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The Links to Cancer: How Golf Became Dangerous and What We Can do to Save the Game

Meredith Boos
University of Montana, Missoula, mb160011@umconnect.umt.edu

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Meredith Boos, Davidson Honors College and Wildlife Biology Thesis
Committee: Dr. Chad Bishop, Dr. Doug Emlen, Ben Hamman

Introduction

Choosing the University of Montana for my undergraduate education was a "no-brainer," as they say. Montana gave me the opportunity to pursue my two passions in life: wildlife biology and golf. When I was in the process of applying to the Davidson Honors College, I was given an article about another Davidson Honors College student-golfer, Teigan Avery (Speltz, 2020). Teigan's story was so inspirational that she quickly became my role model and my hero. She lived through the tragic death of her father and then cancer. I am so grateful for her guidance and friendship.

Then, in my first year, another teammate, Kylie Esh, was diagnosed with soft-tissue sarcoma (Gogola, 2021). I watched Kylie fight through her cancer and finish her golf career with the Lady Griz as one of the all-time bests. I am also grateful for her guidance and friendship.

Shortly after Kylie's diagnosis, another teammate was diagnosed with tumors. It was then that my training in wildlife biology and the research skills I was developing as a Davidson Honors Student kicked into high gear. I began to consider what effect golfing has on people and the environment. I couldn't help but ask the logical questions: 1) does repetitive exposure to golf courses increase the risk of cancer? And, 2) if exposure to golf courses does have a negative impact on human health, then what is it doing to the rest of nature? And, most importantly, 3) what can we do to improve golf courses? With that, my senior thesis was born.

Using the knowledge and skills I developed as a wildlife biology major at the University of Montana, I decided to perform a meta-analysis on health claims linked to exposure to golf courses. While I was tempted to narrow my research down to a specific set of chemicals that golf

course superintendents use to maintain that pristine, postcard appearance, the wildlife biologist in me could not get past the massive amounts of water used on golf courses, the problem of run-off, the issue of bio-accumulation of the chemicals, the narrowing of the ecological spectrum near courses, and many other negative impacts golf courses have on the environment.

What I found was disturbing, to say the least. It turns out that golf courses may not be the idyllic playgrounds they purport to be, but rather an ecological nightmare. Despite their verdant appearance, the ostensible beauty of golf courses is a "synthetic aesthetic." Underlying the vast swaths of green is a chemical soup that is unstable. In short, I discovered that golf is not an industry that prioritizes environmentally friendly practices.

Worse yet, I discovered that environmental law in the U.S. is an arcane bureaucratic system that has had almost no bearing on the development and operation of our 16,000 golf courses. According to the Attorney General of New York Report, golf courses use about 50,000 pounds of pesticides, herbicides, and fertilizers each year, and they cause significant run-off from the 5.9 billion gallons of water they use (collectively) each year in the U.S. This combination of chemicals and water use contaminates groundwater, rivers, lakes, and streams, and has a deleterious effect on the local flora and fauna. That which doesn't run off accumulates in the soil and remains dangerous for decades (The Attorney General of New York, 1995) (Hartmann, 2022).

The lucrative pairing of golf and real estate in recent decades mocked the impotence of environmental law in the hands of politicians and zoning boards and golf communities sprung up all over the globe (Lusk, 2020). In places like Florida, Texas, Colorado, Arizona, Nevada, and California, golf communities account for more than half of residential subdivisions. There are over 800 golf communities in Florida alone (Huitt, 2019). These average about 1500 homes each

and that's a lot of people breathing, drinking, and walking in chemicals. Yet, few have studied the effects of golf operations on those people who live in such communities. The golf industry, it seems, acted very irresponsibly.

This deeply saddened me and made me feel as if I had to choose between the sport that I love, and the values instilled in me by my professors. I'm happy to report, however, that my education paid practical dividends as I was able to identify several things that golf courses can do to lessen their negative impact. I never expected that pursuing my first passion in life (wildlife biology) through the University of Montana might become a career track that saves my second passion (golf). But thanks to my wonderful education at the University of Montana, I've learned that the principles of sustainability and ecosystem management have a place in the golf industry.

And the time has never been better to push for a "greening of the greens!" The golf industry has become the focus of attention ever since a Federal Court handed down a 280 million dollar verdict against Monsanto for its use of glyphosate in their name brand pesticide Roundup—which is used on almost every golf course. The Court made clear a connection between glyphosate and cancer, and it opened a 10-billion-dollar floodgate of litigation. That case was followed by *Lindebald v Monsanto,* and *Walsh v Monsanto,* two cases involving golf course superintendents who got cancer from using Roundup.

No sooner did these lawsuits commence than the Golf Course Superintendents Association of America (GCSAA), initiated its 50 by 2020 plan. That plan was to get all 50 states to adopt a Best Practices Management Plan that would govern water use, chemical use, and other environmental practices for each golf course in the state. These BPM plans are a great first step, however, they don't contain enough wildlife conservation strategies or remediation plans to help the environment recover from 50 years of chemical damage from the golf industry.

