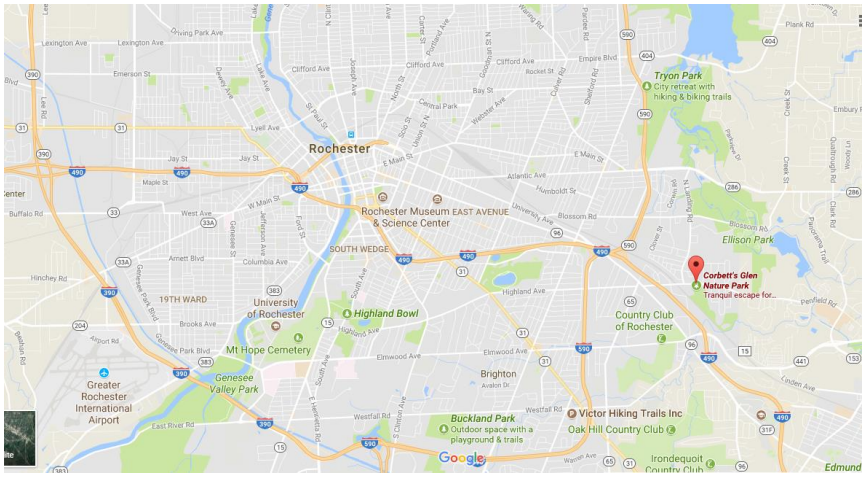
Allen Creek in Corbett's Glen. Despite its proximity to the city and 490 Expressway, the Creek and surrounding area in the Glen retain their natural beauty. Author's photo.

Share map images (such as the following) and explain where the park is in location to the school. Discuss reasons why the park could look so natural despite being right outside the city and surrounding a housing development.

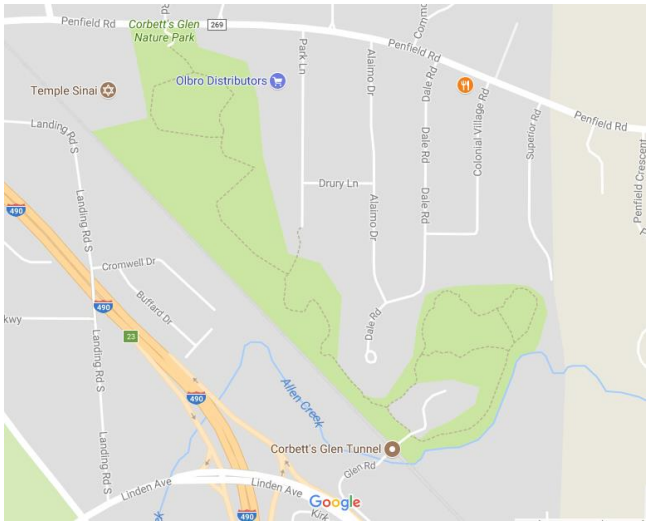
(Possible explanations: protected area, little human interaction, well regulated)

Share distances from school and details about arrival.

Ex: We will board the bus at 9:00, and should be ready to leave school by 9:15. It is about a 12 minute drive to the park, and the bus will drop us off at the Glen Rd entrance by 9:30. We are going to walk down this road, and enter the park through the Corbett's Glen Tunnel that is marked on the map.



Google Maps image of Corbett's Glen in relation to the Greater Rochester Area



Google Map view of the park at Corbett's Glen

Share the information from Location Attributes section with the class.

Share group assignments and assign chaperones so that students know who they will be working with.

Rules and expectations:

- Stay within view of your chaperone and remain in your group. Be sure to listen to your chaperone for directions and treat your chaperone and your group members respectfully.
- Do not pick or break anything off of live plants- leaves, fruit, flowers etc. You may take something off of the ground (such as fallen leaves) but check with your chaperone first. We do not want to disturb the environment by picking flowers that need to be pollinated, taking fruit with valuable seeds or food for animals, etc.
- DO NOT LITTER. Be sure that anything that is taken into the park with you comes back with you on the bus. This includes worksheets and writing utensils, water bottles, lunch wrappers etc.
- Stay on the paths unless otherwise directed by your chaperone. We need to be careful of poison ivy, and of stepping on young plants.
- Stay off of private lawns

On-Location Student Activities:

Timeline of events:

- 8:30 - Arrive and enter the park. Everyone will meet at picnic table near the sign and map
- 8:45- Worksheets and clipboards passed out. Groups assemble (pre-formed groups) with chaperone.
- 9:00- Groups embark into the park to make observations and complete worksheets.
- 11:00- Groups meet back at picnic table by sign.
- 11:15- Bus arrives
- 11:30- Return to school, all supplies brought down to science classroom

Details of completing activities

Students will have the following worksheet that they will be completing during the trip. They will travel throughout the park and in each different ecosystem they find themselves in, they will take note of organisms they observe and classify them on their worksheets as producers, consumers or decomposers. They do not have to visit each of the 5 ecosystems, but should fill out at least 3.

If Possible: Cameras will be provided (or phones can be used depending on the class and school rules) and students will take photographs of each organism they record on their sheet.

(Note: some animals move quickly- mice, voles, birds, fish- so some may not be able to get a picture of every animal they see)

Though some organisms may be unfamiliar to students, they are encouraged to use the provided identification guides to ID the organisms they see. Chaperones and the teacher can help if needed.

Name: _____ Date: _____

Energy Transfer in Corbett's Glen

Record organisms you observe in the park in the correct column of the tables below. Work together with your group or consult a chaperone if you are unsure of what an organism does for food. Fill out a new table for each different ecosystem you encounter. The possible ecosystems are: **hardwood forest**, **successional shrub land, successional old field, shallow emergent marsh** or **stream**

Use the cameras to photograph each organism you are including in your chart (we will be using these photographs later)

Habitat: _____

Producers	Consumers	Decomposers

Evidence of human interaction:

Habitat: _____

Producers	Consumers	Decomposers

Evidence of human interaction:

Habitat: _____

Producers	Consumers	Decomposers

Evidence of human interaction:

Post- Trip Extension:

Sharing findings:

Begin the following class by having groups meet to recap their observations on the trip. Allow students to share something they learned, something surprising they observed, or how they felt about the trip if they wish to the class.

Each group of students will create an energy web from one of the five ecosystems they visited in the park. All 5 ecosystems will be covered so groups will either be assigned their ecosystem, or students can share their preferences if they want a particular ecosystem. See "**Assessment**" below for details about this project. Each web poster will be presented to the class, so that students can compare their findings with a completed web. Students will become the class "experts" on their assigned ecosystem, and their peers may ask any questions that they have.

Extending ideas:

The **Assessment** below illustrates the extension from observations and classifications we made in the field to organizing and designing webs in the classroom. This does not always have to be done through assessment, however this was a great opportunity to share and extend ideas while also assessing what students were able to learn.

Assessment:

Upon returning to school, students will use their observation charts from the trip to create energy webs that will be shared with the class and displayed in the hallway.

Assignment:

Name:_____ Date:_____

Group Members: _____

Energy Web Poster

Using the tables you created at Corbett's Glen, each group will create an energy web for one of the ecosystems we visited. Use pictures of the organisms you saw in your chosen ecosystem to create your web. Be sure to include the following information that is outlined in the rubric. Chromebooks are available for printing of pictures and for extra research that needs to be done, such as for creating descriptions of organisms.

Rubric:

Criteria	4-5 Points	2-3 Points	0-1 Points
Each organism is labeled with a name,	Name, role and picture are all present	One label is missing or incorrect	Multiple labels are missing or incorrect

a role and a picture	and correct		
Label (producer, consumer or decomposer) for each organism is correct	Label is included and correct	All labels are included but 1-2 are incorrect	Labels are missing or incorrect
The web correctly shows flow of energy	Flow of energy is displayed and correct	Flow of energy is displayed but there are errors	Flow of energy is not displayed or is mostly incorrect
A short description of each organism is present (appearance, food source and habits)	Descriptions are clear, detailed and correct	Descriptions are incomplete or incorrect	Descriptions are not included
Creativity and effort into creating the poster is evident	Creativity and effort into creating the poster is evident	Creativity and effort into creating the poster is not apparent or minimal	Little to no creativity or effort appears to be put into it

Further extension could follow:

Using the interactions we observed in our learning experience to discuss other interactions between organisms and symbiotic relationships.

Moving from the energy portion of ecology to learning about population ecology

Metacognitive Reflection

Have the students complete the following exit assignment following the presentations of their energy webs. If time allows, they may volunteer to share some answers with the class or with group-mates.

Name:_____ Date: _____

Corbett's Glen Reflection

Please answer the following questions, using what we have learned about ecosystems and energy webs, your experience at the Glen and your own opinions.

1) What do you think is the most important thing you learned from this trip?

2) What skills involved in this trip were you good at? What skills do you think you could work on?

3) How can you use your ability to identify plants and animals in your life outside of school?

4) How can our knowledge of energy webs be useful to us outside of the classroom?

5) How do you feel about nature parks like Corbett's Glen? Did you feel the same or differently before our learning experience?

Module 2: Tadpoles Teaching Life Cycles and Patterns of Development

Grade Level/ Content Area: 7th grade Living Environment

Unit: Reproduction and Development (With ecology portions as well)

Main Question:

How does an organism develop from a single cell to an adult?

What changes in body structure and function can be seen as an organism grows from a single fertilized cell to a mature adult?

NYS Intermediate Level Science Standards:

4.1 Observe and describe the variations in reproductive patterns of organisms, including asexual and sexual reproduction.

4.1c Methods of sexual reproduction depend upon the species. All methods involve the merging of sex cells to begin the development of a new individual. In many species, including plants and humans, eggs and sperm are produced.

4.1d Fertilization and/or development in organisms may be internal or external.

4.3 Observe and describe developmental patterns in selected plants and animals (e.g., insects, frogs, humans, seed-bearing plants).

4.3a Multicellular organisms exhibit complex changes in development, which begin after fertilization. The fertilized egg undergoes numerous cellular divisions that will result in a multicellular organism, with each cell having identical genetic information.

4.3c Various body structures and functions change as an organism goes through its life cycle.

4.3d Patterns of development vary among animals. In some species the young resemble the adult, while in others they do not. Some insects and amphibians undergo metamorphosis as they mature.

4.3f. As an individual organism ages, various body structures and functions change

4.4 Observe and describe cell division at the microscopic level and its macroscopic effects.

4.4a In multicellular organisms, cell division is responsible for growth, maintenance, and repair.

Prior Knowledge:

Organisms can reproduce asexually or sexually, depending on the organism.

Sexual Reproduction takes place in animals like amphibians, where an egg is fertilized by sperm.

Body cells multiply via mitosis, which results in growth and repair of an organism

The steps of mitosis and that it results in identical daughter cells.

The steps of meiosis, and that it is only found in gametes that have half of the necessary chromosomes.

Learning Objectives:

Students can describe and illustrate the life cycle of a frog, including information about its habitat.

Students will understand changes that occur in organisms as they mature from fertilization to adult.

Students will recognize changes in structure of the body of a frog from a tadpole to an adult through observation and are able to describe the resulting changes in function.

Location Attributes:

This trip can take place to any vernal pond in which tadpoles are present. Be informed of the spawning seasons for tadpoles in your area- generally, this is a springtime trip.

While amphibians generally return to spawn in the same pools year after year, I suggest that a preliminary trip is made to the location you are planning on using before bringing students to check for tadpoles. With that being said, sometimes nature is unpredictable and it may be hard to find any.

This learning experience has two parts: the trip into the field to observe tadpoles in their natural habitat, and the raising of tadpoles in the classroom from a trusted source such as Ward's Science (see below).

According to Kwan and Textly's (2003) book, *Inquiring Safely : A Guide for Middle School Teachers,* it is not appropriate to bring wild amphibians such as tadpoles into the classroom from their natural habitat. This is mainly because there are a number of endangered species of amphibians, and pulling unidentified organisms from their natural habitat can be destructive. They also state the dangers of raising animals from the wild to return later in their lives after a period of captivity, and how this can disrupt their ability to migrate and otherwise care for themselves (2003). Therefore, the tadpoles raised in the classroom should come from a reputable source such as Ward's Science.

This trip will require traveling to a body of water. Safety measures surrounding the possibility of falling into the water and the potential of drowning need to be considered. A life preserve device should be on hand for trips to bodies of water where falling in might be a possibility.

Materials Needed:

Appropriate dress for outdoors and water resistant footwear

Amphibian pocket identification guide

Aquatic and woodland plant identification guide

Clipboards and writing utensils

Water resistant cameras (or regular cameras kept from the water's edge)

Worksheets

Tadpoles ordered from a science supply vendor such as Ward's- be aware of shipping details. Often these are shipped overnight, and need to be received immediately upon delivery

Pre-trip Preparation:

Topics to be covered before the trip

Introduction to life cycles – discuss what a life cycle is and that some organisms go through very different stages in their lives, whereas humans do not. A graphic organizer can be used to compare life cycles- like that of a butterfly, a tadpole, or other organisms students know of- to how humans develop.

Amphibians and their habitat- While most of this will be learned through observation, be sure to go over the basics with students before the trip: Frogs are amphibians, amphibian means in water and on land, they lay eggs in water where tadpoles hatch, then come out of the water as adults, this water is often ponds in the woods, etc.

Native frogs and their tadpoles- Share pictures of the native species of frogs and what their egg masses and tadpoles look like.

Introducing the location

This would be a great learning experience to conduct on school grounds if possible. A number of school campuses have small ponds, which are prime spawning locations for frogs and other amphibians. If water quality and other safety checks allow it, students would be able to explore an exciting life cycle and habitat that takes place right in their "own backyard."

A definite location cannot be provided for this example module, but a possible location could be the Nature Center at Spencerport. This location, like other similar areas on school campuses, is convenient in location, interesting to students who can learn about animals that live right on the same property where they go to school, and even allows for students to return to see the wild tadpoles as there are developing, and can compare them to the ones they will be raising in captivity.

The Spencerport Nature Center is a 30 acre forested area encompassing a number of foot trails and a small pond with fountains and dock-like platforms along the water's edge. It is owned and operated by the Spencerport Central School district and is open to the public from 4:00- dusk on school days, or during daylight hours on non-school days.

Looking northwest across the pond in the Spencerport Nature Center. Author's photo, taken in October.

Rules and expectations

The rules posted by the Spencerport School District for the Nature Center are as follows:

- Please stay on designated trails, docks, paths
- Carry in—Carry out with all waste
- Dogs allowed on leashes only. Please clean up after your dog
- Bikes & motorized vehicles are not permitted
- Building any structures, paths or passage devices is not allowed
- Removal or destruction of vegetation/wildlife is not allowed
- Introduction of any animals, plants, etc. is not allowed
- Firearms, hunting, baiting, fishing and fires is not permitted

- Use of any tobacco product or alcoholic beverage is not permitted

Additional Rules:

- No horseplay near the water: be aware of the risk of falling into the pond. Check with students (privately) to know if there are any that are not confident swimmers
- Keep any equipment or materials back away from the edge of the water. Let students know that anything that is dropped in will not be retrieved.

On Location Student Activities:

Timeline of events

This trip can be a shorter one; especially if it is on campus, this trip can take place within class time. Example:

10:00: Equipment is gathered, directions are revisited and class prepares to leave the building at the teacher's lead.

