

A Proposal for a Disc Golf Nature Trail at the Allegheny College Recreation Complex

By

Liam McCann

Department of Environmental Science

Allegheny College

Meadville, Pennsylvania

March 2023

**Submitted in fulfillment of the senior thesis requirements of the
Department of Environmental Science and Sustainability at Allegheny College
and approved by the senior thesis committee.**

Dr. Richard Bowden

Date

Jared Luteran

Date

Pledge

Name: Liam McCann
Major: Environmental Science
Thesis Committee: Richard D. Bowden, Jared Luteran

Date: March 2023

Title: A Proposal for a Disc Golf Nature Trail at the Allegheny College Recreation Complex

Outdoor education programs at all levels serve as ideal theaters not only for physical activity but also the cultivation of critical social skills such as resilience, leadership, and communication - all of which are particularly important in the developing stages of adolescence. The sport of disc golf has exploded in popularity over the last decade for its low entrance costs, minimal invasiveness to the surrounding environment and high social potential. Members of the disc golf community are no strangers to environmental stewardship, either; disc golfers exemplify the innate human desire to spend time in nature while thoughtfully considering the impacts of having a presence there. Holistic sustainability has long been a hallmark of Allegheny College's organizational goals, which foster engagement with the outdoors through various student-led organizations like the Outing Club and offer unique educational opportunities through its renowned Environmental Science and Sustainability department. The valuable product of such an education is a population that is both informed about problems associated with the physical environment and well-equipped to zealously pursue their solutions. When combined, outdoor recreation and environmental education can become a powerful force for promoting sustainability and awareness. The purpose of this project, therefore, is to explore the potential of a disc golf course for Allegheny College as a guided education program wherein players can be presented different environmental topics relevant to northwest Pennsylvania at each hole in an engaging, nondisruptive manner to their game. The final program is entirely digitized in the form of an ArcGIS StoryMap.

List of Figures

- ❖ Fig. 1: Aerial view of proposed Disc Golf Nature Trail 9
- ❖ Fig. 2: Tee pad QR code for ArcGIS StoryMap 12
- ❖ Fig. 3: Fire tower view, Cook Forest State Park 13
- ❖ Fig. 4: Forest ecosystem services 14
- ❖ Fig. 5: Eastern Hemlock 15
- ❖ Fig. 6: Whitetail Deer 16
- ❖ Fig. 7: Distilled maple syrup barrel, Firth Maple 17
- ❖ Fig. 8: Confluence of French Creek & Allegheny River 19
- ❖ Fig. 9: Sediment stratification in Wintergreen Gorge 20
- ❖ Fig. 10: Yellow-legged bonnet in Bousson forest 21
- ❖ Fig. 11: Trail sign on French Creek Valley Conservancy property 22
- ❖ Fig. 12: Financial and labor cost breakdown 23-24

Introduction

History and Rules of Disc Golf

Ed Headrick - known as the “Father of Disc Golf” - founded the Professional Disc Golf Association from the social and financial support generated by hosting tournaments nationwide (PDGA, 2022). The sport of disc golf began its professional life in 1974 at the American Flying Disc Open, held in Rochester, New York, the success of which led to the installation of the first permanent disc golf course at Oak Grove Park in Pasadena, California (PDGA, 2022). Disc golf would not be the activity it is today without two crucial patents of Ed’s: the famous Wham-O Frisbee, a classic flying disc design claimed by Headrick during his time with the company; and the disc golf pole hole, the foundation upon which every modern disc catching device is based (Justia Patents, 2022). The namesake and inspiration of the Frisbee both come from the Connecticut-based Frisbie Pie Company, whose pie tins were once more popular to consumers than the pies themselves due to their flat shape and lipped edges which made them suitable for throwing and catching (Spencer, 2015).

The rules of disc golf are simple and highly similar to those of traditional golf, making it easily adoptable as a pastime: players begin at an established tee pad and navigate the hole with the execution of various throws, and as is the case with traditional golf, the objective is to reach the end of the hole in as few throws as possible (Dynamic Discs, 2021). One main difference between the two types of golf, however, is that the concept of tee times does not really exist in disc golf outside of the competitive sphere (PDGA, 2022). This contrast contributes to making disc golf the more casual pastime of the two, exemplifying its potential to access a wider audience of individuals.

Environmental, Economic and Social Benefits of Disc Golf

Disc golf courses have the unique advantage among sports of being minimally invasive to their surroundings, which makes them favorable options for communities hoping to pursue and implement more sustainable recreational outlets (Hotchkiss, 2002). Large swaths of land need not be leveled, cleared or groomed for a disc golf course to be successful; in fact, when asked about their ideal course, touring members of the Professional Disc Golf Association largely tend to prefer the dense, wooded layouts of Idlewild, Kentucky or the hallowed Maple Hill, Massachusetts over the open, temporary golf course layouts of Emporia, Kansas or Las Vegas,

Nevada (Williamson, 2021). Courses in the woods in particular may command more strategy and technical throws from players, but they provide in return some services unique to forest ecosystems: most notably, tree cover acts as a buffer from wind, rain, excessive heat and other undesirable weather conditions, greatly expanding the daytime hours during which individuals can feasibly go out and play a round (Chavez, 2005; Martins, 2017).

Another appeal for disc golf which sets it apart from other sports is its economic viability. There are virtually no major startup costs, with the only necessary monetary investments being any reliable pair of shoes and a flying disc, the latter of which can be purchased at professional quality for as little as 5 to 10 dollars per disc (Panis, 2021). Additionally, 90 percent of all courses in the United States are free to play, though many feature optional donation boxes meaning players are not compelled to contribute financially (UDisc, 2022). Installation costs can run high depending on the location and quality of the proposed course, but the disc golf community boasts a culture rich in stewardship and players tend to return the favor of free-to-play courses by handling any light maintenance completely of their own accord - a unique bonus recreational planners in particular greatly appreciate (Mahoney, 2013).

Disc golf is renowned for being a “lifetime activity”; in other words, it is a highly individualized, accessible, user-friendly sport playable to people from all ages, skill levels and backgrounds (Menickelli et al., 2016). Some courses may be more physically demanding than others due to placement and other factors, but being ambulatory is only recently not a full requirement as the PDGA updated its course design guidelines to accommodate at least a portion of new permanent courses for physically handicapped players (Martins, 2017; PDGA, 2022).