The good news is that the plans are adaptable. As better science is discovered, the plans can be amended. This process should be supported with a stronger system of oversight and regulation.

This paper will consider Montana's BPM plan as an example of where improvements can be made. Aside from the changes I would make to BPMs, I also advocate for stronger legislative support of state university extension services to create programs to modulate the best management practices of golf courses. This topic is worthy of more study and professional concentration. I aim to create a wholistic, ecological approach that integrates land use principles and wildlife conservation tactics. It is my hope that this thesis plays a part in making golf a game for everyone—birds, butterflies, and bees included.

Legal Landscape Surrounding the Game of Golf

The game of golf in the United States has grown from about 1,000 courses and 125,000 participants in 1900, to over 16,000 courses and nearly 30 million golfers by the end of the 20th century (Hueber, pg 3). The growth in golf's popularity was not a gradual and consistent trajectory, but rather, it followed a "boom and bust" pattern (Napton and Laingen, pg 24). In its infancy in the United States, golf was limited to the social elites. From 1878-1919, nearly all of golf's 962 courses were private, and their locations reflected the urban wealth and decision-making hierarchy (Napton and Laingen, pg 26-27).

Golf experienced its first real surge during the economic boom of the 1920s. Golf figures such as Bobby Jones and Walter Hagen popularized the sport and new courses were developed at a rate of 600 per year from 1923-1929 (Hueber, pg 9). By 1930, there were 5,600 golf courses in the United States, and over a million people playing the game regularly (Hueber, pg 9). This rapid expansion came to a screeching halt with the Great Depression and World War II—the first bust.

The post-war epoch (1950-1969) saw another big boom that forever changed the aura of golf. The socio-economic conditions after WWII put golf within reach of a newly emerging middle class. Individual wealth increased as did leisure time for the average American. Time and money became available to the masses—two factors that had previously kept golf among the social elites. Television facilitated the spread of golf's popularity as figures like Arnold Palmer, Sam Snead, Jack Nicklaus, Gary Player, and even President Dwight D. Eisenhower could be seen playing the game (Napton and Laingen, pg 29,31).

More importantly, the Government of the United States facilitated the spread of golf in the post-war years. From 1963 through 1975, the U.S. Department of Agriculture's Farmers Home Administration (FmHA) offered 10.5 million dollars in subsidized loans to assist rural communities in improving public recreation facilities and more than half of that went into golf courses and driving ranges (Napton and Laingen, pg 31-32). This is especially important because the composition and style of the courses changed radically. In the early years of golf, courses were tight and narrow because their location near cities mandated efficient use of the space. But, when golf "went rural," space was no longer an issue. "The golf courses that were built between 1950 and 1970 were typically longer than the golf courses constructed in the 1920s in order to accommodate the technological advancements in golf equipment used by golfers, such as improved golf balls and golf clubs with steel shafts." (Hueber, pg 11).

The changing nature of the game, the emergence of the middle class with expendable income and leisure time saw the decade of the 1960s build 380 new courses a year (Hueber, pg 11). By 1970, "the NGF [National Golf Foundation] reported that the number of golf courses had more than doubled from 4,900 in 1950 to 10,200….and there were now an estimated 12.5 million golfers." (Hueber, pg 11). Two more golf-related phenomena occurred in this epoch.

First, the majority of the new courses were public. Second, “the 1960s was a hallmark in golf course development because real estate developers discovered that golf courses could be an amenity that enhanced lot sales.” (Hueber, pg 11). This resulted in the size of golf courses doubling to an average of 150 acres each.

The big boom of the 1960s was followed by another bust in the 1970s. High interest rates, inflation, a gas crisis, the end of the Vietnam conflict, a contraction of the economy, and several other factors saw the golf industry take a big hit (Napton and Laingen, pg 35). “Golf course development slowed dramatically from averaging 380 new golf courses per year to 150 per year in the 1970s and then to 100 per year in the 1980s” (Hueber, pg 11).

No sooner than golf hit bottom in the 1980s, the 1990s brought the biggest boom ever to the sport of golf. The introduction of the internet and the personal computer hit home in the 1990s. The surge in the tech industry produced untold wealth for many. This, coupled with the new migration of baby-boomers and industry to the South and Southwest, and the “snow-bird” phenomena, led to an unprecedented growth in golf. The late 90s also brought us Tiger Woods, and suddenly, the perception of golf as being a “game played by overweight, middle-aged white guys in double-knit plaid pants,” changed forever (Hueber, pg 12). By the year 2000, “more than 14,000 high schools fielded golf teams.” (Napton and Laingen, pg 38)

With the aid of computers, the golf industry was able to track market trends, social and economic projections, and keep its fingers on the pulse of society’s changing demographics. The NGF convened “Golf Summits” and presented new research that promised a very optimistic outlook for the game of golf and developed a ‘Strategic Plan for the Growth of the Game’.” (Hueber, pg 12). That plan boasted an audacious goal to build one golf course every single day from 1990 to 2000…and they did it! (Hueber, pg 12)