10:10: Arrive on site. Groups take turns approaching the water to look for tadpoles and observe their behavior under the watchful eye of the teacher. When not looking into the water, other groups are making observations of the surrounding habitat

10:35: Groups come back together to share interesting observations and ask questions

10:45: Head back to classroom

10:55 Back in classroom and unpacked for dismissal to the next class

Details on Completing Activities

Students will work in partners or small groups to compile observations made in the aquatic environment, in the surrounding environment, and of the tadpole's behavior using the worksheet below.

Name: _____ Date: _____

Wild Tadpole and Habitat Observations

Use the following prompts to guide you in making observations in the frog and tadpoles natural habitat.

1) List observations of the pond environment (water, objects, other living things, etc.):

2) List observations of the surrounding forest environment (what do you notice when you look around the pond? Plants, animals, objects, climate, etc.):

3) List observations of the tadpoles (what do they look like, what are they doing, etc.):

Post- Trip Extension:

Sharing findings

The following class, partners/ groups will pair up with another partner/ group and discuss their observations from the trip. Students will add to their list if their new partners made observations that they did not have.

After sharing their observations in these groups, students will use their observations to make a list of things that must be included in the habitat that we will build for our tadpoles so that it resembles their natural habitat and provides everything they need to survive.

They then can use books provided by the teacher, internet sources and articles to research requirements for a habitat for the species of tadpole that they will be raising.

Name: _____ Date: _____

Group Members: _____

Building a Tadpole Paradise

1) What things that are found in the tadpoles' natural habitat need to be included in our tadpole home?

Item	Purpose

2) What kind of water do we use in our tadpole home?

3) What kind of conditions should we provide to our tadpoles?

4) How much space do we need for our tadpoles?

5) How will we have to change the “tadpole home” when our tadpoles become frogs?

Come together as a class and make a class list of specifications for the habitat you will be building. Be sure to have researched this topic yourself, so that you can check your students’ facts and fill in any gaps they may have missed!

Extending ideas

Once the homes are set up and the tadpoles arrive, students will be able to make weekly observations of the growth and development of the tadpoles. While the every-day focus of science class may move on to other topics, there should be at least one day a week to make and record observations of the tadpoles/ frogs, to discuss what changes

can be seen in structure and why those changes are occurring, and how the changes will result in a mature frog.

*Note: Northern Leopard Frogs (the species available as tadpoles from Wards) take between 2 to 3 months to develop, and that can vary based on conditions such as temperature. Therefore, an observation schedule might have to be altered based on how quickly or slowly the frogs are developing.

A graphic organizer such as the following can be used.

Name: _____ Date: _____

Tadpole Growth Observation Sheet

We will be using this sheet to take notes on our tadpoles every week, so keep it safely in your binder!

Week 1:

Body Structure	Picture	Behavior

Week 2:

Body Structure	Picture	Behavior

Week 3:

Body Structure	Picture	Behavior

Week 4

Body Structure	Picture	Behavior

Week 5:

Body Structure	Picture	Behavior

Week 6:

Body Structure	Picture	Behavior

Week 7:

Body Structure	Picture	Behavior

Week 8:

Body Structure	Picture	Behavior

Week 9

Body Structure	Picture	Behavior

Week 10:

Body Structure	Picture	Behavior

Metacognitive Reflection

The first can be used as an exit ticket after the trip outside. The second can be a part of their project at the end of this unit, or an exit ticket on the day that the projects are completed.

Name: _____ Date: _____

Tadpole Trip Reflection

1) What is something you learned from our trip to the pond today that you didn't know before?

2) Why is it important to study the tadpoles' natural habitat before we raise our own?

Name: _____ Date: _____

Tadpole Unit Reflection

1) Why was studying the growth and development of the tadpoles important?

2) What benefits did raising the tadpoles have over learning about development through pictures?

3) What skills did you use during this unit? How are these skills important or how can you use them in the future?

Assessment:

Independent Project

Directions: Imagine you are an explorer who has traveled to a faraway land and has discovered the first frog. You came across a pool of tadpoles and have taken a few into captivity to study. Imagine your excitement at being the first person to witness the metamorphosis from tadpole to adult frog!

Your Task: To write about your findings to the people from your home who have never seen a frog before. Your writing must include:

- A description of the habitat from which your frog specimen was captured
- Your initial thought on what you had found (what you though the tadpole might be or do- get creative!)
- The stages of development that you have witnessed the tadpole/frog go through – be descriptive and include photographs or drawings at different stages
- What the animal was able to do at each stage (swim, what it ate, walk on land, reproduce, etc.)
- A description of the mature adult and a name for it, and what other animals it might be closely related to
- Be creative and include personal thoughts, such as what your reactions were when watching the animal go through these stage (remember, this is the first time you have seen this) !

*** While you may and should get creative with the scenario, all of the information on the animal, its life cycle and its habitat must be accurate based on what you learned, observed and researched during this unit

Choose a format you prefer to use from the following options. It must include **pictures or drawings** *and* **writing or speaking** that is descriptive. If you have an idea that is not listed below, talk with your teacher.

- Write a series of letters to someone back home- your significant other, or the person/institution who funded your trip
- Write a news series that will be printed in your home newspaper
- Write a scientific article describing your findings for the science community
- Make a documentary video using pictures or video clips of the tadpole/ frog, and narrate it or star in it
- Create a video diary in which you recount different recordings and show the tadpoles/frog or pictures of them

Rubric:

Criteria	Well done- 2 points	Partially Included- 1 point	Missing or completely incorrect- 0 points
Accurate description of habitat			
Accurately covers all stages of development			
Accurate description of function at different stages			
Description, name and classification of the mature frog			
Descriptive throughout			
Creative storyline and communication			

Module 3: Alien Invaders

Grade Level /Content Area: 7th grade Living Environment

Unit: Ecosystems and Human Impact

Main Question: What happens when a foreign species is introduced to a new area?

NYS Intermediate Level Science Standards:

7.1 Describe how living things, including humans, depend upon the living and nonliving environment for their survival.

> 7.1b Given adequate resources and no disease or predators, populations (including humans) increase. Lack of resources, habitat destruction, and other factors such as predation and climate limit the growth of certain populations in the ecosystem.

7.2 Describe the effects of environmental changes on humans and other populations.

> 7.2c Overpopulation by any species impacts the environment due to the increased use of resources. Human activities can bring about environmental degradation through resource acquisition, urban growth, land-use decisions, waste disposal, etc.

Prior Knowledge:

> Populations, communities and how different species interact with the environment
>
> > Students know that populations are a group of one species that live in an area and a community is all the species that live in an area.
>
> Basic needs of life for all organisms and sources of competition
>
> > Students know that there are limited resources in a community that all organisms living there have to share
>
> Energy pyramid/ web and the interconnectedness of all species in the environment
>
> > Students know that all living things in an environment are connected and that change in one place or one part of the pyramid will result in changes elsewhere.

Learning Objectives:

> Students can identify invasive species in the field
>
> Students can observe and predict effects that an invasive species has or will have on an ecosystem

Students can use research and problem solving skills to propose solutions to prevent, limit or remedy spread of invasive species and resulting damage.

Location Attributes:

This is another great trip to take on a school campus or within walking distance of the school, because it shows students that environmental changes like invasion of species are happening right outside of our windows, and a lot of us don't even notice what is happening. The location may vary from year to year, or a new invasion may take place that offers a better learning opportunity and call for a change from the original plan. Wherever you choose to carry out this activity, be sure to take a visit before the trip to make sure you can find what students will be looking for, even if it is expected to be the same year after year.

The pictures below were taken in Oatka Creek Park in the town of Wheatland and are a great example of a landscape affected by an invasive species. GPS Coordinates: 43.006117, -77.791754

Invasive Swallow Wort taking over a patch of forest; a common sight in Oatka Creek Park. Author's Photo.

Materials Needed:

Outdoor attire

Invasive species identification pamphlet/ book/ material

Clipboards and writing utensils

Cameras (cell phones are fine)

Worksheets

Pre-trip Preparation:

Introducing the topic

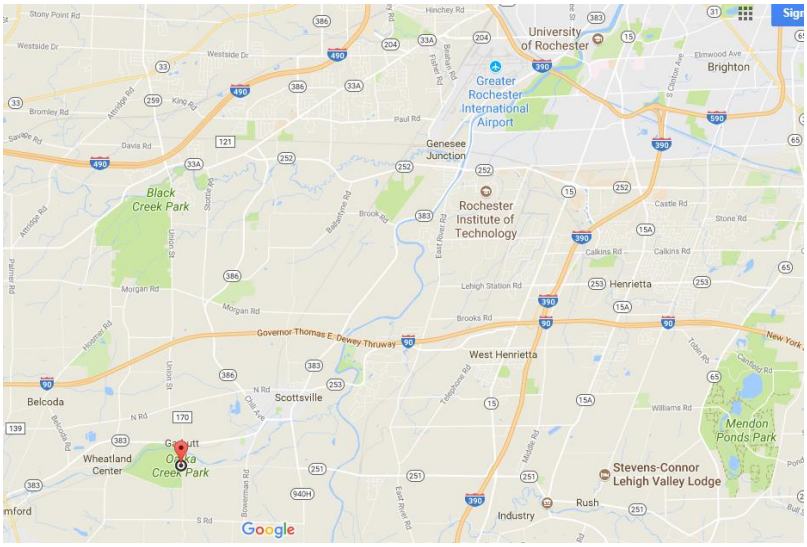
This lesson can begin with a fun introduction of “alien invasion”. Students can come into the room to find an image of a typical alien on the front board, maybe images of aliens on their desks and elsewhere. The class will think-pair-share about what they think of when they hear the word “alien” and some words that can be used to describe an alien. Then together as a class, make a list of words and characteristics of aliens (for example: they are from somewhere else, they are similar in some ways but also different, nobody knows how to interact with them, etc.), and what they think of when you say “alien invasion.”

This introduction will lead into the introduction to invasive species, and how these invaders are often considered “alien” to their new surroundings. Highlight similarities between this situation and the lists that students came up with when they think of aliens.

Review necessary information about the workings of an ecosystem, and skills that will be used in making observations in the field that we have used previously in other field ecology experiences.

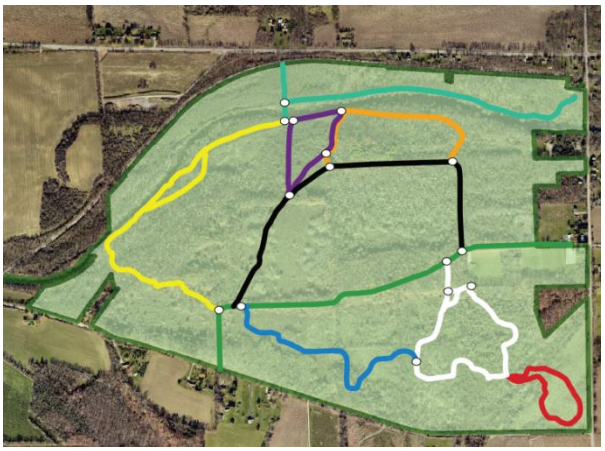
Introducing the location

This location may be just behind the school, or may be in a nearby park such as Oatka Creek Park discussed above. Show a map of the area that will be explored, even if it is on school grounds.



Google Maps image of Oatka Creek Park in relation to the Greater Rochester area

Google map image of the park



Map depicting the different colored trails throughout the park.

Rules and expectations

- Stay within view of your chaperone and remain in your group. Be sure to listen to your chaperone for directions and treat your chaperone and your group members respectfully.
- Pay attention to which colored trail you are on, and keep a map with you (to be provided by teacher from https://www2.monroecounty.gov/files/parks/oatkatrailmap.pdf)
- Do not pick or break anything off of live plants- leaves, fruit, flowers etc. You may take something off of the ground (such as fallen leaves) but check with your chaperone first. We do not want to disturb the environment by picking flowers that need to be pollinated, taking fruit with valuable seeds or food for animals, etc.
- DO NOT LITTER. Be sure that anything that is taken into the park with you comes back with you on the bus. This includes worksheets and writing utensils, water bottles, lunch wrappers etc.

- Stay on the paths unless otherwise directed by your chaperone. We need to be careful of poison ivy, and of stepping on young plants.
- Be careful with cameras, phones or other valuables when near the creek
- If you encounter any horses or dogs along the trail keep your space unless otherwise directed by their owners.
- Always keep your distance from wildlife, even if it seems friendly or looks injured.

On Location Student Activities:

Timeline of events for the trip

Example: Traveling from Wheatland Chili Middle School to Oatka Creek Park

Drive time from school: 6 minutes

- 9:00 - Arrive and enter the park. Busses will drop off students in parking lot and everyone will meet at the gated trail by the soccer field
- 9:10- Worksheets and clipboards passed out. Pre-assigned groups will meet up with chaperones.
- 9:15- Groups embark into the park to make observations and complete worksheets.
- 10:45- Groups meet back at picnic table by sign.
- 10:50- Bus arrives
- 11:00- Return to school, all supplies brought down to science classroom

This trip could be expanded to take more time, or could be condensed to fit within one class period and take place on school campus if more time cannot be allotted.

Details of completing activities

Students will embark on an expedition to locate, identify and observe invasive species in the park. The will fill out the following worksheet to organize their observations:

Name: _____ Date:_____

Group Memerbers:_____

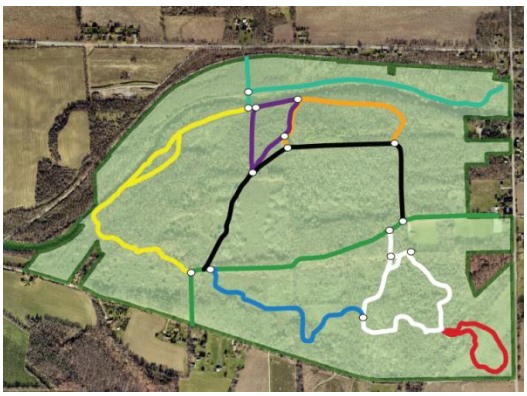
Oatka Creek Aliens

Locate at least one invasive species on your journey through Oatka Creek Park. Fill in your observations and inferences below. You may work with your group members, but each person needs to fill out a sheet of their own.

Name of invader:

Plant/ Animal/ Insect:

Location Spotted: Draw the point on the map below- if it is seen in multiple locations, record them all



Observations (What does it look like? What is it doing? How many or how much is there?):

Does it look like it is having any effects on the organisms around it (ex: Is it eating something? Is it growing on something? Etc.)

Multiple sheets can be printed so that students can fill out observations on more than one species.

Post- Trip Extension:

Sharing findings

During the following class, put up the trail map of the park on the Smartboard for students to make a class map of where they found invasive species. As a class, make a

list of species that were found and come up with a key and legend so they can be recorded on the map. Have each group mark where they found their species based on that key on the map projected on the Smartboard.

Have each group work together to discuss and answer the following questions:

1) Which species was the most commonly found in the park?

2) How might park officials stop the spread of this species?

Extending ideas

1) Have each group work together to consider the following and complete this worksheet based on the species they observed:

Name: _____ Date:_____

Invaders in the Ecosystem

Directions: Complete this with your field experience group. You may complete it on paper or online and submit it electronically.

Name your Species:

Provide a picture from the field experience:

What other organisms were living alongside of it (these don't have to be super specific if you could not identify its neighbors):

What resources do you think that this invader is taking up?