Although more communities that are viewed as “healthy” tend to have a higher likelihood of installing a disc golf course, physical well-being is not the only aspect of personal health improved by disc golf (Woods et al., 2020). The sport’s social utility was brought into the spotlight by the COVID-19 pandemic of 2020, during which the popular disc golf app UDisc saw a nearly fourfold increase in reported scores from individuals seeking a socially-distant escape from the boredom of quarantine (UDisc, 2022). Remarkably, participation has not waned off since the end of the pandemic - quite the opposite has occurred, actually - and in the last year over half of current UDisc users introduced at least one new person to disc golf (UDisc, 2022). Disc golf should be regarded as an exemplary vessel for discovering and strengthening the innate connection between the individual and the outdoors.

The Significance of Environmental Education

One of the most well-known definitions of environmental education comes from *The Concept of Environmental Science*: “Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution” (Stapp et al., 1969). It is held in the same work that the world possesses adequate resources with which to achieve such a society, but simply lacks the willpower to do so from a lack of awareness on present environmental issues (Calzadilla et al., 2013; Stapp et al., 1969).

As Stapp’s definition states, environmental education must go beyond simply making individuals aware of environmental issues; it must naturally promote appreciation for the environment and compel individuals to lead more sustainable lifestyles. The concept of intrinsic motivation is critical in environmental education, yet it is what most current programs lack (Carr, 2004). Humans thrive off of intrinsic motivation because it signifies an autonomous decision to participate in an activity solely for the reward of doing that activity, regardless of external benefits (Cameron and Pierce, 1994).

It has long been theorized that placing emphasis on conceptualized education rather than instructional education generates the greatest amount of appreciation for the environment, especially among adolescents (Brookes, 1989). Similarly, those activities which generate a strong sense of place should transitively enhance an individual’s intrinsic motivation. “Sense of place” refers to an individual’s personal attachment to a location or its features, often generated through repeated physical exposure to, or knowledge of, that location (Kudryavtsev, Stedman and Krasny, 2012). This concept is believed to be so influential that a percentage of primary schools in Denmark were placed in wooded areas to reflect the Scandinavian cultural ideal of *friluftsliv* - “free-air life” - that encourages spiritual connection with one’s environment and a good relationship with nature and others (Mackenzie, Son and Eitel, 2018).

Disc golf can be a tool for environmental education because intrinsic motivation is already present in the disc golf community. An ethnographic study conducted in 2011 concluded that, within the subculture of disc golf, there is generally a lack of awareness of the environmental impacts directly and indirectly associated with playing the sport; however, those in the study also conveyed a strong sense of belonging to their local course coupled with an eager commitment to its regular maintenance (Trendafilova, 2011). For instance, the sense of

belonging both to a local course and within a social sphere of players would be a factor for educators to consider in designing an intervention program whose aim is to reduce environmental degradation from disc golf (Trendafilova, 2011; Quade, 2013). Instrumental to the sport of disc golf is an appreciation for the outdoors; disc golf, therefore, should be considered a suitable activity for environmental educators to help students conceptualize and practice environmental stewardship.

Outdoor Education Encompasses Environmental Education

A 2007 study interviewed a group of schoolchildren just before and one year after going on a class field trip to Great Smoky Mountains National Park. It was found that many of the students could recall the details of the trip not only with clarity, but also with zeal, indicating a possible shift in the child's thinking toward a more favorable view of the environment (Farmer, Knapp, & Benton, 2007). This mental paradigm shift is, indeed, a critical first step, especially in the developing stages of youth; but environmental education is more than just field trips.

The positive consequences of exposure to the outdoors are plentiful, and studies show time and time again that outdoor ecosystems provide an ideal setting for key character developments such as cognitive capacity, physical education, resilience, and mental fortitude, particularly among school-aged children (Eigenschenk et al., 2019). Outdoor adventure programs such as the National Outdoor Leadership School exemplify the practice of outdoor education by hosting guided adventure classes in which students are exposed to and work together toward the solution of some environmental issue, all while developing communication and leadership skills (Breitenstein and Ewert, 2013).

The practice of learning through play benefits the educational sphere but has seemed to disappear over time as less emphasis is placed on "recess" and more classwork piles up in students' laps instead (Brookes, 1989). Disc golf specifically is becoming a popular physical education activity in schools for several reasons: it is less of a sport in the traditional sense, meaning it appeals to and motivates a broader range of students who may be off-put by more physically demanding activities; the act of throwing a disc is a compound movement that teaches students to have some level of biomechanical awareness, yet is simple enough not to be too disheartening or frustrating; and the slow-paced nature of the activity even greatly improves

behavior back in the classroom by giving even the most restless students a digestible form of exercise with which to blow off steam (Powell and Newgent, 2006).

Disc golf is but one of many immersive ways for the individual to strengthen their inalienable connection with nature; this connection has the potential to yield awareness of - and eventually appreciation for - the environment, the problems associated with it, and solutions to those problems. While players are welcome to ponder environmental problems during a round, there is to date no known disc golf course tailor-made for a tandem educational and recreational experience, particularly not one that considers the impacts of playing disc golf on forest ecosystems. Allegheny College's recreational and administrative staff have jointly voiced a desire for wider use of the college's natural spaces for the purpose of fostering student and community engagement with the outdoors, but ways of accomplishing this are still under discussion.

There are several attributes of the Allegheny College community that make it a suitable environment in which to install a Disc Golf Nature Trail. Firstly, there is much unused land at Robertson Complex which requires little to no alteration for a disc golf course to be viable; thus, a disc golf course aligns well with administrative outdoor initiatives. Additionally, Robertson's past land cover and species composition can be deduced by examining its present-day conditions, meaning much of the educational material can be presented in an interactive format. As for Allegheny College itself, the social climate is a strong fit for outdoor programs. Students are highly active and eager to engage with their environment, participating in clubs like the Outing Club, Bird Club, and Sustainable Design Team. The Environmental Science and Sustainability program is renowned for its excellence and Allegheny is noted for its various environmental efforts, such as achieving carbon-neutrality in 2020 or providing each student with a reusable utensil kit to discourage single-use waste. The college sits in an area with numerous environmental assets and conservation agencies, including the Foundation for sustainable Forests, French Creek Valley Conservancy, and Watershed Conservation Research Center, meaning there is regional relevance for an accessible outdoor education program.

A nine-hole Disc Golf Nature Trail for Robertson Complex will demonstrate the effectiveness of outdoor education in encouraging individuals not only to learn about and engage with the environment, but to eagerly become involved with its safekeeping. Disc golf itself is an

activity long regarded for its accessibility, versatility, community and cognizance, further exemplifying it as a bridge between recreation and education.