Following the "Tiger Phenomena" and the NGF's "course a day" strategic plan, the entire golf industry followed suit with a massive commitment to growing golf. PGA tournament purses, advertising budgets, public relations campaigns, and television ratings soared (Hueber, pg 13). By the year 2000, the golf industry had over 16,000 courses and nearly 30 million people playing golf (Hueber, pg 13). During the "course a day" campaign, "60% of the golf courses built in the 1990s were real estate related." (Hueber, pg 16). Given the new relationship between golf and real estate that emerged, "about 12% of all golf courses in the United States today are in master-planned communities." (Napton and Laingen, pg 35). Most of these golf communities have about 1500 houses, so that means there are about 3 million homes on, or adjacent to, a golf course in the United States (Napton and Laingen, pg 36).

The real impact of golf's trajectory of growth to its peak in 2000 has yet to be felt. As David Hueber points out, "the democratization of the game, in terms of the number and kind of golf courses built has occurred without regard for the environmental, economic, or social consequences." (Hueber, pg 3). The lengthening of the game because of changes in golf equipment and the abundance of land as well as golf's marriage to real estate has led "golf course designers to construct larger courses with a greater emphasis on beauty and landscaping." (Napton and Laingen, pg 38). Unfortunately, this was done with "little concern among the golf course real estate developers for environmental issues…. the golf courses were not environmentally sensitive." (Hueber, pg 3). As Hueber states, "the environmental footprint for these new courses nearly doubled in order to maximize golf course lot frontage for the accompanying real estate development." (Hueber, pg 16). Plain and simple, "too many courses were built in the 1990s and they were often built where they were not needed and cannot be sustained." (Hueber, pg 5).

The unchecked expansion of golf courses has now been called into question. As David Hueber says, “in today’s politically charged environmental movement, the golf industry is not viewed in a favorable light” (Hueber, pg 26). The realities of climate change have forced discussions of sustainability and stewardship of resources and golf’s top organizations have been called to account. The Golf Course Superintendent’s Association of America founded the Environmental Institute of Golf (EIG) in 2003, and immediately commissioned a study on the physical attributes of golf courses, water use and conservation, nutrient use, pesticide use, and energy use. The United States Golf Association (USGA) announced in 2010 that it would be taking a more definite role in fostering sustainable golf practices. As David Hueber sees it, “this will result in a change in what American golf courses look like and how they will play. Golf course operators will not be able to spend as much as they have in the past to maintain to the perfectly manicured and pristine look” (Hueber, pg 24).

But nothing will bring change faster than the shifting legal landscape regarding the use of pesticides, herbicides, and fertilizers on golf courses. On August 10, 2018, a unanimous jury in San Francisco, California, held that the Monsanto Corporation was responsible for causing Dewayne Johnson’s non-Hodgkin’s lymphoma. They held that Monsanto knew that glyphosate, a key ingredient of their popular weed-killing product Roundup, was cancer-causing. In an unprecedented decision, the jury awarded Mr. Johnson 39.2 million dollars in damages and hit Monsanto with additional punitive damages of 250 million dollars.

The background of the case gives us important details that will undoubtedly affect golf course management in the future. Dewayne Lee Johnson was a grounds manager who used Roundup, Monsanto’s glyphosate-based herbicide, every day of his career. He was a certified applicant of the chemical products he used and followed all the proper protocols. After two

major incidents, both spills resulting in lesions on 80% of his body from direct contact with the solution, Johnson was diagnosed with non-Hodgkin's lymphoma. He then filed suit against Monsanto.

Much of Johnson's case relied on the testimony from independent doctors, scientists, and researchers from the International Agency for Research on Cancer (IARC) whose research suspected cancer risks on a voluntary basis (*Johnson v Monsanto,* 2018). This case surfaced information regarding the dangers of pesticide use and chemical exposure and it called into question corporate product analysis, chemical license processing, and the EPA's risk assessment protocol.

Researchers of IARC who testified on the cancer risk of glyphosate-based products agreed that Roundup is carcinogenic. Dr. Alfred Neugut, an oncologist and cancer epidemiologist who testified for Johnson, found that there was a risk ratio of 1.3, "meaning that there was a 30-percent increased risk of non-Hodgkin's lymphoma in the context of glyphosate exposure" (*Johnson v Monsanto,* 2018). Neugut testified that such a percentage was a "statistically significant increased risk" *(Johnson v Monsanto,* 2018). He opined that exposure to glyphosate causes non-Hodgkin's lymphoma "to a reasonable degree of scientific certainty" (*Johnson v Monsanto,* 2018).