What other organisms do you think are competing with this invader?

Draw a picture of the ecosystem in its natural state (without the invader):

Draw a picture of the ecosystem if the invader takes over:

2) After students complete that worksheet, share the following video for some examples of invasive insects and fungus that are attacking trees in our area:

http://on.rocne.ws/2w32YZi

3) Read the following article on a solution to stop one particularly invasive species using another invasive species:

http://www.democratandchronicle.com/story/news/local/blogs/environment/2015/10/21/grass-carp-henrietta/74318436/

*This should be read together as a class, due to some challenging ideas and vocabulary. This is a good opportunity for a read aloud.
Be sure to stop and talk about the Triploid Carp and what this means- think back to genetics unit and how chromosomes need to come in a specific number for each species. Discuss why triploid carps will not be a threat to the ecosystem like a natural carp would (answer: because they can't reproduce)

Additionally there is a link within this article to the original article about finding *hydrilla* in the pond in Henrietta

*Important discussion point: This invasion of *hydrilla* most likely began when someone dumped an aquarium into the pond, including aquarium plants that are sold in pet stores but not native to our area. Discuss with students why it can be so detrimental to an ecosystem to release plants and animals purchased in the pet store into the wild.

Metacognitive Reflection

Post-trip:

Exit Ticket

Name: _____ Date: _____

1) What are three things you learned in the field today?

2) What are three skills you learned in the field today?

3) What is something you would do differently next time you do field work like this?

After completion of the Unit:

Exit Ticket/Addition to assessment:

Name:_____ Date:_____

1) Why is it important that we and all people know about invasive species?

2) What do you think the most important thing you learned from this unit was?

3) How can you help your community understand and fight invasive species invasions in your everyday life?

Assessment:

Using your knowledge of invasive species and research skills, each student will create a brochure on an invasive species and how to limit/ minimize their spread and effects.

Product: A tri-fold brochure, the size of a regular sheet of computer paper

Audience: The general public. Imagine that this brochure will be available for people to take when entering a park.

Things to Include:

- Pick a species to cover- can be plant, insect, or animal
- A picture of your species
- Where it came from and where it is now invading
- Why it is a problem- what effect will it have on the environment?
- How to stop it from spreading
- What to do once it is found invading an area
- Contact information on how to report

Rubric:

	2 Points	1 Point	0 Points
Species selected that is invasive			
Picture Included			
Original and invaded locations			
Explain the problem			
How to stop spread			
What to do after invasion			
Contact info for reporting			
Detailed and correct information			
Creative, well organized and neat			

Brochures can be printed and put on display anywhere information is shared in the school, or even brought to a local information booth at a park.

Module 4: Pondering Pond Water

Grade Level /Content Area: 7th grade Living Environment

Unit: Cells and Single-Celled Organisms

Main Question: Is there more to pond water than meets the eye?

NYS Intermediate Level Science Standards:

Standard 1, Key idea 2

S2.1 Use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information.

S2.1a Demonstrate appropriate safety techniques

S2.1b Conduct an experiment designed by others

S2.1c Design and conduct an experiment to test a hypothesis

S2.1d Use appropriate tools and conventional techniques to solve problems about the natural world, including: measuring, observing, describing, classifying, sequencing

Process Skills:

1. Manipulate a compound microscope to view microscopic objects

2. Determine the size of a microscopic object, using a compound microscope

3. Prepare a wet mount slide

4. Use appropriate staining techniques

Intermediate Science Living Environment Standards:

1.1 Compare and contrast the parts of plants, animals, and one-celled organisms.

1.1a Living things are composed of cells. Cells provide structure and carry on major functions to sustain life. Cells are usually microscopic in size.

1.1b The way in which cells function is similar in all living things. Cells grow and divide, producing more cells. Cells take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.

1.1c Most cells have cell membranes, genetic material, and cytoplasm. Some cells have a cell wall and/or chloroplasts. Many cells have a nucleus.

1.1d Some organisms are single cells; others, including humans, are multicellular.

1.1e Cells are organized for more effective functioning in multicellular organisms. Levels of organization for structure and function of a multicellular organism include cells, tissues, organs, and organ systems.

Prior Knowledge:

Cells are the basic unit of life

Cells are the smallest living thing. Some exist on their own as single celled organisms, while other cells also make up tissues, organs, organ systems and whole organisms.

Cell organelles and functions

Students know the organelles of both plant and animal cells and they know the function of each organelle.

Learning Objectives:

Students can collect samples from the field to analyze back in the classroom/ lab

Students can use microscopes to locate, observe and examine microscopic organisms

Students can prepare wet mount slides and utilize fixing and staining techniques for examining microscopic samples

Students can identify phyla of organisms found in local bodies of water

Students can make comparisons between organisms found in different locations

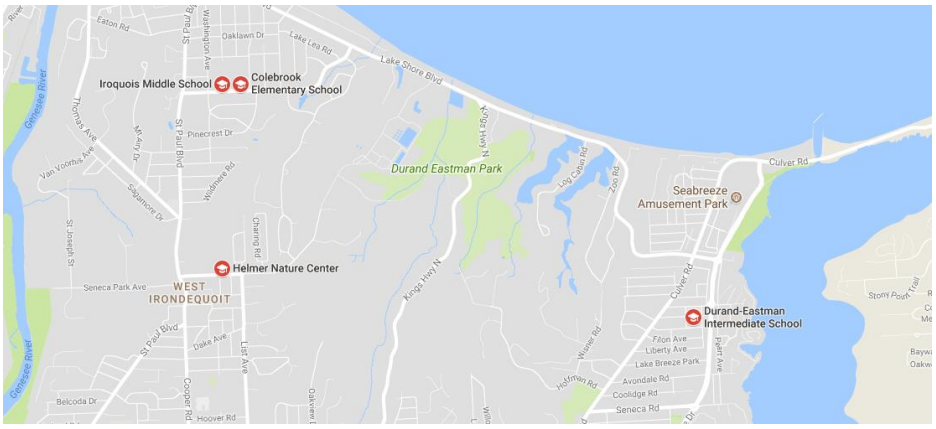
Students can identify cell organelles and structures in live or fixed specimen using the microscope

Location Attributes:

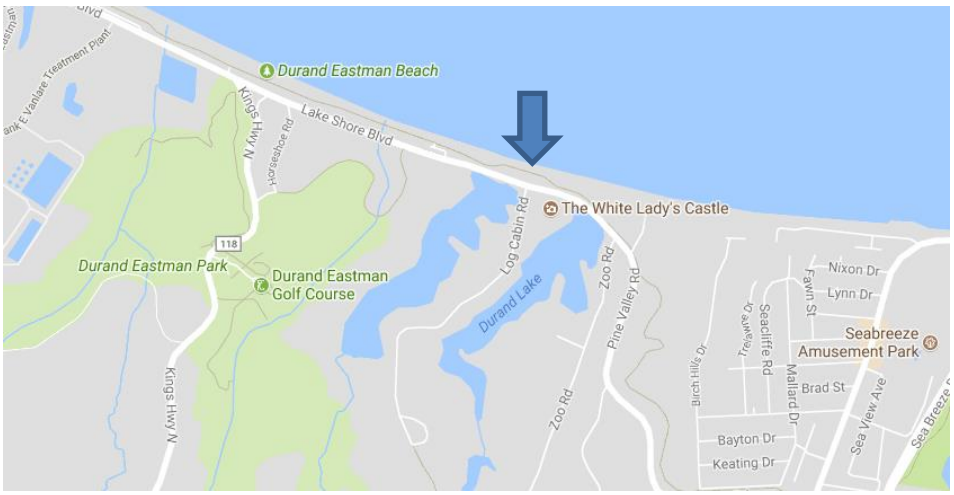
The location for this type of trip is flexible and can take place anywhere that a body of water can be safely accessed.

For this example, we will be using Eastman Lake in Durand Eastman Park and Lake Ontario at Durand Eastman Beach as the locations. These two bodies of water are just across the street from each other, and can be compared to see how their microbial makeup is similar and different.

This location is a 10 minute drive from East Irondequoit Middle School and West Irondequoit's Dake Junior High School. GPS Coordinates: 43°14'12.1"N 77°33'33.0"W



Google Map image of Durand Beach and Park in relation to the two schools mentioned above



A closer view of the location via Google Maps

View of Lake Ontario at Durand Eastman Beach from the walkway. Students can collect samples from the lake here. Author's photo.

View of Lake Ontario from standing on Durand Eastman Beach. Author's Photo

Eastman Lake in Durand Eastman Park. Though called a lake, it is a smaller body of water, more appropriately that of a pond. Author's photo.

The banks of Eastman Lake where samples can be collected. Author's photo

Another view of the water's edge at Eastman Lake: muddy, but accessible. Author's photo

The two bodies of water are very near each other but have a lot of differences. Students can look at pictures such as these and make a list or fill out a chart or Venn Diagram comparing and contrasting the two bodies of water.

* Safety Note: Participants on this field experience will need to cross Lake Shore Blvd in order to get from one body of water to the other. This road can have heavy traffic at times, and crossing can be dangerous. Teachers will need to check with school safety codes and/or use their

judgement on crossing this street. Alternatively, busses could take students from one parking lot to the other.

If the street will be crossed, be sure to go over safe crossing procedures with students beforehand, and ensure that no students will cross without their chaperone.

Materials Needed:

Thermometers

Sample collection vials

Microscopes

Slides and cover slips

Fixing and staining materials for slides

Worksheets, Writing Utensils and clipboards

Maps

Prepared mounts and/or live samples of protists, algae, arthropods, daphnia, paramecium, hydra, rotifer etc.

Pre-trip Preparation:

Introducing the topic

What lives in the lake?- Draw an image of a pond or lake on the board. Begin class by asking students what lives there. Have students come up and draw each organism that they think lives in the lake, with the goal to see if they will name microscopic organisms along with more well-known organisms (fish, seaweed, etc.). They can be prompted if needed by asking them to think smaller, though this may be the first time some students are introduced to this idea.

Students would have just completed a unit on cells and organelles, where generally cells are looked at as small units of larger organisms. Here we introduce the idea that some

cells live on their own as complete organisms, and there is a lot of variety amongst them.

Introducing the skills

There are a lot of new skills that are being introduced in this experience and they will need to be explained at practiced first. These skills include:

- Collecting water samples containing live organisms
    - Students are taught how to fill vials, how to store them for transport, at what temperature and for how long
- Preparing wet mount slides
    - Students learn how to use an eyedropper to put wet specimens on a slide, and how to properly cover with a coverslip
- How to use the microscope
    - Introduction to the microscope: different parts
    - Using the microscope: which objective lens to use and when, when to use the high power immersion lens, how to locate objects in the field of view
- How to apply stains or fixatives to slides

Introducing the location

The following links provide some interesting history and other information regarding these areas.

https://en.m.wikipedia.org/wiki/Durand_Eastman_Park

The land on which Durand-Eastman Park and Beach stands was donated in 1907 by friends Dr. Henry S. Durand and George Eastman (Kodak) "to be used as a public park forever, a tract of land of about 484 acres situate in the Town of Irondequoit on Lake Ontario." Portions now include Camp Eastman and a golf course.

http://www.rochestersubway.com/topics/2014/07/durand-eastman-beach-bath-house/

The beach used to be much wider than it is today and bathhouses were located there from 1916 until water levels got too high in 1949 and the buildings had to be abandoned. The beach was closed until 1966 when a dam was built on the St. Lawrence river, which allowed people to be able to regulate the level of the lake.

White Lady's Castle

A rumor states that there is a white ghostly figure of a lady that haunts the park at night. Her "castle" was believed to stand where the remaining brick wall exists across from the beach. However this castle was really just a dining hall.

Have students look up more information about the lake and pond and record information such as:

Average water depth
Average and/ or max/min water temperature in summer and in winter
Area, surface area or volume
Shoreline length

Rules and expectations

- Stay within view of your chaperone and remain in your group. Be sure to listen to your chaperone for directions and treat your chaperone and your group members respectfully.
- Do not pick or break anything off of live plants- leaves, fruit, flowers etc. You may take something off of the ground (such as fallen leaves) but check with your chaperone first. We do not want to disturb the environment by picking flowers that need to be pollinated, taking fruit with valuable seeds or food for animals, etc.
- DO NOT LITTER. Be sure that anything that is taken into the park with you comes back with you on the bus. This includes worksheets and writing utensils, water bottles, lunch wrappers etc.
- Stay on the paths unless otherwise directed by your chaperone. We need to be careful of poison ivy, and of stepping on young plants.
- No crossing the road without a chaperone. Be very careful when doing so, be sure to look both ways and pay attention to where you are going until you are safely on the other side (*NO looking at phones while you cross)
- No horseplay near the water: be aware of the risk of falling into the pond. Check with students (privately) to know if there are any that are not confident swimmers
- Keep any equipment or materials back away from the edge of the water. Let students know that anything that is dropped in will not be retrieved.

On Location Student Activities:

Timeline of events for the trip:

Before departure, equipment will be packed and ready to hand off to each group.

- 9:00: Arrive at location. Organize into pre-determined groups with chaperones. Pass out equipment.
- 9:10: Move towards beach site first and make observations of the Great Lakes ecology. Record observations.
- 9:20: Each group collects water sample from Lake Ontario, recording observations of the water using thermometers and other instruments, and recording the time.
- 9:30: Move back towards bus to move to next site, or as a class prepare to cross the street to the next body of water
- 9:40: Make observations of pond ecology
- 9:50: Each group collects water sample from Eastman Lake, recording observations of the water using thermometers and other instruments, and recording the time.
- 10:10: Wrap up sample collections and gather back together to board the bus back to school.

Details of completing activities:

Name: _____ Date: _____

Group:_____

Durand Trip Observations

Fill in observations in the organizer below of the environments at Durand Beach and Durand-Eastman Park.

	Lake Ontario/ Beach	"Eastman Lake" – Pond
Movement of the water		
Material of the shore and water bed		
Plants growing in the water		
Plants growing along the water		
Animals in or around the water		

Water Sample Collection:

Location	Date	Time	Conditions	Air Temp	Water Temp

Sample Collection:

One vial of water will be collected at each location by each group. That means each group will have a total of two vials.

Partner 1: Will label the first vial with:

- Initials of group members
- Body of water (Ontario or Eastman)
- Date

Partner 2: Will collect the sample and seal the vial

Partner 3: Will label the second vial with:

- Group number
- Initials of group members
- Body of water (Ontario or Eastman)
- Date

Partner 4: Will collect the second sample and seal the vial.

Remember: Samples should be collected beneath the surface of the water, without getting a lot of sediment into the sample. Small amounts of plant material are good to have in a sample, but avoid large chunks of plant material, rocks or too much other solid material.

Teacher will supervise to be sure samples are collected correctly, according to guidelines that will be taught previously in class.

Remember that samples need to remain refrigerated, and need to be used in class within a week. Therefore this trip should most likely be planned on a Monday, with analysis of the samples throughout the week and wrapping up on Friday.

Post- Trip Extension:

Sharing findings:

Name: _____ Date: _____

Lake vs. Pond Compare & Contrast

Lake Characteristics Only	Pond Characteristics Only
Shared Characteristics	

Extending ideas:

Name: _____ Date: _____

Microscope Investigation

It is time to look at your water samples under the microscope! Read and follow the directions below, then fill out the sheet as you work.