Methods/Approach

Description of Site

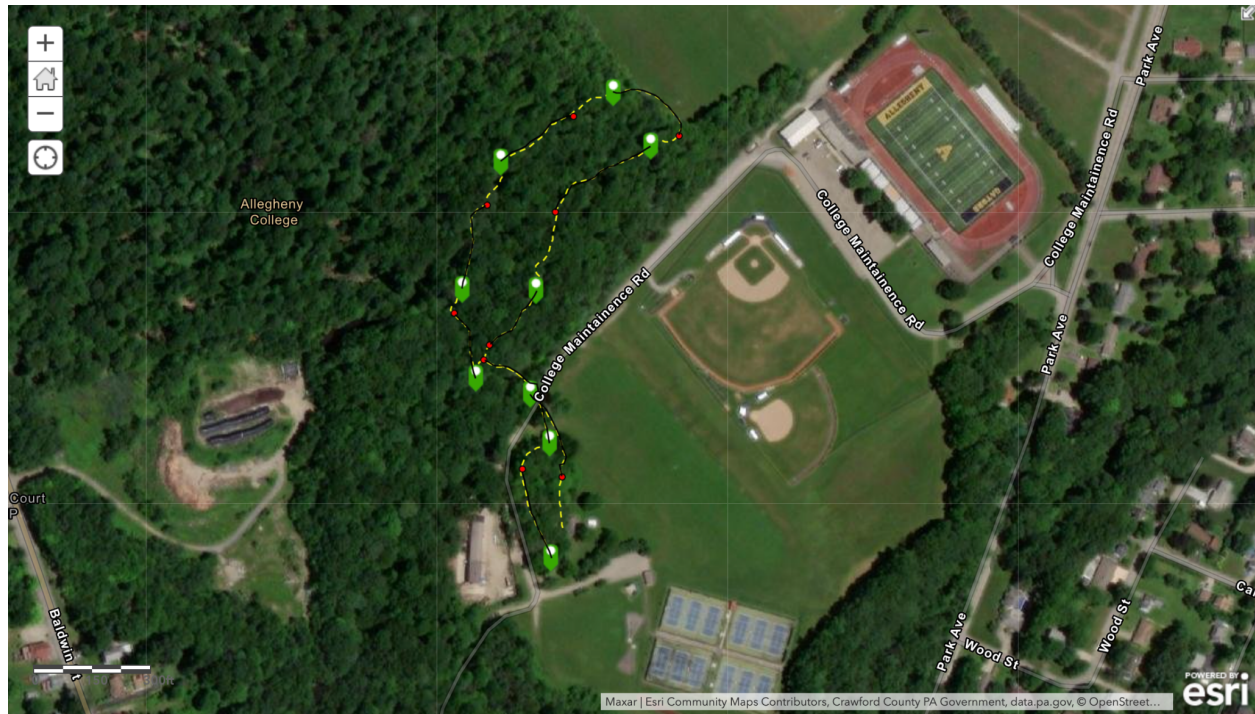


Figure 1. Aerial view of proposed Disc Golf Nature Trail (2023). Photo Courtesy of ESRI.

The Robertson Athletic and Recreational Complex (Robertson Complex) is located roughly one half mile northwest from Allegheny College's main campus. Land cover distribution is fairly even between developed and deciduous forest, primarily covering the eastern and western halves of the complex, respectively (Multi-Resolution Land Characteristics Consortium, 2019). Aerial images of Robertson Complex from various decades over the last century indicate that the land was once agricultural pasture and cropland which then gradually succeeded into deciduous forest; this story is the same for many of Pennsylvania's forests (Bills, n.d.; Ludwig, 2018). Within the forested area of Robertson is a small network of existing trails; a concentrated section of these trails on the south-central part of the complex is the area within which this project is being designed. In the above figure, green flags denote tee pad locations, and red dots denote pin locations. The course begins at the southernmost green marker (Hole 1) and runs clockwise through the above woods.

General Considerations for Disc Golf Course Design

Disc golf courses aim to provide a fluid experience for players while simultaneously minimizing the physical impact of human presence in nature (Kam, 2017). Courses, at minimum, must satisfy a few requirements to be considered “well-balanced”: the holes vary in length, par, and difficulty; there is some variance in elevation, where possible, though not so much as to quickly tire players; and there is at least one clearly visible throwing option off the tee to progress toward the basket (Gentry, 2020). In addition to these general play-oriented recommendations exist a more nuanced set of guidelines which tailored to any specific course: general spacing and layout, including the selection of a relevant, easily accessible area; environmental consequences, such as soil tamping and erosion from foot traffic or damage to the exteriors of trees from flying discs; social compatibility with the rest of the complex in terms of passerby safety as well as any conflicts of interest with sports teams or other school organizations; and presence of natural features, such as topography and species diversity, to provide a suitable educational environment for players.

Approach to Project Design

The first step of designing the Disc Golf Nature Trail was to envision its harmony with Robertson Complex’s current facilities and topography. I began by consulting with Jared Luteran, Assistant Director for Facilities and Recreation, and Angelo Panzetta, Director of Athletic Equipment and Facilities for Allegheny College. With them joining me on a walkthrough of the property, supplemented by several of my own, open areas were discussed but ultimately ruled out in favor of focusing on the woods - versatility of placement is, after all, a key advantage of disc golf. Further determining a suitable area focused primarily on two criteria: social compatibility with the complex given the high volume of year-round usage by sports teams and other school officials; and the role of college physical plant staff and groundskeepers in the installation and maintenance of the proposed course. Both aforementioned issues were weighed in concert with multiple physical inspections of the complex and ultimately used to guide the creation of the Disc Golf Nature Trail’s design.

After ascertaining the area with which I wanted to proceed based on that which best fit all relevant considerations as listed above, I was able to begin the multi-step process of creating,

collecting, digitizing and publishing the course's geographic data using several programs within the ArcGIS suite. Firstly, in ArcGIS Pro, I designed a geographic database (or geodatabase) which allowed me to categorize and eventually digitize certain features of the Disc Golf Nature Trail - specifically tee pads, baskets, hole distance, and all accompanying attributes - on an online map of Robertson Complex. I then published the geodatabase to ArcGIS Online, where I would be able to further edit and manipulate data as needed. After syncing my published web map with ArcGIS Field Maps - a smartphone app used for field data collection - and using Field Maps in tandem with a Juniper Geode sub-meter GPS receiver, I could return to Robertson Complex and begin bringing the course to life.