As early as 1991, evidence has been compiling that glyphosate, the active ingredient in Roundup, is cancer-causing. Monsanto was charged with misleading consumers and false marketing in 1996 after continuing their claims that "glyphosate is safe, nontoxic, harmless, and free from risk" despite evidence in their studies of reprotoxic effects (ITAA, 2020). Studies have since shown that long-term users of Monsanto's product show a 41% increased risk of non-Hodgkin's lymphoma (NHL) (ITAA, 2020).

Johnson v Monsanto (2018) was a landmark legal decision that brought to light the undeniable linkage between pesticide and herbicide use and cancer. It set a legal precedent and opened the floodgate of litigation for an estimated 200,000 people that are expected to join a major class action lawsuit against Monsanto (Bayer), the producer of glyphosate-based weed killers and other pesticides (Turfnet News). Monsanto has initially agreed to set aside at least 10 billion dollars for 95,000 cases in this class action lawsuit (Cohen, 2020).[1]

The Johnson lawsuit was not the first case to make the connection between human health and dangerous chemicals in pesticides, herbicides, and fertilizers—many of which are used on golf courses. Indeed, those dangers were well documented beginning with the New York Attorney General's 1995 report, ***Toxic Fairways: Risking Groundwater Contamination from Pesticides on Long Island Golf Courses*** (Attorney General of New York, 1995). That report stated the potential connection between pesticide use and cancer when it stated unequivocally that, "several pesticides on the market have been identified as probable human carcinogens and some have been linked to birth defects, nervous system disorders and reproductive problems. In addition, as this report will discuss, pesticide use has the potential to threaten wildlife and contaminate natural resources" (Attorney General of New York, 1995).

More importantly, that report highlighted the problem with environmental law in the United States regarding the use of chemical pesticides, herbicides, and fertilizers. It pointed out that the Environmental Protection Agency was charged with reviewing pesticides, herbicides, and fertilizers. These chemicals do not fall under the Toxic Substances Control Act of 1976, which would give the Federal Government, through the EPA, direct enforcement powers, but

[1] Patricia Cohen, Roundup Maker to Pay $10 Billion to Settle Cancer Suits, (New York Times, June 24, 2020), at: https://www.nytimes.com/2020/06/24/business/roundup-settlement-lawsuits.html; last viewed 1/20/2023. There are another 30,000 cases outstanding that did not join the initial class action suit.

rather, they fall under a separate federal designation: (FIFRA) the Federal Insecticide, Fungicide, and Rodenticide Act. FIFRA is the Federal statute that governs the registration, distribution, sale, and use of pesticides in the United States. With certain exceptions, a pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant, or desiccant, or any nitrogen stabilizer (EPA).

The focus of the EPA under FIFRA is on registration, distribution, sale, storage, labels, and records. Enforcement on usage is the exclusive domain of the States under FIFRA. Since the rules governing pesticides are generated by the EPA, and those are almost all having to do with registration, distribution, sale, storage, and reporting, then the actual application of the chemicals is an arbitrary designation on a state-by-state basis. The states defer to federal standards on chemicals, but most of those have not been tested, so the states end up accepting what the manufacturers tell them is safe. Furthermore, FIFRA contains no citizen enforcement provisions.

The clear motive behind placing these toxic substances under a separate designation (FIFRA) was because of their use in agriculture. As the FIFRA website states, “FIFRA’s initial intent was to protect farmers” (EPA). Congress and the EPA clearly did not want to stand in the way of American agriculture, so they included a “cost-benefit” calculation for producers to use to their benefit. Before the EPA may register a pesticide under FIFRA, the applicant must show, after “taking into account the economic, social, and environmental costs and benefits of the use of any pesticide,” that using the pesticide according to specifications “will not generally cause unreasonable adverse effects on the environment” (EPA).

The main problem with this scheme is that the pesticide producers control the flow of scientific information. The EPA has historically lacked the ability to keep up with the science on these chemicals. They are extremely slow to review them and often defer to the producers to

"self-report" any problems. As the Attorney General of New York report pointed out, "when the EPA permits a pesticide to be sold in the United States, the Agency does not decide that the product poses no environmental or health threats… [FIFRA] requires the EPA only to decide that the pesticide poses 'no unreasonable risk'" (Attorney General of New York, 1995). At the time the New York Attorney General commissioned the report on golf courses, "only one of the 34 most commonly used pesticides for turf and lawn care had completed this review" (Attorney General of New York, 1995).

Some might question the integrity, honesty, and practicality of a system that allows producers to introduce new synthetic chemicals into consumer products with virtually no oversight for human safety. To give some scope of the magnitude of the problem, the Environmental Working Group points out that "under the broken and outdated federal Toxic Substances Control Act only about 7 percent of the approximately 3,000 high volume chemicals (used in excess of a million pounds a year) have been tested for safety" (EWG). Even worse, says Mark Scialla, "more than 60,000 commercial chemicals were allowed on the market without safety testing. And regulators had to prove a substance posed an 'unreasonable risk' before they could take action – a burden of proof so difficult that the Environmental Protection Agency couldn't ban asbestos, a known carcinogen that still kills 15,000 people each year" (Scialla, 2016). There are roughly 2000 new chemicals introduced each year, and at their current rate the EPA can review 20 chemicals at a time with a 7-year time limit. Then producers of those chemicals get 5 years to comply with any EPA requirements (Scialla, 2016). During that time span, the producer can lobby for political protection, or undercut the government scientists by publishing confounding science in academic journals, or simply tweak the chemical slightly and the process starts all over. Human safety seems a very remote concern.