You will view the water under the microscope using two techniques:

1) Using a depression slide: Take a drop or two of water from the eyedropper and place it in the depression in the slide. Remember the slide should be like a shallow cup that holds the water. Make sure you are holding the correct side up. View immediately (note: organisms will likely start to die after a few minutes in the light of the microscope. Do not be surprised).

2) Using a cover slip: this may squish living things, but will make them easier to view. Place a drop of water on a regular slide and lower a cover slip on top as we practiced before the trip.

Record what you see below!

Step 1:

Sample info (location, group, date): _____

Number	Characteristics of the organism (describing words)	Image of the organism (do the best drawing you can do!)
1		
2		
3		
4		
5		

Sample info (location, group, date): _____

#	Characteristics of the organism (describing words)	Image of the organism (do the best drawing you can do!)
A		
B		
C		
D		
E		

Step 3:

2) Count and tally how many of each organism you find in a field of view of each sample

Sample location	Organism	Count
	1	
	2	

	3	
	4	
	5	
	A	
	B	
	C	
	D	
	E	

Step 4: Looking at known samples.

There are 5 organisms provided that we will be looking at under the microscope next. Like step 1, we will be recording characteristics and making drawings of the organisms we see, only this time we know their names instead of using number and letters to identify them.

Organism Name	Characteristics of the organism (describing words)	Image of the organism (do the best drawing you can do!)
Paramecium		
Amoeba		
Hydra		
Algae /diatom		

Daphnia		

Step 5: Staining for *e.coli*

Staining procedure (adapted from https://microbeonline.com/simple-staining-principle-procedure-results/)

Laboratory Coats or t-shirt "smocks" are recommended for the staining procedure. Be sure students understand that the stain will stain their clothes if not careful. Gloves should be worn as well, and tables can be covered with newspaper.

The teacher should model this procedure first, or walk through it with students.

Name: _____ Date: _____

Learning to Stain

Samples of hard-to-see microorganisms like bacteria are often stained using a colored liquid that allows us to see our sample more easily under the microscope. We will be staining a drop of water from our pond water sample to see if we can see any hard-to-see bacteria, or other transparent organisms.

1) Place a drop of pond water on a microscope slide and allow it to dry. They can air dry if time allows, or a microscope dryer can be used if one is available (Bunsen burners or routinely used for this, but it can be done without them to maximize laboratory safety, especially with young students)

2) Cover the smear with methylene blue dye and allow it to sit for about a minute.

3) Rinse with distilled water from a wash bottle

4) Cover sample on the slide with iodine and allow again to sit for about a minute

5) Rinse with tap water to remove all iodine. Dry the back of the slide with a paper towel if necessary, but do not wipe the sample off of the slide

6) Place the slide under the microscope and view beginning with the 10x objective lens to locate stained specimen. Increase magnification until reaching 100x, place a drop of immersion oil and view!

(Because pond water is unpredictable, there may not be a lot of bacteria present to see in our samples. This procedure can be used instead with a culture of *e.coli*, to ensure that bacteria are visible.)

Draw what you see in your sample below. Use colored pencils.

10X Objective Lens	40X Objective Lens	100X Objective lens

Metacognitive Reflection-

Name:_____ Date:_____

Reflection

1. Why do you think it is important to learn about the microscopic organisms that live in bodies of water?

2) How can information from this unit be useful to you someday?

3) What skills did you use in this unit that you feel confident in?

4) What skills did you use in this unit that you think you need more practice with?

5) What is one thing you would tell a friend that you found interesting from this unit?

Assessment:

Name: _____ Date: _____

BEACH CLOSED

You are a scientist who works for the Department of Health and it is your duty to be sure that the bacteria and harmful algae levels at Durand Beach are within safe levels for people to swim there. A huge rainstorm has just cleared up and people want to head to the beach on the first sunny day: but your team has tested the water and had to CLOSE the beach to all swimmers due to high levels of bacteria and algae that could make people sick.

A news reporter is interviewing you about the beach closures, because the people in the community don't understand why it is important that they stay away from the beach until further notice. Your assignment is to answer the following questions in complete sentences (as if you are responding to an interviewer) to teach the public about how and why you test the waters at the beach. Please answer the following questions either in written form (as if you are part of a newspaper article) or verbally in a video (as if you are part of a T.V. news story).

You may work in partners for this activity. Submit any notes or scrip that you create as a group.

Interview Questions:

1. What do you and your team test the waters for?
2. Why is it important that your team test the waters at the beach?
3. Why do the levels of bacteria and algae get so high?

4. How do you test for these microorganisms (briefly explain the technique and procedure we followed)
5. How could people in the community help keep bacteria and algae levels in the lake from getting too high?

Use the following articles to do a little research to help you better understand some responses to the questions

http://wxxinews.org/post/ontario-beach-park-closed-37-time-last-summer

https://www.theswimguide.org/beach/135?set_language=en

https://www.healthtalk.umn.edu/2014/08/11/meaning-of-e-coli-in-lakes/ (more complex and would be best as a read aloud in which teacher guides students through reading and annotating, helping to pick out key ideas)

Rubric:

Criteria	Well done- 2 points	Partially completed- 1 point	Missing or completely incorrect- 0 points
Q 1 addressed and accurate			
Q 2 addressed and accurate			
Q 3 addressed and accurate			
Q 4 addressed and accurate			
Q 5 addressed and accurate			
Written/ performed as news story			

Module 5: Lamberton Conservatory & Highland Park

Grade Level /Content Area: 7th grade Living Environment

Unit: Ecosystems

Main Question: What are similarities and differences between different ecosystems and how do the plants within them adapt to these characteristics?

NYS Intermediate Level Science Standards:

1.1: Compare and contrast the parts of plants.

> 1.1f Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.

3: Describe sources of variation in organisms and their structures and relate the variations to survival.

> 3.1b Changes in environmental conditions can affect the survival of individual organisms with a particular trait. Small differences between parents and offspring can accumulate in successive generations so that descendants are very different from their ancestors. Individual organisms with certain traits are more likely to survive and have offspring than individuals without those traits

> 4.3e Patterns of development vary among plants. In seed-bearing plants, seeds contain stored food for early development. Their later development into adulthood is characterized by varying patterns of growth from species to species.

5: All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment. Organisms respond to internal or environmental stimuli

> 5.1a Animals and **plants** have a great variety of body plans and internal structures that contribute to their ability to maintain a balanced condition

> 5.1b An organism's overall body plan and its environment determine the way that the organism carries out the life processes.

> 5.1d The methods for obtaining nutrients vary among organisms

7: The number of organisms an ecosystem can support depends on the resources available and physical factors: quantity of light, air, and water; range of temperatures; soil composition. To ensure the survival of our planet, people have a responsibility to consider the impact of their actions on the environment

7.1a A population consists of all individuals of a species that are found together at a given place and time. Populations living in one place form a community. The community and the physical factors with which it interacts compose an ecosystem

Prior Knowledge:

Students understand the importance of an organism's ability to maintain homeostasis.

Students know the seven life processes that all organisms must carry out in order to be considered living and to sustain life.

Students know the process of photosynthesis including what materials are needed, what materials result and why this is important for the plants and other organisms (creation of food for plants and oxygen for animals).

Learning Objectives:

Students can identify characteristics of an ecosystem that effect organisms that live there.

Students can compare and contrast characteristics of different ecosystems.

Students can identify and explain adaptations of plants to survive in particular ecosystems.

Location Attributes:

The Lamberton Conservatory is located in Highland Park in the City of Rochester. Highland Park was dedicated in 1888 and was designed by Fredrick Law Olmstead, the man who designed Central Park in NYC. It was the first arboretum (tree garden) in the U.S. In 1911 the original Lamberton Conservatory was built, and in 2007 it was completely reconstructed.

This park and conservatory offer a scenic and natural oasis from urban life, located within walking distance of Highland hospital, only a few minutes' drive from downtown Rochester. Located between South Ave and Goodman St, the park covers 150 acres and is organized by different types of plants in different sections. The reservoir at Highland Park has been providing City residents with water from Hemlock Lake since the mid-1870s (A History Time Line, n.d.).

Materials Needed:

Worksheets

Clipboards

Writing utensils

Appropriate outdoor attire

Pre-trip Preparation:

Introducing the topic

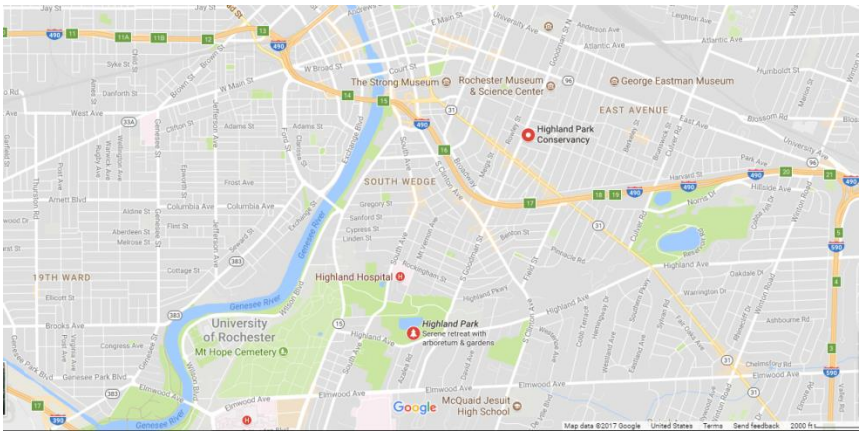
Display the Observation/Inference/ Question chart on the board and define expectations for what goes in each column. Have students look out the window of the classroom (or use the classroom itself if there are no windows) and provide example observations, inferences and questions. Model for students how to fill out the chart, or how to use observations to come up with inferences and questions if necessary. Let students know that they will have this worksheet with them on the trip, and give them a range for how many entries they should complete.

Display the Ecosystem Exploration worksheet on the board. Show students the number and length of questions that will be asked of them, and discuss how you would like them to answer (in complete sentences, using examples, incorporating their observations, etc.).

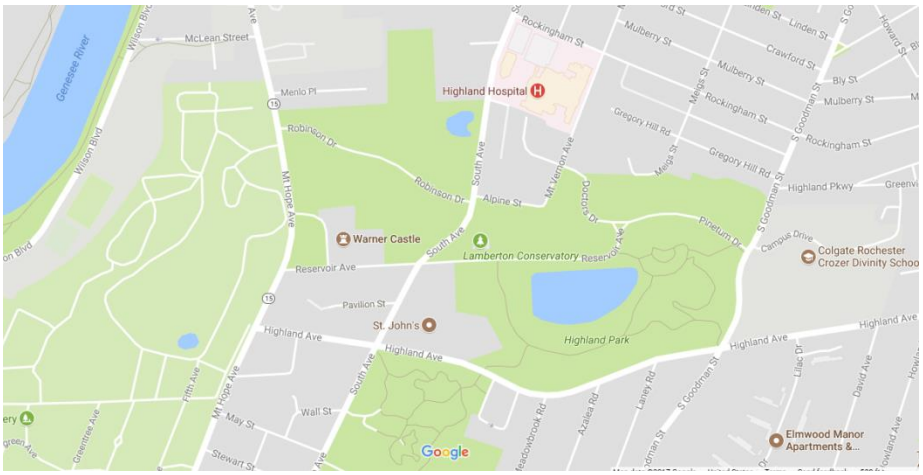
In this context, this experience is an introduction to the differences between different ecosystems, such as an engaging discrepant event that begins an inquiry lesson. This means that I do not want to "spoil" students' experiences in entering the conservatory and seeing that the different rooms are so different, but instead just want to prepare them for the idea that they will be looking for similarities and differences between rooms in the conservatory/ in the park.

Introducing the location

Show students where the park is located on a map, how long it will take to get there, and how travel will be arranged. Ask students if they have been to Highland Park, and if they know anything about the park, such as it is the location of the Lilac festival. Allow a few to share their experiences.



Google Maps image of Highland Park in relation to the Greater Rochester Area



A closer map of the park from Google Maps

Discuss what a conservatory is and what it looks like. Ask students if they have seen a greenhouse before, and what they know about greenhouses (what do they look like, what are they used for, why are they used, etc.).

Share the two brochure pamphlets with the class: Either pick some up from the park to pass around for students to examine, or display the following images on the smartboard. Be sure that students are familiar with what to expect as far as what to wear, what to bring with them, and how long the activities will take.

Pamphlet provided by Lamberton Conservatory with a map and description of different scenes

Welcome to
LAMBERTON CONSERVATORY

Originally constructed in 1911, the Lamberton Conservatory was named in honor of Alexander B. Lamberton who was the President of the Parks Board from 1902 to 1915. Original funding from the relatives of Lamberton provided for the building costs and would allow for continuous specialized exhibits of diverse plant species. Already a nationally renowned arboretum designed by Frederic Law Olmsted, Highland Park's horticultural status was certainly heightened by its construction. The structure would expand over time and its interiors would become known as a tranquil destination or even a tropical respite to Rochester's chilly winters. By 2006, the original building had deteriorated so much that it was not cost effective to maintain and like most historic structures, time had just gotten the better of it. But in 2007, the Monroe County Parks Department sought the one million dollars it needed to do a complete tear down and historic reconstruction, maintaining every possible detail of the original design.

The Historic Restoration

The restored Tropical Dome of the Conservatory has approximately 1,800 square feet of floor area and boasts nearly 1,000 new panes of glass specially formed for structures of this type. The full restoration became necessary because of the toll that the high temperatures and humidity required for tropical displays had taken on the steel and the glass that was more than 80 percent original by 2008. For the $1 million project, $800,000 came from Monroe County's capital budget, while the Parks Department secured a $200,000 grant from the State of New York in order to keep the Conservatory at this location for at least another century.

The original Conservatory was disassembled down to its foundation and reconstructed with modern materials as an exact replica of the historic structure. The existing steel framework was removed and used as a pattern for the new galvanized-steel framing system. The original interior cypress gutter system was salvaged, refurbished and reused as were the operable ridge-vent, the exterior cast iron gutter system, and the memorial to Alexander B. Lamberton that is, once again, mounted over the front doors. The reconstruction effort was jointly managed by the Monroe County Department of Parks and the Monroe County Department of Environmental Services. With their strict attention to detail, the Conservatory's reconstruction is a testament to Monroe County's dedication to our history and our continued commitment to our community's wonderful quality of life.

Why Plants Are Important by Noelle Nagel, Horticultural Interpreter

Have you ever thought about what we get from plants? It's much more than just salad and lawns. If there had never been any plants, we wouldn't be here either. Food - everything we eat is a plant, has eaten a plant, or has eaten something that ate a plant. The entire food chain is based on plants. Fuel - because of the existence of plants millions of years ago, we now have petroleum products like gasoline, oil, coal, and natural gas. Building materials - if we didn't have plant products (wood, straw) to build with, what would we use? If you're thinking about metal, glass or bricks, they have to be heated to be manufactured (remember the section about fuels). Bricks might be a option if you could sun-dry them, but they wouldn't stand up to the elements well which is why they are usually strengthened with straw. Clothing - all the things we wear are either plant derived (cotton, linen, etc.) or petroleum products (nylon, polyester) or from animals (fur, leather, feathers). Plants are, of course, instrumental in oxygen production and the water cycle also. We sure can't live without those! So thank your houseplants, your shrubbery and your trees when you get home - if it wasn't for them, you wouldn't be here!