Field data collection was carried out on several different days throughout the end of the fall semester and into the beginning of the spring semester. Multiple data collection days were necessary due to several alterations in the final course design, weather and some technical issues with the GPS receiver. To preserve the integrity of the data, each hole was digitized uniformly according to the following process: obtain GPS "point" coordinates for the tee pad and designate which number hole with which that tee pad corresponded; without moving from that spot, begin a "line" feature and proceed down the hole's fairway to determine its distance in both feet and meters, digitizing a new vertex of that line every ten steps; upon arrival at the proposed basket location, digitize another "point" feature to mark its place, once again without moving. Each and every point placed on the Field Map was digitized with fewer than 3 feet of horizontal accuracy to best portray the spatial relation of all features. This method of gathering information minimizes gaps and inconsistencies, which further strengthens the integrity of the data.

The product of syncing the Field Maps app with ArcGIS online was the same web map I had previously created and published, but this time featuring all the geographic data I had collected. I went back to add hole-specific information - such as distance and the supplemental educational topic of my choice - and finally brought the web map into ArcGIS StoryMaps where I created an interactive website featuring the course design and educational program.

Results and Discussion

Below is a hole-by-hole breakdown of the Disc Golf Nature Trail, including the following attribute information: hole number, par and distance in both feet and meters; GPS coordinates for the proposed basket location; GPS coordinates for the proposed tee pad location;

title and body information for that hole's chosen educational topic; and a cover image, which is featured on that hole's digital ArcGIS StoryMap preview. The GPS receiver, in addition to collecting user-specific data, collected passive information by default called metadata which are integrated into the final design of this project. Such relevant metadata include latitude and longitude, elevation, and horizontal accuracy (how far away on the ground the GPS point is digitized in relation to where you are actually standing).

Presentation of the results of this project will be followed by a discussion of the implications of its installation, including an overview of the financial cost, required labor hours, and initial user compatibility with the digital StoryMap interface, which is found [here](#).

Full URL for ArcGIS StoryMap:

<https://storymaps.arcgis.com/stories/394d251eb5a8409db824075da3b34d56>

Full URL for Web Map containing the data used to create the Story Map:

<https://arcg.is/1uuPOe>



Figure 2. QR Code to be featured at each tee, linked to ArcGIS StoryMap of the course.

Hole 1: Par 3, 236 ft (72m)

Basket Coordinates: (-80.149954, 41.656738)

Tee Pad Coordinates: (-80.149677, 41.656112)

Educational Topic: The Story of Penn's Woods



Figure 3. Fire tower view at Cook Forest State Park, Pennsylvania (2021). Photo by Liam McCann.

The land which now belongs to the commonwealth of Pennsylvania was initially granted in 1861 by King Charles II to a man named William Penn. Its namesake combines William Penn's name with a derivative form of *silva*, the Latin term for "woods;" Pennsylvania, simply put, is Penn's Woods! The story of all of Pennsylvania's forests is mostly the same. They have always been home to indigenous tribes like the Erie, Shawnee, Monongahela, and countless more. These communities benefited from the many services of forest ecosystems long before any European settlers arrived on the scene, using trees for every aspect of life from housing to medicine to spirituality.

European families more fully settled the region in the late 19th century, most of whom sought land for farming. Large tree stands were resultantly clear-cut to make way for agricultural pastures. This practice, along with those of the leather and lumber industries, required excessive forest harvesting, affecting their species composition, richness, and land cover area.

The beginning of the 20th century sparked further westward expansion by the populations of the east, resulting in widespread agricultural abandonment of many regions. Those pastures and logging operations, left unattended for some time, were slowly succeeded once more by forests. The result of succession in this manner is less diverse, more even-aged groups of trees. Much of the woods at Robertson, for instance, is of various maple and oak species, most notably red and sugar maple, white and red oak. This pattern is representative of much of Pennsylvania's forests today, which comprise 60% of the commonwealth's land cover - a figure equal to over 16 million acres!

Hole 2: Par 4, 304 ft (93m)

Basket Coordinates: (-80.150310, 41.657504)

Tee Pad Coordinates: (-80.149696, 41.656920)

Educational Topic: Forest Ecosystem Services



Figure 4. Forest Ecosystem Services (2022). Photo courtesy of the U.S. Energy Department.

“Ecosystem Services” fittingly refers to the benefits the world’s different ecosystems provide us simply by virtue of their existence. According to the United Nations, all ecosystem services fit into four main categories: provisioning, such as building material or food; regulating, such as climate or erosion control; culture, such as recreation and spirituality; and support, providing a theater for life to unfold and thrive.

Forest ecosystems in particular have countless rewards to consider. For instance, Pennsylvania is the largest contributor of hardwood tree species to the national timber industry, with species like maple and black cherry coveted for their use in the crafting of furniture. The commonwealth is even known as the Black Cherry Capital of the World for its relative abundance of the sun-loving species whose population was able to grow thanks to widespread clear-cutting and resultant removal of forest canopy for agricultural pasture (sound familiar?). Overall, the Pennsylvania timber industry is massive, employing over 30,000 people and claiming over 36 billion dollars in annual economic impact.

The versatility of forest ecosystems is also present in the recreational realm. Such activities for which the forest is a perfect medium are hiking, camping, hunting, bird watching, and of course, disc golf! The destressing practice of forest bathing is also growing in popularity

as more individuals come to love the peaceful, reflective nature of walking or sitting in the woods.

Though we realize many tangible benefits from forests, there is a lot going on behind the scenes we fail to appreciate in our daily lives. For instance, forests play a crucial role in regulating the climate and the carbon cycle, capturing and sequestering harmful emissions from our atmosphere. They also safeguard our landscapes from erosion, landslides, flooding and other changes by stabilizing runoff water from streams.

Hole 3: Par 3, 177ft (54m)

Basket Coordinates: (-80.150596, 41.657838)

Tee Pad Coordinates: (-80.150390, 41.657381)

Educational Topic: Eastern Hemlock



Figure 5. Eastern Hemlock stand, Pennsylvania (2023). Photo by Liam McCann.

The state tree of Pennsylvania is the Eastern Hemlock (*Tsuga canadensis*). These majestic trees are among the tallest and oldest in the eastern U.S., growing up to 140 feet tall and reaching full maturity around 250 years - although some of the oldest hemlock found exceed 800 years of age! Hemlock prefer cooler, more moist environments, making them a common feature along streams and other bodies of water. They were harvested heavily in the 1900s for the tannins in their bark which were used to preserve leather products like shoes, belts, saddles, and the like.