But make no mistake about it, that is the American system. “Rather than the *precautionary approach* implemented by countries like Germany and Denmark, where products are required to be proven safe before approval, the United States uses an evidence-based approach. With this reasoning, products can remain on the market, even if exposure is likely to pose a threat to human health. Until a direct, causal link can be determined between a chemical and negative consequences for human health, citizens are continually and unknowingly exposed to toxic chemicals” (Garris, 2016). And of course, the producers can continue to market their products as safe for human use even when they are in doubt. So, in spite of the long history of scientific evidence showing a connection between glyphosate and cancer (beginning at least in 1991), it remains on the market today.

As a matter of law, establishing the causal link between any chemical and cancer is next to impossible in American jurisprudence. First of all, if someone is injured by a consumer product, or in this case, they claim their cancer is caused by Roundup because it uses glyphosate, they must pursue their cause of action in tort. Tort simply means personal injury. The law of torts requires an exact procedure. The plaintiff (injured party) must establish that the defendant had a duty (to act, or not act in a manner that causes harm to another). Producers of consumer products have a general duty not to produce things that cause harm to those who use their products (Lumen Learning). There is a different standard for products that are inherently dangerous like chainsaws, cars, guns, knives, and it puts some responsibility back on the user for proper use (Paper, pg 89). But generally, you cannot produce something that the average person would never suspect would hurt them. When you use Johnson’s baby powder, you don’t expect that it will contain asbestos and cause cancer (Griffin et al., 2022).

If there is an established duty (not to harm), then the plaintiff must prove that the defendant breached their duty. A plaintiff must prove that the defendant's act or omission caused the plaintiff to be exposed to unreasonable risk of injury and/or harm (Lumen Learning). This is done by showing that the defendant was negligent in performing their basic duty of care. The legal definition of negligence turns on the "reasonable person" standard—would a reasonable person in the same situation have acted similarly? (Lumen Learning) Or in this case, if you knew glyphosate is likely to cause harm, you should not have put it in the Roundup (or sold the Roundup as such).

If negligence is established to Court's satisfaction in the suit, then the plaintiff must show by a preponderance of the evidence that the defendant "caused" the plaintiff's injury (Lumen Learning). This is where most cancer-related tort cases crash headlong into the wall of "confounding variables." Defendants are allowed, during the deposition phase of the lawsuit, to "counter" the claim by asking the plaintiff how many other cancer-causing chemicals they encounter in their daily lives (Federal Rules of Civil Procedure). It's not as simple and clear-cut as asking them if they smoke or drink. The Environmental Working Group has identified "more than 1,400 chemicals and chemical groups [that] are known or likely carcinogens. Through industrial applications, consumer products and food, water and air, Americans are exposed daily to these cancer-causing compounds, which invade the body and build up in blood and urine" (EWG). Products that seem innocuous have cancer-related chemicals and compounds in them. Processed meats like hot dogs, pepperoni, ham, bacon, and sausage; hygiene products like shampoo, deodorant, toothpaste; household products like carpet and linoleum; processed foods, fast food, and soda; all of these share a cancer connection (Breuck, 2018).

The tactic of using confounding variables is part of what is known as the four-dog defense (Cram). “Chemical companies and other manufacturers use this Four Dog Defense to misguide consumers and to hide the fact that their products are hazardous to both health and the environment” (Cram). The first dog happens when someone claims an injury, and the manufacturer denies they have any dangerous things in their product. Cumbersome and confusing federal labeling laws for ingredients often help manufacturers dodge responsibility for including dangerous chemicals in their products. But savvy plaintiff’s attorneys can find their way around that dodge.

The second dog is to deny that the chemical in question is dangerous. They produce their own science to show it’s safe. It is difficult for the plaintiff’s attorneys to produce convincing scientific evidence that the chemical is dangerous because the inventors of such chemicals control all the science about the chemical. Getting independent scientists with enough credibility to punch a hole in that defense is difficult to say the least.

The third dog is to admit that the chemical is dangerous, but that they use it responsibly in the product and they have not exceeded any federal thresholds (Cram). This is a specious argument at best, and dishonest at its core. One example is the federal threshold for lead in drinking water. It’s absurd. There is no safe level….it’s bad….no one should ever drink lead. The federal thresholds are usually developed in tandem with the chemical industry. The American Chemistry Council has controlled too much of the federal scientific research process for too long. As the Union for Concerned Scientists has stated, “The ACC has played a role in pushing for industry-friendly chemical policies that fail to protect public health” (Goldman et al., 2015).