The Conservatory is open 7 days a week, 10 a.m. to 4 p.m. Closed Christmas Day

Adult (19-61) $3.00
Youth (6-18) / Seniors (62 and up) $2.00
Youth (0-5) Free

Seasonal passes are available year round. Individual passes are $10, Family passes are $30 and Company/Institutional (nursing homes & adult care facilities) passes are $50.

Call (585) 753-7270 for more information.

More facts about Alexander B. Lamberton

- Was born in Rich Hill County, Ireland on February 28, 1839.
- He acquired an early education in the United States at Auburn Theological Seminary and then continued at the University of Rochester.
- One of the founding directors of the Genesee Valley Trust Company.
- Elected a park commissioner in 1894, and in 1902 became president of the overall park board.
- Developed numerous facilities for adult recreation, purchased new park lands to be developed and added the innovation of children's playgrounds.
- Contributed to the expansion of Highland Park and Genesee Valley Park, in addition to the establishment of Durand-Eastman Park.
- Died at age 80 of bronchial pneumonia, and was survived by his two daughters Mrs. Charles A. Hone and Mrs. Isaac Kaiser.

This brochure was produced by the Monroe County Parks Department. Written content by Noelle Nagel, T.C. Pellett and Mark Quinn. Brochure creative and photography by T.C. Pellett.

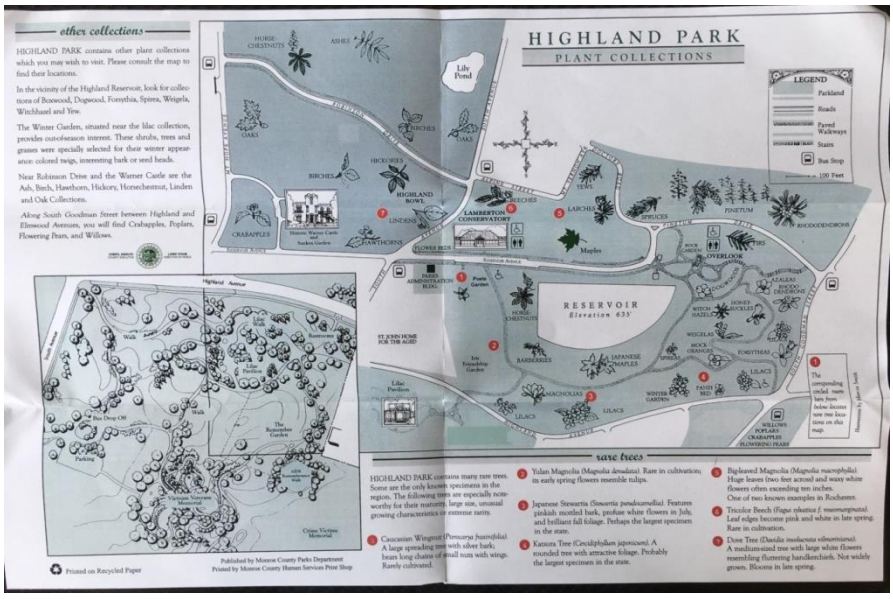
Historic images from the Albert R. Stone Negative Collection, Rochester Museum & Science Center. To see more Albert R. Stone photographs, go to the RMSC Library and Collections catalog http://libcat.rmsc.org and search by subject.

MONROE COUNTY DEPARTMENT OF PARKS
(585) 753-PARK (7275)
www.monroecounty.gov/parks

Cheryl Dinolfo, County Executive
Larry Staub, Parks Director

MONROE COUNTY'S
LAMBERTON
CONSERVATORY
EST. 1911

Pamphlet provided by Lamberton Conservatory providing information and history



other collections

HIGHLAND PARK contains other plant collections which you may wish to visit. Please consult the map to find their locations.

In the vicinity of the Highland Reservoir, look for collections of Boxwood, Dogwood, Forsythia, Spirea, Weigela, Witchhazel and Yew.

The Winter Garden, situated near the lilac collection, provides out-of-season interest. These shrubs, trees and grasses were specially selected for their winter appearance: colored twigs, interesting bark or seed heads.

Near Robinson Drive and the Warner Castle are the Ash, Birch, Hawthorn, Hickory, Horsechestnut, Linden and Oak Collections.

Along South Goodman Street between Highland and Elmwood Avenues, you will find Crabapples, Poplars, Flowering Pears, and Willows.

HIGHLAND PARK
PLANT COLLECTIONS

LEGEND
Parkland
Roads
Paved Walkways
Stairs
Bus Stop
100 Feet

HORSE CHESTNUTS
ASHES
Lily Pond
OAKS
BIRCHES
HICKORIES
HIGHLAND BOWL
LINDENS
CRABAPPLES
HAWTHORNS
LAMBERTON CONSERVATORY
LARCHES
SPRUCES
PINETUM
RHODODENDRONS
OVERLOOK
Maples
RESERVOIR
Elevation 635'
ST. JOHN HOME FOR THE AGED
BARBERRIES
JAPANESE MAPLES
MAGNOLIAS
LILACS
WINTER GARDEN
FORSYTHIAS
WILLOWS POPLARS CRABAPPLES (FLOWERING) PEARS

rare trees

HIGHLAND PARK contains many rare trees. Some are the only known specimens in the region. The following trees are especially noteworthy for their maturity, large size, unusual growing characteristics or extreme rarity.

1. Caucasian Wingnut (Pterocarya fraxinifolia). A large spreading tree with silver bark, bears long chains of small nuts with wings. Rarely cultivated.
2. Yulan Magnolia (Magnolia denudata). Rare in cultivation; its early spring flowers resemble tulips.
3. Japanese Stewartia (Stewartia pseudocamellia). Features pinkish mottled bark, profuse white flowers in July, and brilliant fall foliage. Perhaps the largest specimen in the state.
4. Katsura Tree (Cercidiphyllum japonicum). A rounded tree with attractive foliage. Probably the largest specimen in the state.
5. Bigleaved Magnolia (Magnolia macrophylla). Huge leaves (two feet across) and waxy white flowers often exceeding ten inches. One of two known examples in Rochester.
6. Tricolor Beech (Fagus sylvatica f. tricolor). Leaf edges become pink and white in late spring. Rare in cultivation.
7. Dove Tree (Davidia involucrata vilmoriniana). A medium-sized tree with large white flowers resembling fluttering handkerchiefs. Not widely grown. Blooms in late spring.

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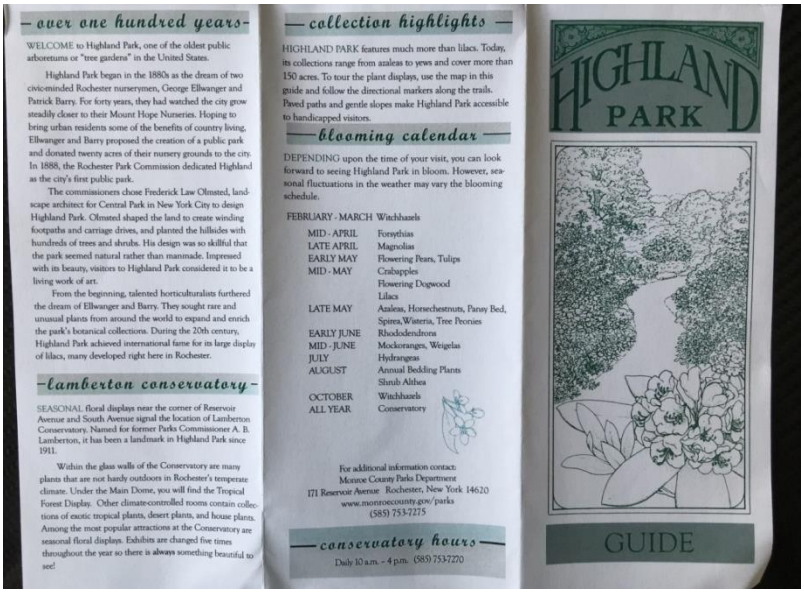
Pamphlet provided by Highland Park mapping out the arboretum and park grounds



over one hundred years

WELCOME to Highland Park, one of the oldest public arboretums or "tree gardens" in the United States.

Highland Park began in the 1880s as the dream of two civic-minded Rochester nurserymen, George Ellwanger and Patrick Barry. For forty years, they had watched the city grow steadily closer to their Mount Hope Nurseries. Hoping to bring urban residents some of the benefits of country living, Ellwanger and Barry proposed the creation of a public park and donated twenty acres of their nursery grounds to the city. In 1888, the Rochester Park Commission dedicated Highland as the city's first public park.

The commissioners chose Frederick Law Olmsted, landscape architect for Central Park in New York City to design Highland Park. Olmsted shaped the land to create winding footpaths and carriage drives, and planted the hillsides with hundreds of trees and shrubs. His design was so skillful that the park seemed natural rather than manmade. Impressed with its beauty, visitors to Highland Park considered it to be a living work of art.

From the beginning, talented horticulturalists furthered the dream of Ellwanger and Barry. They sought rare and unusual plants from around the world to expand and enrich the park's botanical collections. During the 20th century, Highland Park achieved international fame for its large display of lilacs, many developed right here in Rochester.

lamberton conservatory

SEASONAL floral displays near the corner of Reservoir Avenue and South Avenue signal the location of Lamberton Conservatory. Named for former Parks Commissioner A. B. Lamberton, it has been a landmark in Highland Park since 1911.

Within the glass walls of the Conservatory are many plants that are not hardy outdoors in Rochester's temperate climate. Under the Main Dome, you will find the Tropical Forest Display. Other climate-controlled rooms contain collections of exotic tropical plants, desert plants, and house plants. Among the most popular attractions at the Conservatory are seasonal floral displays. Exhibits are changed five times throughout the year so there is **always** something beautiful to see!

collection highlights

HIGHLAND PARK features much more than lilacs. Today, its collections range from azaleas to yews and cover more than 150 acres. To tour the plant displays, use the map in this guide and follow the directional markers along the trails. Paved paths and gentle slopes make Highland Park accessible to handicapped visitors.

blooming calendar

DEPENDING upon the time of your visit, you can look forward to seeing Highland Park in bloom. However, seasonal fluctuations in the weather may vary the blooming schedule.

FEBRUARY - MARCH	Witchhazels
MID - APRIL	Forsythias
LATE APRIL	Magnolias
EARLY MAY	Flowering Pears, Tulips
MID - MAY	Crabapples Flowering Dogwood Lilacs
LATE MAY	Azaleas, Horsechestnuts, Pansy Bed, Spirea, Wisteria, Tree Peonies
EARLY JUNE	Rhododendrons
MID - JUNE	Mockoranges, Weigelas
JULY	Hydrangeas
AUGUST	Annual Bedding Plants Shrub Althea
OCTOBER	Witchhazels
ALL YEAR	Conservatory

For additional information contact:
Monroe County Parks Department
171 Reservoir Avenue Rochester, New York 14620
www.monroecounty.gov/parks
(585) 753-7275

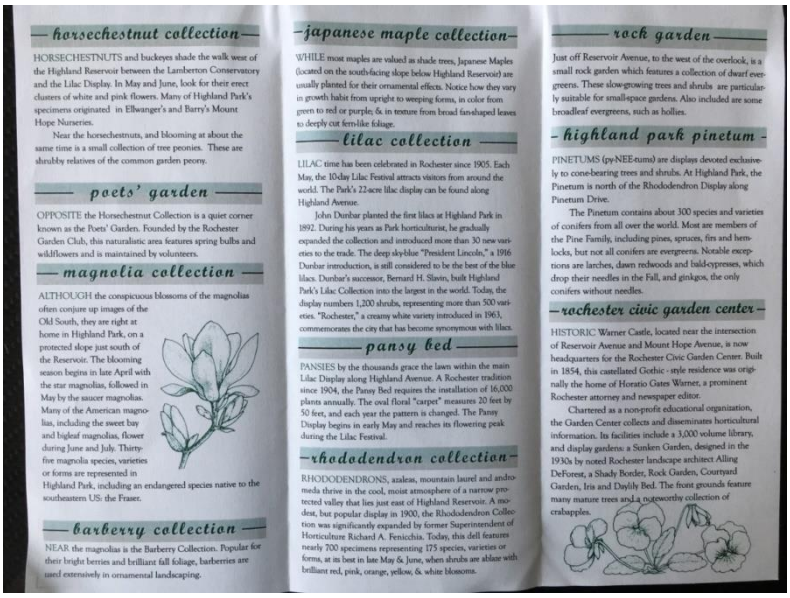
conservatory hours

Daily 10 a.m. - 4 p.m. (585) 753-7270

HIGHLAND PARK

GUIDE

Pamphlet provided by Highland Park containing some park history



horsechestnut collection

HORSECHESTNUTS and buckeyes shade the walk west of the Highland Reservoir between the Lamberton Conservatory and the Lilac Display. In May and June, look for their erect clusters of white and pink flowers. Many of Highland Park's specimens originated in Ellwanger's and Barry's Mount Hope Nurseries.

Near the horsechestnuts, and blooming at about the same time is a small collection of tree peonies. These are shrubby relatives of the common garden peony.

poets' garden

OPPOSITE the Horsechestnut Collection is a quiet corner known as the Poets' Garden. Founded by the Rochester Garden Club, this naturalistic area features spring bulbs and wildflowers and is maintained by volunteers.

magnolia collection

ALTHOUGH the conspicuous blossoms of the magnolias often conjure up images of the Old South, they are right at home in Highland Park, on a protected slope just south of the Reservoir. The blooming season begins in late April with the star magnolias, followed in May by the saucer magnolias. Many of the American magnolias, including the sweet bay and bigleaf magnolias, flower during June and July. Thirty-five magnolia species, varieties or forms are represented in Highland Park, including an endangered species native to the southeastern US: the Fraser.

barberry collection

NEAR the magnolias is the Barberry Collection. Popular for their bright berries and brilliant fall foliage, barberries are used extensively in ornamental landscaping.

japanese maple collection

WHILE most maples are valued as shade trees, Japanese Maples (located on the south-facing slope below Highland Reservoir) are usually planted for their ornamental effects. Notice how they vary in growth habit from upright to weeping forms, in color from green to red or purple; & in texture from broad fan-shaped leaves to deeply cut fern-like foliage.

lilac collection

LILAC time has been celebrated in Rochester since 1905. Each May, the 10-day Lilac Festival attracts visitors from around the world. The Park's 22-acre lilac display can be found along Highland Avenue.