This tree's true strength lies not in its economic but rather its ecological value. As so-called foundational species in their home ecosystems, hemlock play a major role in shaping local life. In the winter, for example, dense groups of hemlock easily trap escaping ground heat, providing a suitable habitat for animals like deer. Similarly, they provide valuable shade cover in warmer months; this is particularly important for maintaining temperatures in wooded streams, where overheating can be detrimental to aquatic life.

Hemlock, like other beloved species native to Pennsylvania, are dealing with a pest. The hemlock wooly adelgid is native to Japan, making it invasive to this region. It weakens and kills hemlock trees by sucking the sap from the tips of their needles, and spreads by riding on birds and other mammals coming from infested areas. Given that hemlock is a foundational ecosystem species, its preservation is of paramount importance. However, little is currently known about stopping the adelgid, aside from costly pesticide treatments that need to be applied every 5 to 7 years. One possible means of treatment researchers are exploring is to introduce a "predator pest" which would target the invasive species and leave other organisms alone. The preservation of hemlock bears substantial economic, environmental and cultural significance for our forest ecosystems and the people who enjoy them.

Hole 4: Par 3, 240 ft (73m)

Basket Coordinates: (-80.150276, 41.658598)

Tee Pad Coordinates: (-80.150521, 41.658003)

Educational Topic: Whitetail Deer



Figure 6. Whitetail deer (2022). Photo courtesy of Pennsylvania State University.

An unregulated hunting market and widespread logging practices in Pennsylvania in the early 1900s decimated the population of whitetail deer; the combination of clear cutting for agricultural purposes and open season for hunters both eliminated the deer's preferred habitat and severely limited their ability to regenerate numbers. But persistence is the name of the game for these resourceful fauna. Across the region agricultural land was reclaimed by forest, whose plentiful young saplings and lack of predators gave the deer a Garden of Eden in which to repopulate; today, Pennsylvania's deer population density exceeds 30 per square mile.

As its main predator, humans historically have hunted deer, either by necessity or for sport, thus controlling their numbers; yet in Pennsylvania, a decline in the sale of hunting licenses has contributed to their overabundance. It is additionally expensive and ineffective to attempt to sterilize herds, and the gradual encroachment on nature by human development offers fewer and fewer viable places to which the deer can be relocated. Pennsylvania also ranks first in the nation for deer-related automobile crashes. Most at odds with ecosystem development, however, is the preferential browsing (eating) habits of deer which often result in a loss of plant biodiversity. Evidence of this is quite literally all around you. As you walk through these woods, check the tips of any sapling branches you see; the odds are pretty high that their buds have been chewed off!

Hole 5: Par 4, 220ft (67m)

Basket Coordinates: (-80.149647, 41.659226)

Tee Pad Coordinates: (-80.150152, 41.658904)

Educational Topic: Sugar Maple



Figure 7. Distilled maple syrup barrel at Firth Maple Products, Pennsylvania (2022). Photo by Liam McCann.

One of Pennsylvania's tastier forest ecosystem services comes from the presence of the sugar maple tree and its production of sap which makes everyone's favorite breakfast topping: maple syrup! Indigenous communities to the region enjoyed this and other maple products long before the advent of any European settlers. Pennsylvania joins other northern states such as New York and Vermont in tapping trees from late winter to early spring. During this time, it's common to see buckets and tubes hanging from groups of sugar maple trees (also called sugarbushes) collecting sap for the production of maple syrup, sugar and candy. Tapping does no long-term harm to healthy trees, either; the holes, if responsibly placed, will grow over within a couple of years.

Maple sap is roughly 98 percent water and 2 percent sugar. To become maple syrup, the ratio of water to sugar must be roughly 33 percent water and 67 percent sugar; this is done by placing the sap in an evaporator where the excess water is filtered and boiled off. It takes roughly 40 gallons of sap, or four tapped maple trees, to produce one gallon of syrup.

The sugar maple's native habitat range extends down from Canada, encompassing the northeastern United States and certain parts of the Great Lakes. These regions are quite unique in that they're the only places in the world where sugar maple are found, and by extension the only places where pure maple syrup is produced. In addition to syrup, maple is a highly valued timber species for its use in flooring, furniture and cabinetry. These services, however, are under increasing threat. As our climate warms, life for the sugar maple grows progressively imperiled, and the species could disappear entirely sometime in the next century. Higher acid content in our rain and the prominence of invasive pests only serve to worsen the issue. Proper forest management is essential if we are to safeguard this valuable tree and its many beautiful, delicious byproducts.

Hole 6: Par 4, 273ft (74m)

Basket Coordinates: (-80.148470, 41.659084)

Tee Pad Coordinates: (-80.149094, 41.659394)

Educational Topic: French Creek Watershed



Figure 8. French Creek and Allegheny River confluence in Franklin, Pennsylvania (2022). Photo by Liam McCann.

Upon entering the woods, you may have noticed that you crossed over a ravine containing a small stream. This stream, among many others like it, is a tributary of the nearby French Creek. Originating in Chautauqua County, New York, French Creek flows 117 miles and covers over 1,250 square miles of land on its way to join the Allegheny River in Franklin, Pennsylvania. In 2022, French Creek was selected as Pennsylvania's River of the Year for its extensive recreational offerings and rich biodiversity, the latter of which distinguishes it as one of the most important rivers of its size in this region of the United States.

French Creek bears deep historical significance to northwestern Pennsylvania. Before the arrival of settlers, the indigenous Seneca and Delaware tribes used its waters for everything from agriculture to fire management. The creation of meadows through controlled burns also gave way for wild grasses and flowers to grow, thus attracting greater animal biodiversity. The region was subsequently overwhelmed by Europeans, who forced indigenous populations out to make room for the eventual establishment of prominent cities like Erie and Franklin. Today, roughly 40 percent of the French Creek watershed is farmed and roughly 50 percent is forested; protection from development is a large reason why its waters are additionally so well-kept.

Among the most fascinating yet least abundant creatures who call French Creek home is the Eastern Hellbender. These giant salamanders are the largest in Pennsylvania, growing up to 29 inches in length and weighing as much as 5 pounds! Hellbenders are a hard find for stream ecologists and avid amphibian enthusiasts due to their nocturnality, reclusiveness, and waning population caused by human interference with their home ecosystem.

French Creek is also a haven for freshwater mussels, fish, waterfowl, and numerous rare plant species amidst the remarkable hardwood forests through which sections of the river flow.