The fourth dog in the classic defense against liability is for the defendant to argue that their dog did bite the plaintiff, but their injury is the plaintiff's own fault, and their injury is not that bad (Cram). In the case against Roundup, the claim is that the applicator's were not careful, and/or didn't follow directions. This fourth dog is used after a court accepts the argument for causation. What the defendant is ultimately moving toward is the next level of a tort suit which is "proximate cause."

Proximate cause occurs when the other tort steps have been proven, and now the defendant is asking the court to assign partial blame to the plaintiff, or possibly some other entity. The plaintiff will rely on foreseeability to counter any claim of the plaintiff's responsibility. In other words, the plaintiff will argue that the defendant, given their vast knowledge of chemistry and the product in question, either knew or should have known, that someone using the product would be harmed. This portion of the tort suit will connect very closely to the damages portion of the suit because it can impact how much money a jury thinks a plaintiff is owed as compensation. The defendant will always argue that the plaintiff shares some responsibility in their own injury (this is sometimes referred to as comparative negligence). But where a defendant controlled all the knowledge of the development and attributes of a product, the damages are likely to be high.

The bar is very high for plaintiffs in this kind of system. There is much they must overcome. The classic expression of the 4-dog defense is the tobacco litigation. It took 40 years for plaintiffs to crack the corporate veil of big tobacco (PBS). Had it not been for corporate memos from department to department at the tobacco companies stating that the chemicals in cigarettes were put there to make them addictive, plaintiffs might never have won. But herbicides, pesticides, and fertilizers have an additional hurdle to overcome.

The second problem that the federal scheme for regulating toxic substances presents in the case of pesticides is that FIFRA was clearly established to insulate the agricultural sector—even though farmers are clearly not the only ones using these chemicals. As the New York State Attorney General report stated in 1991, "Although the risks of using pesticides to grow food crops may be worthwhile to ensure a continuing food supply, most people would agree that the benefits of pesticides used merely to produce green lawns and turf are far less. Despite the relatively limited benefits of turf and lawn care pesticides, three to six times as many pesticides are used per acre on home lawns than to grow the food we eat…. [A]nd golf courses on Long Island use almost four to seven times the average amount of pesticides used in agriculture, on a pound per acre basis" (Attorney General of New York, 1995).

The prolific amount of these chemicals being used on golf courses is no secret. Yet, efforts to change the practice have met stout resistance. According to Aliya Uteuova in her article, "*Botox for Your Lawn: The Controversial Use of Pesticides on Golf Courses*," Senator Cory Booker proposed legislation banning certain chemicals called *Protect America's Children from Toxic Pesticides Act* and it ironically met immediate resistance from the Golf Course Superintendent Association of America. This is unfortunate since the scientific knowledge that golf course superintendents have a much higher incidence of specific cancers than the general population was documented in the New York Attorney General's report (Attorney General of New York, 1995).

More importantly, the research linking residential proximity to agricultural sites and carcinogenic, endocrine, and reproductive effects due to chemical exposure is abundant, but not much has been done by way of analyzing the chemical exposure of those living near golf courses, according to Whitney Garris (Garris, 2018). "The use of organochlorines and

organophosphates on golf courses poses a serious threat…. I argue that the use, density, and unfiltered exposure to golf course pesticides warrant further attention," avers Garris (Garris, 2018).

This is especially important since we have 16,000 golf courses and "about 12% of all golf courses in the United States today are in master-planned communities," which have an average of 1500 homes around them (Napton and Laingen, pg 35-36).[2] That means there are upwards of 3 million homes within a few hundred yards of a course—many of them located directly on the edge of the course. As Garris points out, "one of the most common routes of exposure to these toxic chemicals is a process known as pesticide drift. Drift can occur during or after application, whereby pesticide particles and/or vapors become airborne and leave the application site, landing on a non-target surface. These surfaces include exterior walls, outdoor furniture, doors, windows, and residential lawns that citizens continually come into contact with and track inside the home" (Garris, 2018). Coupled with the problem of drift, there is the basic problem of those who live on golf courses playing golf regularly. As Garris says, "after a golf course is sprayed with pesticides, golfers can accumulate residue on their clothing and skin, which can be absorbed by the body and/or transferred into the home" (Garris, 2018).

Studies are useful, but without a systematic enforcement method, it doesn't seem likely to change. Enter the Johnson lawsuit. That verdict effectively put the entire golf industry on notice. Likewise, a couple of companion cases propelled a green movement in golf, such as the case of Tom Walsh. Tom was a career golf course superintendent who contracted myeloid leukemia in

[2] Napton and Laingen, pp. 35-36. David Hueber presents slightly different statistics on courses built in golf communities. He cites the National Golf Foundation's findings that 25% of all courses built in the 1960s were in planned communities for an approximate total of 950. And he cites the NGF findings that 60% of all courses built in the 1990s were in planned communities. That is approximately 2400 courses for a national total of 3350. That would put the total number of homes on golf courses above 5 million. See David Hueber, pp. 13-14.