John Dunbar planted the first lilacs at Highland Park in 1892. During his years as Park horticulturist, he gradually expanded the collection and introduced more than 30 new varieties to the trade. The deep sky-blue "President Lincoln," a 1916 Dunbar introduction, is still considered to be the best of the blue lilacs. Dunbar's successor, Bernard H. Slavin, built Highland Park's Lilac Collection into the largest in the world. Today, the display numbers 1,200 shrubs, representing more than 500 varieties. "Rochester," a creamy white variety introduced in 1963, commemorates the city that has become synonymous with lilacs.

pansy bed

PANSIES by the thousands grace the lawn within the main Lilac Display along Highland Avenue. A Rochester tradition since 1904, the Pansy Bed requires the installation of 16,000 plants annually. The oval floral "carpet" measures 20 feet by 50 feet, and each year the pattern is changed. The Pansy Display begins in early May and reaches its flowering peak during the Lilac Festival.

rhododendron collection

RHODODENDRONS, azaleas, mountain laurel and andromeda thrive in the cool, moist atmosphere of a narrow protected valley that lies just east of Highland Reservoir. A modest, but popular display in 1900, the Rhododendron Collection was significantly expanded by former Superintendent of Horticulture Richard A. Fenicchia. Today, this dell features nearly 700 specimens representing 175 species, varieties or forms, at its best in late May & June, when shrubs are ablaze with brilliant red, pink, orange, yellow, & white blossoms.

rock garden

Just off Reservoir Avenue, to the west of the overlook, is a small rock garden which features a collection of dwarf evergreens. These slow-growing trees and shrubs are particularly suitable for small-space gardens. Also included are some broadleaf evergreens, such as hollies.

highland park pinetum

PINETUMS (py-NEE-tums) are displays devoted exclusively to cone-bearing trees and shrubs. At Highland Park, the Pinetum is north of the Rhododendron Display along Pinetum Drive.

The Pinetum contains about 300 species and varieties of conifers from all over the world. Most are members of the Pine Family, including pines, spruces, firs and hemlocks, but not all conifers are evergreens. Notable exceptions are larches, dawn redwoods and bald-cypresses, which drop their needles in the Fall, and ginkgos, the only conifers without needles.

rochester civic garden center

HISTORIC Warner Castle, located near the intersection of Reservoir Avenue and Mount Hope Avenue, is now headquarters for the Rochester Civic Garden Center. Built in 1854, this castellated Gothic - style residence was originally the home of Horatio Gates Warner, a prominent Rochester attorney and newspaper editor.

Chartered as a non-profit educational organization, the Garden Center collects and disseminates horticultural information. Its facilities include a 3,000 volume library, and display gardens: a Sunken Garden, designed in the 1930s by noted Rochester landscape architect Alling DeForest, a Shady Border, Rock Garden, Courtyard Garden, Iris and Daylily Bed. The front grounds feature many mature trees and a noteworthy collection of crabapples.

Pamphlet provided by Highland Park describing different plant collections

Rules and expectations

Remind students of the school rules or code of conduct; briefly review what is expected of students on a daily basis in the classroom, and ensure them that the same expectations will be held on the trip.

Go over any rules that are explicit to the trip. Discuss expectation on the bus, how they will be expected to stay with their groups and chaperone, and outline usage for mobile devices if necessary.

Within the conservatory:

- Walking only throughout the conservatory. Space is limited so be mindful of who and what is nearby you at all times.
- Be mindful that there may be other people in the conservatory who are there to enjoy the experience too. Keep voices at appropriate indoor levels and do not crowd other guests.
- Keep hands to yourself. Do not touch the plants, do not pick leaves or flowers, and do not take anything out of the conservatory.
- There are some animals that live in the conservatory- do not touch, chase or otherwise harass them.

In the park:

- Stay within view of your chaperone and remain in your group. Be sure to listen to your chaperone for directions and treat your chaperone and your group members respectfully.
- Do not pick or break anything off of live plants- leaves, fruit, flowers etc. You may take something off of the ground (such as fallen leaves) but check with your chaperone first. We do not want to disturb the environment by picking flowers that need to be pollinated, taking fruit with valuable seeds or food for animals, etc.).
- DO NOT LITTER. Be sure that anything that is taken into the park with you comes back with you on the bus (papers, writing utensils, etc.).

On Location Student Activities:

Timeline of events for the trip

- 8:45 - Arrive at Lamberton Conservatory and split class into two.
- 9:00- Pass out worksheets and clipboards. Groups assemble (pre-formed groups) with chaperone. Half of the class will enter the conservatory and half will explore the park.
- 9:45- Groups meet back at the conservatory to switch roles: those from the park will enter the conservatory and those leaving the conservatory will now explore the park
- 10:30- Groups meet back outside the conservatory
- 10:40- Bus arrives

Return to school by 11 am

Details of completing activities

Due to limited space within the conservatory, students will be divided into two groups: one group will enter the conservatory and begin with the “In the Conservatory” portion of the worksheet. The second group will complete the outdoor activity first and

begin the “Highland Park Ecosystem” portion of the worksheet. Halfway through the visit, the groups will switch.

During both parts of the visit, students will record observations in the graphic organizer below. Independently or in groups they will then come up with inferences to explain their observations, and questions about what they observe. Depending on teacher preference, students likely will have more observations than inferences/ questions. The inference/ question portion could also be completed after the trip, depending on time constraints.

Name: _____ Date:_____

O/Q/I Chart

As you visit the conservatory and outdoor park, take down some observations below. Record questions that arise from these observations in the second column. In the final column, record any answers or responses you may find to those questions as you continue to observe. The inferences do not need to be completely correct, use your best judgement and do your best.

Observation (What do you see?)	Question (What do you want to know about the observation, or your inference?)	Inference (What ideas do you have that might explain your observation? Does it connect to anything in class?)

Plant Observation and Comparison

Choose any two plants that you saw during your visit that are very different from one another. Record their names, where you saw each one, and draw each plant below (to the best of your ability!)

Plant Name		
Location		
Drawing		

Name: _____ Date: _____

Group Members: _____

Ecosystem Exploration at Lamberton Conservatory and Highland Park

In the Conservatory

Walk through the conservatory and answer the questions below. You do not all need to pass through the rooms in the same order as the map, and you do not need to complete the questions in the order they are listed below. In fact, splitting up would be better due to limited space. Be sure to be taking notes in your Observation/Inference/Question graphic organizer as you do as well. Your observation charts will help you answer the questions.

1 a) Which room had the most biodiversity? Explain your answer.

1 b) Which room had the least biodiversity? Explain your answer.

2) How are the plants in the Tropical Dome unique?

3) What is unique about the tropical environment?

4) How are the plants in the Exotic room unique?

5) What is unique about this “Exotic” (Epiphytes, Ferns and Orchids) environment?

6) How are the plants in the Desert room unique?

7) What is unique about the Desert environment?

8) Compare the Old World desert plants to the New World ones. In what ways do they look the same?

9) In what ways do the Old World and New World desert plans look different?

In The Park

1) List three plants that you have seen before growing in a park, a yard or in the wild.

2) Are there any similarities between these three plants?

3) Name three plants in the park that you have not seen before.

4) Do the name tags say where these three plants are from? If so, record that here:

5) Do you see any similarities between these three plants?

Do you see any obvious differences?

Conservatory and Park Comparison

Complete this section after you have visited both the conservatory and the park

1) What are some similarities you saw between the plants in the park and the plants in the conservatory?

2) What are some differences between the plants in the park and the plants in the conservatory?

3) Could the plants that you saw in the conservatory grow outside in the park? Explain your answer

Upon returning to the school, collect students' worksheets (and clipboards) so that they will all be available for the next class.

Post- Trip Extension:

Sharing findings

Begin by passing back the students' worksheets. Allow students time to finish any sections that they were unable to complete on the trip, especially the final section of the Ecosystem Exploration activity. They will complete this with their groups from the trip.

Once all are finished, rearrange groups so that students are working with new classmates. Have them discuss their findings to the Ecosystem Exploration worksheet. They can organize their findings into a graphic organizer or table, either one provided by the teacher or they could come up with their own if they are familiar with that skill.

Extending ideas-

Once all groups have shared their findings, lead a whole class discussion comparing the unique characteristics of each room and the plants found within them. Make a list on the board of unique features of plants and the corresponding unique characteristics of their environment.
Ask students to draw conclusions as to why these unique features were advantageous in their environment. This discussion will include characteristics of the environment that the plants were located in, as well as the life processes (a review) that the plants have to carry out in each environment (ex. need for sun, water, carbon dioxide and nutrients). Have students incorporate their drawings into their answers about unique features. Discuss the parts of the plant and their functions (this is likely a review of plant structure, but these plants may be atypical of what was taught during this unit).

Metacognitive Reflection

Name: _____ Date:_____

Reflection

1) What was the most memorable part of your trip to Highland Park and the Conservatory and why?

2) In what ways do you think these places might be valuable locations to the community?

3) What did you learn from your observations that you think you could use outside of living environment class?

4) Why might it be important that humans understand the workings of the ecosystems they live in?

5) What skills did you use on this trip that you feel confident in? What skills might you need more work on?

Assessment:

Name: _____ Date: _____

Biome Project

We will be working in groups to become experts about each of the world's different biomes, and teaching each other what we learned. Each group of three will choose a biome to learn about, and each will create a presentation to teach what they have learned to their classmates.

There will be two parts to this grade: one part for making your presentation, and one part for taking notes on other students' presentations.

Presentations must include the following information:

- Name of ecosystem
- Location on a world map
- Conditions and Climate
- Plant and animals present
- Conservation status
- Any other interesting facts
- Include References

Note sheet for watching presentations:

Biome Name	Locations in the World	Conditions and Climate	Plants and Animals	Conservations Status	Other Facts

Rubric:

Criteria	Well done- 2 points	Partially Included- 1 point	Missing or completely incorrect- 0 points
Name of ecosystem			
Location on a world map			
Conditions and Climate			
Plants and animals present			
Conservation status			
Additional Facts Included			
References Included			
Work is Complete and creative			
Effort by all groups members			

Module 6: Growing in the Garden

Grade Level /Content Area: 7th grade Living Environment

Unit: An extended project that fits into a few: Reproduction and development in plants, photosynthesis and/or ecosystems.

Main Question: How do plants grow, reproduce and carry out life functions?

NYS Intermediate Level Science Standards:

> 1.1f Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.

4.1 Observe and describe the variations in reproductive patterns of organisms, including asexual and sexual reproduction.

> 4.1a Some organisms reproduce asexually. Other organisms reproduce sexually. Some organisms can reproduce both sexually and asexually.
>
> 4.1b There are many methods of asexual reproduction, including division of a cell into two cells, or separation of part of an animal or plant from the parent, resulting in the growth of another individual.

4.3 Observe and describe developmental patterns in selected plants and animals (e.g., insects, frogs, humans, seed-bearing plants).

> 4.3c Various body structures and functions change as an organism goes through its life cycle.
>
> 4.3e Patterns of development vary among plants. In seed-bearing plants, seeds contain stored food for early development. Their later development into adulthood is characterized by varying patterns of growth from species to species.
>
> 6.1c Matter is transferred from one organism to another and between organisms and their physical environment. Water, nitrogen, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environment.

6.2 Provide evidence that green plants make food and explain the significance of this process to other organisms.

> 6.2a Photosynthesis is carried on by green plants and other organisms containing chlorophyll. In this process, the Sun's energy is converted into and stored as chemical energy in the form of a sugar. The quantity of sugar molecules increases in green plants during photosynthesis in the presence of sunlight.

6.2b The major source of atmospheric oxygen is photosynthesis. Carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.

6.2c Green plants are the producers of food which is used directly or indirectly by consumers.

Prior Knowledge:

Sexual reproduction involves two organisms that contribute half of their chromosomes to the offspring to create a new organism with genetic variation.

These two sets of chromosomes are combined via the fertilization of egg by sperm- students are familiar with this idea in the human or other animal cell (maybe not yet in a plant).

The functions of all living things are: made of cells, grows and changes, responds to environment, maintains homeostasis, has a metabolism, reproduces and passes traits on to offspring

Learning Objectives:

Students understand and can explain basic sexual reproduction in plants.

Students can explain different forms of asexual reproduction/ vegetative propagation in plants.

Students can identify and explain the function of different plant tissues (roots, stems, leaves).

Students can describe structural and functional changes in development of a plant from seed to reproducing adult.

Students can label the male and female parts and sex cells of a flower

Students can describe process of photosynthesis, including what materials are needed and what materials result.

Students understand that plants need nutrients and those nutrients come from other organisms breaking down organic matter

Location Attributes:

This project offers another opportunity for science exploration to take place right on school property, in any available space that can be utilized such as a courtyard, or anywhere else on school grounds that receives ample sunlight. Some schools may have greenhouses that can be utilized, but otherwise plants can be started in the regular classroom. Urban schools can seek out community garden space in areas nearby the school if no property on the school campus is available for planting.

This project offers the opportunity for a year or semester-long investigation that can span multiple units, and can provide students the experience of growing their own plants and watching them complete their life cycle, or result in produce that can be used by the class.

This project also offers an opportunity for students to learn how to reuse and recycle a number of everyday, single-use products or even food scraps, instead of disposing of them as waste. Even the gardens can be built from recycled materials.

An example of a raised bed garden using materials that already be on the property: a garden bed made from concrete pavers and cinderblocks. Utilizing extra materials like this can result in a no-cost, no waste garden area for your classroom to use.

Example layout of cinder blocks and paving blocks for a raised bed garden. Author's photo.

The main cavity can be filled with dirt, as can holes in the cinder blocks. Potted plants can be placed on blocks, or in the empty spaces. Author's photo.

A wooden raised-bed garden is also easy to build, and could possibly be built using pallets from items being shipped to the school. Additionally, the technology department could be contacted for scraps of wood and other materials, and an interdisciplinary or joint project could be created.

Simple, wooden raised-bed garden boxes in Goodwin Park Community Garden. Author's photo.

A 4 ft. x 8 ft. garden box provides enough room for four tomato plants, six pepper plants, six romaine lettuce, four basil plants, a peppermint plant, with a few flowers for pollinators and 2 ft x 3 ft still unplanted. Author's photo.

Everyday food packaging and other items can be used as seed starting trays, small planters, scoopers, storage containers and more. An NSTA Publication titled *Classroom Creature Culture* includes an article that suggests using soup cans as scoops for soil, sand and vermiculite, and suggests starting seeds and cuttings in paper cups or milk cartons (Hampton & Hampton, 1981). Students can bring in items from home that would otherwise go in the trash for reuse such as egg cartons, yogurt containers, milk or juice cartons, even plastic bags.

Egg cartons make great containers for starting seeds indoors. Author's photo.

Egg cartons can also be used for propagation using leaf cuttings. Author's photo.

Glass jars of all shapes and sizes can be used to root cuttings in water, and students can see the roots as they grow. These cuttings all came from the plant on the right. One single plant can provide enough cuttings for a whole class. Author's photo

Additionally, a composter can be built to use food scraps provided by the class to create rich fertilizer for the garden. Many different types of composters exist, but the following are particularly suitable for the school setting:

- Milk Crate Composter for outdoors : uses a few interchangeable layers for proper aeration. Milk crates may be available from the school, or local business may be able to donate a few
- Garbage Can Composter for outdoors: A 32 gallon plastic garbage container can be purchased for about 10 dollars. With some holes drilled in the sides and bottom, it can hold a lot of compost, as long as it is mixed with a shovel once a week
- Vermicomposter for indoors: These composters use Red Wiggler worms to break down most plant/ fruit and veggie food scraps, and can be kept anywhere there is room for a small bin indoors. The worms allow for a smaller bin and no need to turn the contents, and there is no smell (though there shouldn't be with a properly maintained outdoor bin either). A 20 gallon storage bin can be purchased for about $6 and with some holes drilled in the sides and bottom, will make a fine worm bin. Newspaper will have to be added regularly, and Red Wiggler worms must be purchased (earthworms will not do). Red Wigglers are sold online for about 13 dollars by Ward's Scientific (though sometimes you can find them online for less- once a worm bin takes off, they start to multiply and people are willing to get rid of some for cheap so check your local Craigslist posting or similar as well). More information at: http://compost.css.cornell.edu/worms/basics.html

A simple vermicomposting bin made from a storage bin, ideal for indoor composting. Author's photo.