Hole 7: Par 5, 309ft (94m)

Basket Coordinates: (-80.149642, 41.658550)

Tee Pad Coordinates: (-80.148740, 41.659010)

Educational Topic: Regional Geology

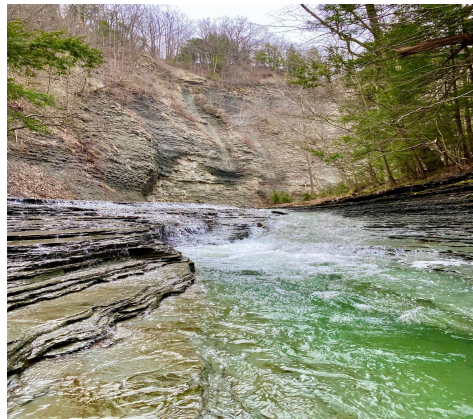


Figure 9. Stratification in Wintergreen Gorge, Pennsylvania (2022). Photo by Liam McCann.

During the Paleozoic era (400-300 million years ago) this region was an inland sea whose bedrock primarily consisted of sandstone and shale. But Pennsylvania's landscape did not fully take form until the Pleistocene epoch, a comparatively recent period of geologic history which lasted until about 12,000 years ago. Several separate glacial advances resulted in the deposition of sand, clay, silt and gravel across the region, giving the land its distinctive marshes, rolling hills and fascinating rock formations. The deposition of porous calcium carbonate (limestone) turns the ground beneath us into an aquifer and buffers local waterways from acid rain, thereby preserving water quality.

Perhaps the most remarkable consequence of glacial activity is the reversal of drainage flow in the rivers and streams of northwestern Pennsylvania. Initially, the common outlet for watersheds - like that of French Creek - was Lake Erie and eventually the Saint Lawrence River. Glacial sediments then built up gradually enough to obstruct northward flow and cause these watersheds to reverse course and drain south - in the complete opposite direction - toward the Ohio River!

The deposition and compaction of sediments and organisms over time created large underground reserves of fossil fuels which humans now harvest at alarming rates, resultantly emitting harmful greenhouse gasses into our atmosphere and warming our planet's climate - a fact we can no longer dispute. Nearby Titusville, Pennsylvania actually achieved the feat of successfully drilling the first-ever operational oil well in 1859, giving rise to an industry which is presently responsible for the vast majority of global emissions. Today our society depends far too heavily on these fossil fuels, and the consequences of our consumption will soon reach a tipping point if we continue on this path.

Hole 8: Par 3, 190ft (58m)

Basket Coordinates: (-80.150261, 41.657612)

Tee Pad Coordinates: (-80.149816, 41.657996)

Educational Topic: Fungi Fun Facts



Figure 10. Yellow-legged Bonnet mushroom at Bousson Forest, Pennsylvania (2022). Photo by Dan Gonzalez.

Despite having about 7,400 described species in Pennsylvania alone and an estimated 5.1 million species worldwide, fungi are heavily understudied - and heavily misunderstood. We commonly associate mushrooms, the fruiting reproductive bodies of fungi, with more pleasant things like soup or pizza; but the word fungi itself is generally associated with feelings of repulsion and disdain. Their abundance in nature should be no surprise, nonetheless; 85 percent of vascular plants (those who use “tubes” to distribute food and water) have an established symbiotic relationship with fungi.

One such relationship is through their underground root systems, known as mycelia, and they play just as critical a role in ecosystems as their aboveground counterparts. In forest

ecosystems in particular, mycelium networks serve as telephone lines by which the trees actually communicate, share nutrients, and even warn of distress such as animals feeding on leaves. They can become massive, too; the largest known mycelium network spans over 3.5 square miles and is estimated to weigh close to 35,000 tons!

Another impactful mark left on ecosystems by fungi is their role as a facilitator of nutrient cycles. Fungi feed on and decompose organic matter, such as fallen leaves or trees, recycling their valuable nutrients back into the ecosystem for others to use. It can therefore be said that fungi are the bridge between life and death in their home ecosystems; as one organism dies, fungi return it to the earth and new life can emerge.

Humans across the globe, particularly in certain Eastern cultures, have long used the medicinal properties of fungi for treating and preventing disease due to their immune-boosting properties. Most incredibly, fungi are now being studied as means of pest control; there are two known fungal pathogens native to the United States that target and kill the invasive spotted lanternfly, a pest known in Pennsylvania for feeding on fruit trees.

Hole 9: Par 4, 250ft (76m)

Basket Coordinates: (-80.149576, 41.656684)

Tee Pad Coordinates: (-80.149876, 41.657263)

Educational Topic: Sustainable Forestry?



Figure 11. Trail sign at French Creek Valley Conservancy property (2023). Photo by Liam McCann

Pennsylvania's forests are celebrated for their heritage, beauty, recreational potential, cultural significance, and rich biodiversity; but it is currently estimated that close to 80 percent of

forests statewide are not managed sustainably. Local logging practices are dominated by clear-cutting and highgrading (removing the best quality trees and leaving the worst behind, thereby hindering the overall health and quality of the forest) in lieu of more gentle approaches such as horse logging.

There is evidence of irresponsible historical management in the species composition of present-day forests, too; more than 100 tree species can be found in Pennsylvania, yet only 16 of those species account for 93 percent of total trees. The earth's warming climate has given rise to more extreme baseline temperatures throughout the year, altering plant and animal reproductive cycles and giving rise to more frequent harmful natural disasters such as wildfires, strong winds, and ice storms. Certain invasive pests - such as the Emerald Ash Borer, Hemlock Woolly Adelgid, and Spongy Moth - take advantage of the warmer climate and susceptible state of these weakened woods, feasting on the leaves and bark of their victim trees and further damaging the forest ecosystem.

Despite these grim threats, our forests continue to flourish and prosper thanks to both natural resilience and human conservation efforts. Troy Firth, founder of the Foundation for Sustainable Forests, once said, "the most important quality a forester can have is humility." Humility takes many forms, but it begins with gratitude toward forests and the countless services they provide. If we are to continue enjoying forests for years to come, it is undeniably our responsibility to ensure their protection and prosperity.

Discussion

Input	Quantity	\$/Unit	Total	Link
Latitude 64 ProBasket Competition Permanent Basket	x9	\$399.99	\$3,599.91	link
Dynamic Discs Basket Ground Sleeve	x9	\$19.99	\$179.91	link
Dynamic Discs Weather Resistant Basket Lock	x9	\$9.99	\$89.91	link
DISCatcher Pro Locking Collar	x9	\$14.99	\$134.91	link

Prodigy Discs Low Impact Tee Sign	x9	\$24.99	\$224.91	link
Rust-Oleum Painters Touch General Purpose Spray Paint	x2	\$6.48	\$12.96	link
Quikrete 20lb Anchoring Cement	x5	\$22.96	\$114.80	link
Total			\$4,357.31	
Labor Input	Hours Needed	x9 = Total		
Assembly/Installation of Basket	2	18		
Removal of Underbrush, Leaf Litter, Saplings (d<3in), Shrubs	1	9		
Tee Post Placement, Attachment of Signage	0.5	4.5		
Marking Trail	0.5	4.5		
Total	4	36		

Figure 12. Financial and labor cost breakdown of Disc Golf Nature Trail.