2008 from the chemical pesticides he used (Beyond Pesticides Daily News Blog, 2014). Pesticides were the only chemicals he worked with as a golf superintendent. He kept records of which pesticides he applied, the most common included chlorpyrifos and chlorothalonil. In 2008, he was diagnosed with acute myeloid leukemia and died a year later (Beyond Pesticides Daily News Blog, 2014). Tom's oncologist identified several chromosomal alterations in Tom's genes due to his heavy use of pesticides (Beyond Pesticides Daily News Blog, 2014). His family filed suit on Tom's behalf, and in 2020 the Pennsylvania Supreme Court agreed that his leukemia was caused by the chemicals he used on the course. Like the Johnson case, this was also a remarkable ruling. For courts to recognize a direct causal link and assign liability to the manufacturer is truly a watershed moment in American jurisprudence.

As cases like Johnson and Walsh gain notoriety, other golf course workers are taking note. For golf course workers like Gary Lindebald, his diagnosis of NHL in 1999 came as a surprise (Parker, 2020). Not until 2020, a year after the first plaintiff win against Monsanto, did Lindebald realize that his 30+ years working at golf courses and spraying Roundup every day caused his cancer (ITAA, 2020). Lindebald's case is pending, but with several major decisions stacking up against Roundup and a national class-action suit in the works, it's very likely his case will settle quickly. And it won't be long before someone decides to track the cancer rates among golf course community residents so that they can be added to the class action group.

It is no small coincidence that while these cases were developing, the Golf Course Superintendents Association of America announced its "50 by 2020" campaign (Unruh, 2017). That campaign was to get all 50 states to adopt a Best Management Practices plan for all golf courses. This comprehensive plan touched on many vital areas of concern, not the least of which was the use of chemicals on the golf courses. As per the plan, "an area of primary concern in golf

course management is the protection of surface waters from pollutants, including fertilizer, and nearly every state in the U.S. is affected by federal legislation such as the Clean Water Act, which was passed by Congress in 1973" (Unruh, pg 1). This sudden "area of concern" for golf courses was precipitated by major problems with nitrogen and phosphorus runoff in Florida that caused toxic algae blooms, and a water shortage in California which led Governor Jerry Brown to ration water (GCSAA). Florida and California are major agricultural states, but they are also ranked first and second respectively in the number of golf courses—a fact that was pronounced by golf's prolific use of chemicals. As the 50 by 2020 Initiative admitted, most of the emphasis on water pollution in the first few decades after the Clean Water Act was passed was on "point source" runoff like effluent pipes from factories. With the algae blooms, and other contamination in Florida, much more focus was put on "non-point source" runoff like farms and golf courses.

Previously the use of chemicals was under the exclusive enforcement mechanism of the states, and the amount of the chemicals being applied to golf courses fell through the cracks of the bureaucratic infrastructure. Licensed applicators were regulated by the state without much oversight at all. The GCSAA fought against tighter restrictions on chemical use at the state level, and against national legislation such as Senator Cory Booker's bill (Alvarado, 2022). But after the Johnson lawsuit, and others that established the legal link between pesticides and cancer, the GCSAA began urging every golf course to follow the state mandates on Best Management Practices. The GCSAA provided a basic template to cover all the essential areas of concern, but states were encouraged to go above and beyond (GCSAA).

Measuring Golf's Impact

The first notable impact that golf has had on the nation as a whole is the vast amount of prime real estate golf occupies. According to the Golf Course Superintendent Association of

America, there were 16,979 golf courses in the United States at an average of 150 acres each (GCSAA, Water Use and Conservation, pg 2).[3] On an aggregate basis, golf facilities cover an estimated 2,244,512 total acres. This number does not account for the total geographical footprint of golf communities. That, of course, would nearly double the total number of acres. More important than the total area they occupy are the locations they choose. To get the most idyllic settings, courses are often built in hard-to-reach locations where the fairways and greens would not naturally grow. This puts further stress on the environment by requiring more water, chemicals, and fossil fuels to maintain the courses. By way of example, golf courses in the Southwest region, are irrigating approximately 115 acres of turfgrass per golf facility, compared to 54 acres in the Northeast region per 18-hole golf facility (GCSAA, Water Use and Conservation, pg 3). To offset this extra dependency on water, 37% of the golf courses in the Southwest use recycled water (GCSAA, Water Use and Conservation, pg 3). This is certainly a noble effort, but there some concerns about the practice (GCSAA, Water Use and Conservation, pg 3).