Instructions for a number of Do-It–Yourself composts bins can be found online at link like this one:

http://backyardgrowers.com/23-ingenious-diy-compost-bin-ideas/

More information about composting can be found online from institutions like Cornell University

Materials Needed:

- Building materials for the garden beds (if none exist already) such as cinder blocks, wooden boards and nails or screws
- Paper, plastic or polystyrene “recycled” containers for seed and plant starting
- Soil, Sand, Vermiculite or Perlite and storage containers for each
- Building material for compost bin – purchased bin and drill, or milk crates, etc.
- Continuous supply of food scraps and brown material such as newspaper, leaves or lawn clippings
- Red Wiggler worms if building vermicomposter
- Seeds , seedlings, plants or cuttings
- Vernier Probes and Labquest equipment, or other similar equipment for measuring CO2 or oxygen

Pre-“trip” Preparation:

Introducing the topic-

This topic can be implemented a bit differently than with the other trips because much of the beginning stages of the garden take place indoors. And some plants are

exclusively grown indoors, meaning that your classroom is just as much a part of this experience as the outdoor garden. As this can be a unit that revisits the garden over and over, each piece can be introduced differently, as a lot of different ideas will be covered.

Initially, however, students can begin exploring what they already know about gardening, plants, and where our food comes from. A think-pair-share on a question such as “What do we know about plants” and “How do plants relate to our lives as humans?” is a good introduction to the overall idea of working with plants. A list can be compiled at the front of the room of the students’ ideas, and the teacher can fill in any immediate gaps that they may see.

The next idea to introduce students to is how to grow plants in a garden. This is where the teacher will discuss all of the supplies that are needed for growing plants. Students can be asked to come up with a list of supplies for their own “garden sheds” of things that they think they would need to start a garden, and then discussion as a whole class can compile a true list of supplies that will be needed for this project. The teacher again can address any missed points here.

Introducing the location-

If the gardening location is going to be off campus, then the teacher should introduce this location as in the previous modules. However it is more likely that this will be located right on campus, so there need not be much introduction.

Provide a map of the school so that students know how to get to the locations, and which doors you will be using when going there and back in to the classroom. If you will be building the garden, mark the location on a map so students can visualize where it will go.

Make a list of materials and instructions for whatever type of garden you’re constructing. Assign tasks to students so that all work is delegated and everyone has a job.

Rules and expectations

Safety Concerns for building the garden:

- All materials must be handled with care
- Do not try to pick up any materials that may be too heavy to handle. Ask an adult for help
- Treat any tools with caution and wear safety goggles if power tools are being used

- Always follow all of the teachers directions

Safety Concerns for gardening indoors and outdoors:

- Use all gardening equipment only according to its intended use
- Use caution when using scissors or gardening spade
- Wash hands thoroughly after any planting activity.

Other gardening rules:

- Be sure to label all seeds and plants with your initials and the name of the plant
- Follow any watering and care schedules that the teacher provides
- Keep all materials in their properly labeled areas
- Do not move, change, or otherwise mess with your classmates' plants unless you are directly instructed to do something with them
- Carefully follow guidelines of what you can and cannot put in the compost bin. Putting the wrong materials in can throw off the system, or kill the worms

On Location Student Activities:

Planting seeds & Transplanting- structure/ function, growth and development

Name: _____ Date: _____

Part I

Step 1: Starting Seeds

We will be beginning our garden by sprouting some of the seeds that we are going to plant. Work in groups of 3 and follow the directions below.

1. Everybody pick a plant that they want to grow- each member of the group pick a different seed from the other members so that everyone's seeds in your group are different
2. Fill in the chart below with information and observations:

Plant Name	Seed Shape	Seed Size	Seed Color	Drawing of Seeds

3) Each person wet a paper towel so that it is completely wet, but not dripping too much.

4) Place all of your seeds on one paper towel, spaced out so they have room to sprout

5) Get a plastic storage bag and write your name, the date, and what type of seed you are growing on it in permanent marker. Place the paper towel in the bag and lay the bags flat in a safe space.

6) Make a prediction of whose seeds will grow shoots or roots the fastest:

Whose seeds will grow the longest roots before we plant them in soil?

Whose seeds will grow the longest shoot before we plant them in the soil?

6) Observe the seeds every day. Use a ruler to measure in millimeters how long the roots have grown each day.

Seed: _____

Date	Number of seeds sprouted	Lengths of the longest three shoots	Lengths of the longest three roots

After about a week they will be ready to plant in soil!

Corresponding lessons with this activity should cover the parts of a sprout, so that students can recognize the roots and the shoot, understand what the function is of each, and are able to label them in a diagram.

Name: _____ Date: _____

Part 1

Step 2: Planting Sprouts

We will be taking the seeds we have sprouted and moving them to soil so that they can really begin to grow.

1) Each group gets an egg carton. Put your names on it somewhere other than the cover.

2) Cut off the top of the carton. Save this top, it will be the tray on the bottom to collect water that drips out from the carton.

3) Label the sides of the carton with which seeds will be located in which spots, so that you can identify the plants once they start to sprout.

4) Poke a small hole with a pen or pencil in the bottom of each compartment so that water can drain out. Not a hole big enough for soil to fall through.

5) Fill the carton with seed starting mix, but be sure that you can still see each compartment of the carton (don't over fill).

6) Place one seed in each compartment of the carton

7) Water the seeds so that the soil is saturated, but not soaking wet. Place the top "tray" on the bottom of the carton and find a spot by the window to let your sprouts grow!

8) Measure your seedlings regularly and compare their length to your partners'.

Make a couple predictions:

Which plant do you think is going to grow the tallest?

Which do you think is going to grow the fastest?

Date	Length of seed 1 (cm) _____	Length of seed 2 (cm) _____	Length of seed 3 (cm) _____

Name: _____ Date:_____

Part 1

Step 3: Transplanting

Our little plants can't live in this egg carton forever: they need more room to grow! Some of our plants in this unit will be transplanted into larger pots and kept inside to grow, while others may be transplanted into our garden outside. The following procedure will be followed either way.

1. Carefully remove the plants from the soil, it's okay if there is a big chunk of soil attached still. Place them on a paper towel or newspaper lined surface.
2. As the teacher will demonstrate, GENTLY break up the roots of the little plant. Do NOT tear the roots off of the plant, but separate them if they are tangled together. There will be some ripping feeling, which is okay.
3. Make sure all containers have holes on the bottom. Fill the new container with potting soil mix, or head out to the garden. Dig a hole a couple inches deep that will fit the roots of the plant, but will leave the plant level with the top of the dirt. Your teacher will provide an example.
4. Set the plant in the hole and fill in with new potting soil. Gently press down so that the plant is secure, but do not squish the dirt down too hard -a little air around the roots is good!
5. Label all of the plants by either writing on the containers, or placing a flag in the soil with your initials and the name of the plant.
6. Water all of the plants that you have transplanted
7. Wrap up the dirt in the paper towels or newspaper. (In schools with an outdoor composter, these can all go in there. In classrooms with a vermicomposter, have students dump the soil in a container and rip up the newspaper and paper towels to use in the vermicomposter.

Draw an image of one of your plants.

Label the different parts of the plant. Include descriptions of the function of each part.

What would your plant look like if you put it in the sun and forgot to water it for a week? Draw image below

What would your plant look like if you watered it too much every day for a week? Draw an image below

What would your plant look like if we planted it in plain soil with no fertilizer to provide minerals and nutrients? Draw an image below

What will your plant look like if we grow it in the right conditions and it is very healthy and happy? Draw an image below

Later lessons can be implemented based on the types of plants that were planted. Lessons on harvesting and using the plants are highly beneficial and are suggested. Even if formal observations are not continued for the whole life of the garden, students should take time to check on their plants, and of course a maintenance schedule will still be followed to ensure the plants continue to be cared for and grow in proper conditions.

Growth from cuttings/Asexual reproduction

A lesson(s) on asexual reproduction will correspond with this activity. The lesson will discuss the different types of asexual reproduction seen in plants: vegetative propagation through corms, bulbs, runners/stolons, tubers and rhizomes. Artificial propagation through cuttings, grafting,

Name: _____ Date: _____

Part 2

Plant Clones

We will be learning to clone some of the plants here in the classroom. No mad-scientists needed! This will take some time- a few weeks- so be patient and we will continue to check on our clones as they develop.

First Experiment: Cloning a succulent from a single leaf

Day 1

1) Each person gently removes a leaf from a succulent plant of your choice. Be sure that the leaf comes completely off of the stem. Your teacher will be coming around to help if you need a hand.

2) Set your leaf on a paper towel or piece of newspaper with your name written near it. They need to sit for a few days, until a callus forms over the end of the leaf that was attached to the stem of the plant.

Day 2 (4 days to a week later)

3) Each person put their initials on the side of an egg carton where you will be placing your leaf. Have one person fill the carton with cactus soil mixture.

4) Each person places their leaf in their labeled section of the egg carton.

5) Use a spray bottle to thoroughly dampen the soil. And now we wait!

6) The carton should be misted with the spray bottle every other day. Work with your group to make a list of everyone's names that can be checked off every time the leaves are watered.

Answer the questions below:

What does your leaf look like on the day you planted it? Draw a sketch below.

What do you think the leaves will look like when the plant starts to grow? Draw your prediction below. (There are no wrong predictions!)

Do you think the new plants will all look identical to each other? Explain your reasoning.

Second Experiment: Cloning a leafy plant from cuttings

Day 1:

1) Each group will be taking a cutting from one Pothos plant, and that cut needs to be made at a node. We have learned about nodes in class but your teacher will point them out on the plant as well so we can see what they look like on a real plant.

2) Take turns at the plant looking for a stem that your group wants to cut. Be sure that there are at least a few healthy leaves on the stem you want to cut. Make your cut and take your cutting back to your lab table so other groups can get to the plant.

3) Using a ruler, measure your plant from the tip of where you cut it, to the tip of the furthest leaf. It's okay if your stem is a little curled up and you can't pull it straight. Be sure to be gentle when handling it. Record length in the table below, as well as number of leaves. If there are no roots yet, record a 0. If the plant was already trying to grow roots in the spot you cut, measure them.

4) Fill a jar with tap water and place the cutting in the water. If there are any leaves under the water, cut them off (but make sure to sill leave a few healthy leaves on the plant). Any leaves that are under water may start to rot.

5) Label your jar by writing your groups initials and the date on a piece of masking tape and tape it on your jar. Place your jar by the window. Now we watch and wait! Check in every few days to make observations.

Date	Number of Leaves	Length of Stem	Length of Roots

Draw a progression of growth of your cutting from the first day, to a time a few weeks later, to the end of our observations.

Cuttings can be kept in water or transplanted into soil once they have established strong roots. A further experiment could compare two groups: one left in water, and one put into soil. Students could use their plants to come up with their own way to test which would lead to more growth.

Connection Questions:

1) How was the cloning of the succulent similar to the cloning of the leafy vine?

2) How was the cloning of these two plants different?

3) Do you think you could clone any plant?

Sexual Reproduction and Flowers

This would be a beneficial introduction to sexual reproduction in plants, as students could investigate different flowers and make their own observations and inferences based on the structures they observe. While I am referring to them as "plants" in the worksheet below, be sure that each plant has a flower.

Name: _____ Date:_____

Part 3

Sexual Reproduction

Plants can reproduce both sexually and asexually. Sexual reproduction in plants is similar in some ways to in animals, but some parts are much different. We will learn about the steps of plant sexual reproduction in class, but first, we are going to try to figure some things out for ourselves.

1) What do you know about sexual reproduction in animals? Include any information that you remember:

2) What parts of sexual reproduction do you expect to be different in plants? Remember that plants still carry out the same life functions as animals, but because they are so different, they go about many of these functions differently.

3) What parts of sexual reproduction do you expect to be the same in plants as it is in animals?

Making Observations:

Each group will obtain at least three different plants to inspect and use to make inferences on how sexual reproduction works in plants. Pick three or more and return to your table with them. Answer the following prompts and questions.

4) What are three things that are similar and three things that are different between these plants?

5) What part of the plant do you think is involved in sexual reproduction? Explain your reasoning.

6) Draw the part of the plant that you think is involved in sexual reproduction and label reasons why. What do you think the function of this structure is?

7) Do you think plants have male parts? Female parts? What about both, or neither? If so, what parts of the plant do you think are male and female? If you don't know the name of the structures, do your best to describe it. Draw and label a picture below.

Follow up on this lab after teaching about sexual reproduction in plants with an activity in which students draw or take a picture of a flower growing in the room and label the male and female parts, and describe and illustrate the life cycle of a plant.

Photosynthesis Rates: Vernier O2 sensor

Students learn before this activity that photosynthesis is a process that takes in water, carbon dioxide and sunlight and results in glucose and a release of oxygen. We can collect evidence of this using oxygen or carbon dioxide probes such as those by Vernier that work with the Labquest system. Vernier provides labs that go with their products, but the procedure below is a simple procedure that can be modified in any way the teacher desires.

Name: _____ Date:_____

Part 4

Photosynthesis

We will be measuring photosynthesis that takes place in a plant that we grew in our classroom, and graphing some results.

Before we begin, predict what we will be measuring in this activity to "show" that photosynthesis is happening. There are no wrong predictions! Explain your answer.

1) Each group obtains a Labquest system and an Oxygen probe, a plastic container with an opening that fits the probe, and a small plant or a piece of one.

Your teacher will show you how to set up the probe and interface so that you will be able to record and graph your data.

2) Be sure that the plant or leaves that you are using are dry. Place the plant or plant pieces into the plastic container. Place the oxygen sensor in the top of the container.

3) The data collection should be set to run for 10 to 15 minutes. Using your system interface, start the data collection. Do not move the container while data is being collected.

4) When the data is finished collecting, it will show you a graph. What does the graph show? What does this data tell you?

5) Using graph paper, graph your results and attach them to this sheet. Your teacher will show you how to switch from graph to chart on your Labquest interface. Use the chart of points to graph oxygen over time.

6) We used a probe that measured oxygen to test the rate of photosynthesis. What else could we test for to check the rate of photosynthesis?

7) What other experiments could we do using this equipment, regarding photosynthesis? Think about what variables we could change. Suggest some experiment ideas below. We will conduct some of these experiments in the near future.

We will return to this in the Extending Ideas section

Composting

The example below is assuming use of a vermicomposter, but could be modified for an outdoor composter.

Name: _____ Date:_____

Part 5

Composting

In this activity, we will be turning all of our food waste into gold. Black gold, it's called. Also known as worm casings, compost, or more simply: a very rich fertilizer.

Why are we doing this? What do you think? Write down your thoughts. We will discuss our ideas as a class before we begin.

1) We first need to set up our compost bin. Your teacher will provide you with some resources on how a worm composter works. Read through these as a group to get an idea of how to build one!

2) First we need to start with some newspaper. Rip the newspaper into about 1-inch wide strips and place them in the buckets provided. Then fill the buckets with water to cover the newspaper. We will let these soak overnight and resume tomorrow.

3) Drain the water from the newspaper strips and squeeze out any extra water. Then fluff up the wet strips again. Place half of the strips on the bottom of the bin.

4) Add the worms to the bin by gently dumping them in. Cover with the other half of the newspaper and put the lid on. The worms do not like the light.