One of the many benefits of disc golf is its relatively low installation and maintenance requirements; long-lasting, professional caliber courses can often be put in the ground for less than a thousand dollars per hole. The same would be true of the Disc Golf Nature Trail, which can be installed considerably beneath such a threshold with a total monetary budget of roughly five thousand dollars.

In addition to the material costs for each hole, there is the aspect of labor to consider. While some physical work is required, it is relatively light; the most complex task of installing disc golf courses is building and setting baskets in the ground, a process which should not take longer than a couple of hours per hole. Similarly, tee posts need roughly an hour per hole for placement, setting and attachment of relevant signage. The final aspect of labor involves clearing away underbrush in order to designate clear fairways and a cohesive path through the course for players to follow. Overall, a conservative labor estimate indicates the Disc Golf Nature Trail can be installed in as few as 36 total labor hours, or roughly 4 hours of labor per hole.

After the installation of the Disc Golf Nature Trail, it will require infrequent - but nonetheless important - maintenance. Once per semester, the course must be walked by a designated maintenance group to ensure fairways are still clearly defined, baskets and tees are intact, and signage is accurate and legible. The total workflow of replacing signs entails procuring a new QR code, linking it to the StoryMap for the Disc Golf Nature Trail, and printing and laminating nine copies to be installed at each hole. Beneath each QR code should be a note detailing the last date on which it was replaced, to ensure maximum integrity and accessibility. [Adobe Express QR Code Generator](#) is a reliable, no-cost means of completing this. In total, semi-annual maintenance of the course should require no more than one day of labor. The designated maintenance group for the Disc Golf Nature Trail was ascertained in the later stages of the design process while gauging student interest in having a course at Robertson Complex. Clubs like the outing club and ultimate frisbee club expressed great interest, the latter of which agreeing to discuss maintenance with me. Frisbee club leadership agreed that one day per semester, they will host a voluntary “cleanup” day where members of their club and otherwise may carry out all necessary maintenance on the tees, fairways and baskets. This prevents Allegheny College’s Physical Plant from having to add to their routine maintenance of Robertson Complex beyond the course’s installation.

Voluntary commitment to service is but one of many hallmarks of the disc sports community, where intrinsic motivation to maximize beauty and playability is high. A known prominent factor behind this motivation is the emotional significance we assign to our environment. If a person finds ways to appreciate something, so will they explore ways to protect that thing’s longevity. This is ultimately the purpose of the Disc Golf Nature Trail: to do an activity you love, in a place you love, while discovering new reasons to love that place that will ultimately make your love for both grow stronger.

References

- Bajocco, S., De Angelis, A., Perini, L., Ferrara, A., & Salvati, L. (2012). The impact of land use/land cover changes on land degradation dynamics: A Mediterranean case study. *Environmental Management*, 49(5), 980–989. <https://doi.org/10.1007/s00267-012-9831-8>
- Borsch, T., & Löhne, C. (2014). Botanic Gardens for the Future: Integrating Research, Conservation, Environmental Education and Public Recreation. *Ethiopian Journal of Biological Sciences*, 13.
- Breitenstein, D. (1990). Health Benefits of Outdoor Recreation: Implications for Health Education. *Health Education*, 20(1), 16–21.
<https://doi.org/https://doi.org/10.1080/00970050.1990.10616165>
- Calzadilla, A., Rehdanz, K., Betts, R., Falloon, P., Wiltshire, A., & Tol, R. (2013). Climate Change Impacts on Global Agriculture. *Climatic Change*, 357–374.
- Chavez, D. J. (2005). Natural Areas and Urban Populations: Communication and Environmental Education Challenges and Actions in Outdoor Recreation. *Journal of Forestry*, 103(8).
- Colucci, A. R. (2022). Emergent specters and disruptive play in the production of Disc Golf. *Sociological Focus*, 55(3), 236–253. <https://doi.org/10.1080/00380237.2022.2080779>
- Discatcher Pro Locking Collar*. Disc Golf United. (2023). Retrieved February 23, 2023, from <https://discgolfunited.com/discatcher-pro-locking-collar.html>
- Dynamic discs basket ground sleeve*. Dynamic Discs. (2023). Retrieved February 23, 2023, from <https://www.dynamicdiscs.com/products/dynamic-discs-basket-ground-sleeve>
- Dynamic Discs Weather Resistant Basket Lock*. Drop Zone Disc Golf (DZDiscs). (2023). Retrieved February 23, 2023, from https://www.dzdiscs.com/products/dynamic-discs-weather-resistant-basket-lock?variant=41358172684476&cy=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&srsltid=Ad5pg_EUC6L881wB39_GQ-7wIEVkkZe7AVK_M5VITCmwQb8wewctb6MGwZU
- Eigenschenk, B., Thomann, A., McClure, M., Davies, L., Gregory, M., Dettweiler, U., & Ingles, E. (2019). Benefits of Outdoor Sports for Society: A Systematic Literature Review and Reflections on Evidence. *International Journal of Environmental Research and Public Health*, 16(6), 937. <https://doi.org/https://doi.org/10.3390/ijerph16060937>

Farmer, J., Knapp, D., & Benton, G. M. (2007). An elementary school environmental education field trip: Long-term effects on ecological and environmental knowledge and attitude development. *The Journal of Environmental Education*, 38(3), 33–42.
<https://doi.org/10.3200/joe.38.3.33-42>

Gentry. (2020, September 29). *Disc Golf Course Design & Development*. Professional Disc Golf Association. Retrieved October 6, 2021, from
<https://www.pdga.com/course-development>.

Godbey, Geoffrey, Outdoor Recreation, Health, and Wellness: Understanding and Enhancing the Relationship (May 6, 2009). RFF Discussion Paper No. 09-21,
<http://dx.doi.org/10.2139/ssrn.1408694>

Hengeveld, D. (2022, April 19). *Disc Golf Course Design elements*. Professional Disc Golf Association. Retrieved October 20, 2022, from
<https://www.pdga.com/course-development/design-elements>

Hotchkiss, Craig, "Disc Golf: Sport for Sustainable Community" (2002). Open Access Master's Theses. Paper 408. <https://digitalcommons.uri.edu/theses/408>

Kam, R. L. (2017). *Urban Forestry Plan Of Birch Point Park Disc Golf Course* (thesis). Lakehead University Knowledge Commons, Thunder Bay.