5) For the next couple days, we will have to save our food scraps for the worms. Your teacher will provide you with a list, but generally they must be raw fruits or vegetables. There are some that we don't want to include, like citrus fruits or onions or hot peppers. Collect these food scraps in a bucket with a lid, and keep the lid closed so that no fruit flies find our scraps.

6) The worms prefer their food in little bites, so the teacher should have a food processor or something similar to chop up the food with. Once the food is chopped up, it can be added to the worm bin.

Worms can eat their weight in food each week, so if we started with a pound of worms, then we need to feed them a pound a week! The worms also will reproduce and multiply, so we will have to continue to feed more after a few weeks.

Post- Trip Extension:

In the previous modules, this section was a very important part in taking an experience that happened outside of the classroom and highlighting all of the relevant connections to what students are learning inside the classroom. Because this gardening experience is happening both inside and outside the classroom, it will be more seamlessly implemented into the curriculum, and these "bridges" don't have to be as extensive. However it is important to be sure that students understand how the activities relate to the lessons, and that they are still provided opportunity to share and reflect on their experiences and findings.

Sharing findings-

Because there are so many parts to this learning experience, I will speak broadly here instead of addressing each individually.

Students should always get a chance to come together to discuss their experiences and findings after each activity. Mix up groups of students so they can share their experience with classmates who were in a different group and may have had different encounters, or come up with different conclusions. Allow time for whole group discussion after each finding, even if it is brief. If there is any confusion, this allows for a chance to get everyone on the same page. Additionally, if a student has anything they really want to share or ask the class, we want to be sure they get a chance.

Though many times students or groups will all be growing the same plants, continuously provide students opportunities to look at everyone else's plants as well as their own.

This will remind us to be sure to bring the whole class together in these experiences, and not keep things broken up into separate experiences per group.

Extending ideas:

- Sources of food/ importance of farmers: Read some articles or watch videos about where our food comes from and why farming is important. In our high technology world, people often forget to consider where their food comes from and how important it is that someone is growing their food for them! This is especially true in urban places where there may not be any local farms, or when people lead highly-processed lifestyles where they don't often eat food that still resembles a plant or animal. Some of the following links can be considered, but each teacher is urged to do some research for local and up to date resources.
  http://makobiscribe.com/why-farming-is-important/
  http://seedmap.org/where-does-our-food-come-from/ --- the interactive online maps in this link offer great resources for classroom activities. Students can explore these maps while posing and answering their own questions on the topic.

  Students can consider these ideas relating to their own lives by making lists of all of the sources of ingredients of the food they have eaten in a day. They can save wrappers from processed food they have eaten and look up the sources of ingredients. Then groups or the whole class can make a chart or graph depicting the raw ingredients that came from for a whole day (ex: 10% wheat, 12% soy, 14% corn, 19% chicken, etc.). Students could also then look up where those ingredients may have come from on a map like the seed map above.

- Pollinators: There are a lot of resources available on bees right now amidst the colony collapse crisis, and students should be informed on the matter. Infographics can be shared, analyzed and discussed to explore the significance of the honey bee as a pollinator to farmers and all humans. Some links to infographics include:
  http://www.visualistan.com/2013/12/disappearing-bees-infographic.html?m=1#postimages-2
  https://visual.ly/community/infographic/animals/buzzing-how-dying-bees-affect-you
  https://www.fastcodesign.com/1663022/infographic-of-the-day-who-cares-if-honey-bees-are-dying

These types of resources are engaging and help build visual literacy skills. Students could even build their own shelter for pollinators, or plant pollinator friendly flowers. Examples and ideas shown in the link below: https://modernfarmer.com/2017/02/build-native-bee-hotel/ - shows examples of do-it-Yourself solitary bee hotels (not used by honeybees).

Note: If bee allergies are a concern (which they often are) students can focus on butterflies as pollinators in their gardens

https://www.fs.fed.us/wildflowers/pollinators/gardening.shtml - planting flowers for pollinators should definitely be a part of your classrooms gardening experience. Students can use resources like this link by the USDA Forest Service to learn all about the importance of providing local, non-hybridized flowers that local pollinators depend on, and other ways to help provide habitats for pollinators.

A major conservation push is preserving natural land where native milkweed grows, because it is the only plant where monarch butterflies lay their eggs. Planting (or refraining from clearing) milkweed is an important point in preserving natural habitats in our own yards and gardens. Students can learn the importance with resources such as these here: http://blog.nwf.org/2015/02/twelve-native-milkweeds-for-monarchs/ https://www.saveourmonarchs.org/why-milkweed.html

Additionally, sometimes conservationists don't quite do things correctly and can actually have negative impacts that they were trying to avoid. This resource explains a scenario in which people were planting the wrong variety of milkweed thinking they were helping monarchs, but actually were harming them. Students will learn how important it is to really do our research, and to use native plants opposed to tropical or hybrid cultivars: http://www.sciencemag.org/news/2015/01/plan-save-monarch-butterflies-backfires

- Who's in the garden? We gardeners and our pollinators are not the only ones in our garden. Students can learn a lot about ecosystems by studying the plants and animals we find in our garden space. Though we generally try to limit the number of rouge organisms in our gardens, there are a number of animals and other organisms who

would love to get in if we give them a chance: Moss, fungi, weeds, slugs, worms, spiders, isopods, snails, mice, squirrels, chipmunks, moles, birds, rabbits, woodchucks and deer can all be found in our gardens (if we let them). While we of course want to protect our crops, students can also learn a lot about the ecosystem by observing the garden to see what animals (or plants or fungi) are living in the garden and how they relate to our plants and each other. More info at: http://theconversation.com/birds-bees-and-bugs-your-garden-is-an-ecosystem-and-it-needs-looking-after-65226

- Nutrition and malnutrition: As we plant herbs, fruits and vegetables students have an opportunity to learn about nutrition and its role in human health and disease. This is a great way to connect the garden to the human body systems unit, as our gardening will likely span across much of the school year. Students can learn about nutritional needs of the human body and about eating a well-balanced diet. They can look into the nutritional content of the plants we are planting, and can learn to plan healthy, balanced meals using the plants that we grow. Resources include:
  https://www.fns.usda.gov/tn/myplate
  https://www.fda.gov/food/ingredientspackaginglabeling/labelingnutrition/ucm063367.htm
  https://www.health-alternatives.com/vitamins-nutrition-chart.html
  Students can also learn about nutrient deficient diseases with resources such as:
  https://www.healthline.com/health/malnutrition#types2

These are just a few examples of concepts that relate to gardening. I urge you to think of some other ways that this learning experience can be related to an important topic or idea, both within the science curriculum and in relation to healthy and informed scientifically literate citizens.

In addition to the main learning experiences described in the “On Location Student Activities” section above, the following experiments can be used to deepen understanding of some of the concepts. One way to go about this is to provide students with a teacher-designed lab to follow in order to explore these questions. Alternatively, it can be left to the students to

design an experiment given an experimental question. Or, students can be given the freedom to come up with their own question regarding something they have planted (or could plant) and each group could design and test their own experiment.

- Experimental Question: Do plants grow better with or without compost added to their growing medium?

- Experimental Question: How are plans affected when grown in different conditions such as amount of light, higher or lower temperatures, color of light, etc.

- Experimental Questions: What is the best medium for rooting cuttings?

Metacognitive Reflection

Reflections could (and should) be made for each portion of this experience, and in many cases could be included at the end of a worksheet or as exit tickets to complete at the end of each lesson or each day working in the garden. Some questions to be included are:

1. Why is it important to know about where we get our food?
2. What skills have you used in today's activity?
3. How can you use these skills outside of the classroom?
4. Would you consider starting a garden at home? Why or why not?
5. Do you think it is important for people to know how to garden? Why or why not?
6. Has this experience changed how you look at food? Explain.
7. Has this experience changed how you feel about what you eat? Explain.
8. Have you learned about nutrition before in regards to your health? What did you know before or what did you learn?
9. How confident are you in using what you have learned here to plant something at home?
10. What is something else that you would like to learn about food or gardening?
11. What did you find most interesting from this experience?
12. What did you find most surprising from this experience?
13. What skills do you feel confident in? What skills do you feel you need more work on?

14. What is something you could teach someone that is not in this class that you think would be important for them to know?

Assessment:

Because this learning experience can stretch into many different units, there will likely be many ideas and concepts covered in these experiences that will be tested and assessed within other units. However to assess the skills and knowledge needed to grow and care for a garden, students can complete the following assessment. They will need ample time in class to work together to compile this portfolio of knowledge.

Name: _____ Date: _____

Garden Experience Assessment

Gardening Manual

Students will work in groups to complete a gardening manual that displays all of their knowledge on how to prepare, start, care for and harvest a garden. This manual will be shared with others in the school who are interested in starting a garden of their own. The manual can be completed and submitted on the computer, or can be done by hand with a hard copy submission.

The manual will include:

- Materials needed and how to prepare a gardening space
- How to start seeds
- How to transplant seedlings
- How to fertilize, water properly, and provide overall optimum conditions
- How to propagate plants and grow from cuttings
- How to compost and how to use compost in the garden
- How to trim and upkeep plants
- Suggestions for keeping pests away and attracting beneficial pollinators
- How and when to harvest your crops
- Bonus: Provide one recipe from plants that can be grown in a garden

Rubric:

Criteria	Well done- 2 points	Partially Included- 1 point	Missing or completely incorrect- 0 points
Materials needed and how to prepare a gardening space			
How to start seeds			
How to transplant seedlings			
How to fertilize, water properly, and provide overall optimum conditions			
How to propagate plants and grow from cuttings			
How to compost and how to use compost in the garden			
How to trim and upkeep plants			
Suggestions for keeping pests away and attracting beneficial pollinators			
How and when to harvest your crops			
Bonus: Provide one recipe from plants that can be grown in a garden			
Well organized and easy to read			
Minimal spelling errors and typos			

CHAPTER 5

Summary

The example lessons in the previous chapter were carefully structured to follow findings and suggestions in the literature made by educators and researchers who have focused on experiential learning lessons in their work. Most importantly, when planning experiential learning lessons and trips, students must understand what is expected of them so that the trip is not viewed as free time and ultimately become a free-for-all. Eshach (2007) describes how to avoid what he calls this "Novelty Phenomenon" by carefully and explicitly connecting what students are learning in class to what they will experience in the field or during their activities. Remmen and Frøyland (2014) also discuss the need to provide students with information they will encounter on the trip pertaining to a number of aspects from the geography of the location to content to be covered and ways of thinking to be explored. This is why all of the examples in the previous chapter include information on the location, a timed agenda, details on the activities to be completed and the expectations of students to be shared before embarking on the trip. The templates allow for any background information and important rules to be laid out before beginning the lesson, so everyone will have the knowledge they need to have in order to have a productive experience.

In addition to to preparing students for their experience, the template was also designed to bridge the experiential learning trip back into the classroom afterward. Morris (2012) explains how students are usually excited by what they experienced on the trip, and that they benefit from opportunities to share their experiences and conclusions afterward, as well as demonstrate what they have learned. Remmen and Frøyland (2014) also discuss the importance of following up on

the ideas explored in the field once students resume class back in the classroom. We do not want students to think that the experiential learning trip was a one-time event, so we must highlight how the observations they made, the questions they created, and the inferences they drew are all important parts of science learning. The "Post-Trip Extension" portion of the template allows the teacher to demonstrate how these are connected to the rest of the lesson and the greater unit, and to build on these ideas to lead to connected topics and higher levels of thinking. Ballantyne et al. (2010) found that students deepened their understanding of what they experienced and broadened their concepts of themselves as thinkers and learning when allowed metacognitive reflection on the experience and their completion of the activities, which is why this is included in the extension portion of each lesson.

Both Eshach (2007) and Morris (2012) explain the importance of providing students with a detailed activity to complete on site during learning trips, which is why the examples above provide extensive activities to keep students on track and working towards a goal during their trips. The activities provided may be easily altered to fit any locations being used, different goals being targeted, or specific needs of students in a class. They are included to provide adequate examples of activities that can guide students to take responsibility for their own learning while remaining on task and focused on a particular question or idea.

A few obstacles discussed in the literature include students becoming off task during the trip or when working on extension activities afterwards. Distractions in the field generally happened when students were left with more open-ended prompts that were intended to result in higher level thinking, but were too challenging for students to handle when the teacher wasn't present (Remmen & Frøyland, 2014). The "On-Location Activities" provided in the examples above provide students with enough guidance that they should be able to complete the activities

without getting frustrated and needing extra help from the teacher. However, they also provide enough open-ended prompts that higher levels of thinking can be achieved. In the examples provided, there are plenty of opportunities for higher level thinking once the class is back in the classroom after the trip, where the teacher can help guide if necessary. The extension activities also provide ample opportunity for students to work together and partake in discussions, because Remmen and Frøyland (2014) suggested that this could keep students engaged better than individual research.

The benefits of experiential learning are demonstrated in a number of research studies that prove that these experiences make valuable additions to the Living Environment classroom curriculum. Numerous studies have found statistically significant increases in science content knowledge following an experiential learning lesson that was not seen in control groups. Examples were provided in the literature review in Chapter 2 such as the studies by Prokop et al. (2007), Hiller and Kitsantas (2014), and To-im et al. (2010). Increases in other areas such as attitudes towards science were recorded in studies by James and Williams (2016), Scogin et al. (2017), Prokop et al. (2007), and Zoldosovoa and Prokop (2006). Weinberg et al. (2011) and Hiller and Kitsantas (2014) saw increase in their students' interests in science and science careers as a result of an experiential learning lesson. Creations of a positive environmental identify were seen by Blatt (2014) and To-im et al. (2010). Students in studies by Scogin et al. (2017) and Gleason et al. (2013) saw improvements in a number of 21st century skills through experiential learning.

Although this type of lesson planning may require some work to implement into a mostly classroom-based curriculum, the positive outcomes are worth the work. Restructuring existing lessons or coming up with new ideas utilizing outdoor space brings fun and creativity into lesson

planning, and students will enjoy the new experiences and new environment that these lessons provide. Teachers can begin with the lessons that take place on school grounds in order to get a feel for the skills and procedures required for this type of learning before moving on to further, longer trips at more remote locations. Remember that these experiential learning trips do not need to be big, long trips in order for the benefits to be gained; short experiences outdoors that take place just outside of school walls offer all of the benefits of experiential learning described within this document.

This project allows for various directions to continue into the future. In completing the final example on experiential learning in a class garden, I realized that there are enough connections to make between a gardening experience and living environment curriculum and related science skills that it could encompass a project of its own. A garden could be used throughout the schoolyear to link to most every unit in the living environment classroom. A garden could also lend itself to an interdisciplinary learning experience, in which classes in other contents could be involved in gardening projects.

Any of these examples can be modified to fit the needs of particular classes. Special education teachers could modify these experiences for their class, or co-taught and inclusive science classes could modify the examples to fit the needs of all students. A project focusing on experiential learning in the special education classroom could be an interesting and valuable direction for this to go in the future. Similarly, any of these experiences can be made interdisciplinary, which would give students a very well-rounded and interconnected understanding of the content they are learning through them. Any number of teachers could use this document to each modify the examples in different ways that they see fit, resulting in any

number of lessons being created from the template and examples provided here. The opportunities are endless, and I hope that this work is used in so many various ways.

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