Karanikola, Paraskevi; Tampakis, Stilianos; Tsantopoulos, Georgios; & Digbasani, Christina (2014). The Public Zoo as Recreation and Environmental Education Area: Visitor's Perceptions and Management Implications. *WSEAS Transactions on Environment and Development*, 10(1), 2-10.

Latitude 64 Probasket Competition Permanent Disc Golf Target. Disc Store. (2023). Retrieved February 23, 2023, from
<https://www.discstore.com/discgolf/basket/permanent-baskets/latitude-64-probasket-competition-permanent-disc-golf-target>

Lichter, J. M. (2005). *Blue Oak Assessment Disc Golf Course Design Review and Blue Oak Management Guidelines*. Friends of Bidwell Park. Retrieved 2021, from
<http://friendsofbidwellpark.org/wp-content/uploads/2013/12/discgolfarborist.pdf>.

Low impact tee sign - 6" x 6". Prodigy Disc Golf Course Design. (2023). Retrieved February 23, 2023, from
<https://www.prodigycoursedesign.com/course-signs-products/low-impact-tee-sign-6-x-6>

Mahoney, H. K. (2013). An Economic Study of the Richmond Hill Disc Golf Course. *University of North Carolina at Asheville Journal of Undergraduate Research*.

- Martins, V. (2017). *Disc Golf as a Public Health Option: Utilizing America's Natural Resources to Offer Low Cost Outdoor Exercise* (thesis). University of South Carolina, Columbia.
- Menickelli, J., Barney, D., Grube, D., & Cooper, C. (2016). Disc Golf and Walking Benefits: A Pedometer-Based Physical Activity Assessment. *International Journal of Physical Education, Fitness and Sports*, 5(1).
- Mutz, M., & Müller, J. (2016). Mental health benefits of outdoor adventures: Results from two pilot studies. *Journal of Adolescence*, 49(1), 105–114.
<https://doi.org/10.1016/j.adolescence.2016.03.009>
- Olafsson, A. S., & Skov-Petersen, H. (2014). The use of GIS-based support of recreational trail planning by local governments. *Applied Spatial Analysis and Policy*, 7, 149–168.
- Panis, J. (2021, September 13). *Course development*. Innova Disc Golf. Retrieved October 6, 2021, from <https://www.innovadiscs.com/course-development/2/>.
- Patents assigned to Disc Golf Association, Inc. - Justia Patents*. Justia. (2022). Retrieved October 21, 2022, from <https://patents.justia.com/assignee/disc-golf-association-inc>
- PDGA. (2020, August 24). *Brief history of disc golf and the PDGA*. Professional Disc Golf Association. Retrieved October 23, 2022, from <https://www.pdga.com/history>
- PDGA. (2022, February 6). *A guide to disc golf from the PDGA*. Professional Disc Golf Association. Retrieved October 21, 2022, from <https://www.pdga.com/introduction>
- Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Briere, N. M. (2001). Associations among Perceived Autonomy Support, Forms of Self-Regulation, and Persistence: A Prospective Study. *Motivation and Emotion*, 25(4), 279–306.
- Powell, M. L., & Newgent, R. A. (2006). *Disc Golf Play: Using Recreation to Improve Disruptive Classroom Behaviors* (thesis). University of Arkansas, Fayetteville.
- Quade, B. (2013). *Best Practices For The Integration Of Adventure Activities And Environmental Education* (thesis). University of Wisconsin College of Natural Resources, Madison.
- Quillin, D. Q. (2003). *A Spatial Information Science Approach To Optimizing Recreational Planning For The Activity Of Disc Golf* (dissertation). Oregon State University Library, Corvallis, OR.

- Ren, Y., Lü, Y., Comber, A., Fu, B., Harris, P., & Wu, L. (2019). Spatially explicit simulation of land use/land cover changes: Current coverage and future prospects. *Earth-Science Reviews*, 190, 398–415. <https://doi.org/10.1016/j.earscirev.2019.01.001>
- Rich cultural history*. French Creek Valley Conservancy. (2019, July 18). Retrieved March 19, 2023, from <https://www.frenchcreekconservancy.org/rich-cultural-history/>
- Rosenberry, C. (2009). *Fewer deer, fewer hunters*. Pennsylvania Game Commission. Retrieved March 20, 2023, from <https://www.pgc.pa.gov/Wildlife/WildlifeSpecies/White-tailedDeer/Pages/FewerDeerFewerHunters.aspx>
- Spencer, L. J. (2015, November 9). *The Frisbie Pie Company*. Atlas Obscura. Retrieved October 21, 2022, from <https://www.atlasobscura.com/places/the-frisbie-pie-company-bridgeport-connecticut>
- Stapp, W. B., Bennett, D., Bryan, W., Fulton, J., MacGregor, J., Nowak, P., Swan, J., & Wall, R. (1969). The Concept of Environmental Education. *The Journal of Environmental Education*, 1(1), 30–31.
- The first successful oil well is drilled in Titusville, Pennsylvania*. The First Successful Oil Well is Drilled in Titusville, Pennsylvania : History of Information. (n.d.). Retrieved March 20, 2023, from <https://www.historyofinformation.com/detail.php?entryid=3061>
- Tucker, P. (2006). Curing "Nature Deficit Disorder". *The Futurist*, 40(3), 13.
- Vernegaard, K., Johansen, B. T., & Haugen, T. (2017). Students' Motivation in a Disc Golf Lesson and a Soccer Lesson: An Experimental Study in the Physical Education Setting. *Journal for Research in Arts and Sports Education*, 1(3), 32–46.
- Williamson, A. (2021, January 26). *World's Best Disc Golf Courses: Idlewild: UDisc*. Release Point - The UDisc Blog. Retrieved October 22, 2022, from <https://udisc.com/blog/post/worlds-best-disc-golf-courses-idlewild>
- What's the approximate cost to build a course?* Professional Disc Golf Association. (2017, December 18). Retrieved November 19, 2021, from <https://www.pdga.com/faq/course-development/estimated-course-cost>.
- Woods, J., Cossman, J. S., & Wolf, J. K. (2020). Disparities in Disc Golf Course Distribution in the United States. *Managing Sport and Leisure*, 1–15. <https://doi.org/10.1080/23750472.2020.1856711>