The second notable impact of golf on the nation deals with its use of water. Of the 2,244,512 total acres of golf courses in the U.S., 67 percent (1,504,210 acres) is defined as managed turfgrass (greens, tees, fairways, rough, driving range/ practice areas, turfgrass nurseries, clubhouse grounds), 80% of which (1,198,381 acres) is irrigated (GCSAA, Water Use and Conservation, pg 3). Practically speaking, that means that "nearly 100 percent of greens, tees and fairways are irrigated" (GCSAA, Water Use and Conservation, pg 3). Water scarcity in the

[3] Golf Course Superintendents Association of America, *Golf Course Environmental Profile, Vol. II*: *Water Use and Conservation Practices on U.S. Golf Courses*, (2009), p. 2; at: https://www.gcsaa.org/docs/default-source/environment/golf-course-environmental-profile--water-use-and-conservation-summary.pdf?sfvrsn=f145cd3e_0; last viewed 1/25/2023. However, according to the GCSAA, the number of courses declined by 12% from 2006 to 2022. See, *Golf Course Environmental Profile Phase III, Volume ll, 2022: Nutrient Use and Management Practices on U.S. Golf Courses*; at: https://www.gcsaa.org/docs/default-source/environment/22_nutrient_report_web.pdf?sfvrsn=952fcd3e_0; last viewed 1/25/2023.

coming future is likely to close many courses. According to Barton in 2008, golf courses use an average of 300,000 gallons a day. In the same article, Barton explains that the United Nations environmental program at the time predicted that by 2025, 1.8 billion people in the world will be living under conditions of absolute water scarcity and 2/3 of the planet will be subject to water stress. These statistics haven't changed much in the past 15 years, yet the way that we operate courses remains much the same. There is no question that global climate change will affect our "normalcy" in the coming years. It will alter the landscape, making many areas arid and potentially uninhabitable. To retain the success of the industry, golf courses need to be adaptable and start reducing water usage preemptively.

In response to this, some golf courses are using treated wastewater or effluent water to irrigate. Unfortunately, toxins, chemicals, and even pesticides have the potential to pass through treatment and bioaccumulate on courses. Using treated water may be a great short-term solution, but it's long-term effects are unclear. It might not be as environmentally friendly a solution as it promises to be.

> As water becomes scarcer, as organic management practices increase, as environmentalism and environmental legislation start to bite more than they have, as the economy struggles, and as we come to appreciate the aesthetics of golf courses in all their many natural, beautiful hues, the way the game looks will change…and the way it plays will change too (Barton, 2008)

The Attorney General of New York's office conducted a study in 1995 examining the risk of groundwater contamination from pesticides on Long Island golf courses (Attorney General of New York, 1995). They surveyed ¬107 courses to determine the average amount of pesticides used, application patterns, and estimated the level of groundwater contamination. Golf courses across the United States are often located near crucial water sources that serve large populations.

Logically speaking, golf courses need to be in these areas because of the vast amount of water needed to operate the course. That hydrological cycle of irrigation contaminates the larger source for the community as chemicals are carried deeper underground through natural filtration processes (King and Balogh, 2010). Golf courses used 50,000 pounds of pesticides each year, applying four to seven times as much as the average agricultural food plot (pound/acre) (Attorney General of New York, 1995). Chemicals leach at different rates (King and Balogh, 2010). Areas with thin, porous surface soils have an increased potential for chemical migration through the soils and saturation into the groundwater (King and Balogh, 2010). Further studies, including geologic surveys and soil testing, could identify which areas are most at risk for contamination.

The continued use of pesticides to maintain the cosmetic appeal of golf courses is a global issue. A paper from 2008 studied the usage practices and exposure pathways of golf courses in Northern Ireland (Kearns and Prior, 2008). The 44 golf courses surveyed used a total of 5,500 pounds annually (Kearns and Prior, pg. 176), which is close to the 2,000 pounds used by *each* golf course in the US (Attorney General of New York, 1995). Other studies, like "Myelofibrosis in Golf Course Groundskeepers", highlight the increased risk of diseases in specific cohorts of workers in the golf industry (Shokeir et al., 1997). Though discussion of such a study falls outside the scope of this research, since the focus is cancer, it demonstrates the variable dangers of current industry practices.

The third notable impact of golf on the nation, and by far the biggest concern going forward considering the new legal landscape, is their use of chemicals. The Golf Course Superintendent Association of America's (GCSAA) official position is that maintaining healthy turfgrass requires the 'responsible' use of pesticides and fertilizers (GCSAA, "Advocacy"). Their

use of such an ambiguous term is consistent throughout the rest of their statement. This leaves superintendents and golf course managers without any formal direction, rather they are left to use as many chemicals as needed to satisfy the "Augusta-syndrome" of owners and greens committees (Barton, 2008).

There's no question that golf courses require millions of gallons of water and fossil fuels per year to maintain, but in combination with toxic chemicals, the synergistic effects make golf an ecologically unsustainable industry, one whose long-term effects could be detrimental to the health of many worldwide. Golf in its present state is unsustainable and ecologically unsound (Millington and Wilson, 2016).

The industry acknowledged the problem in 1995 as 81 people gathered at Pebble Beach to discuss how they could make golf more eco-friendly (Barton, 2008). The proportionate mortality study of golf course superintendents—which noted the elevated occurrence of cancer (non-Hodgkin's, prostate, and brain), respiratory disease, heart conditions, and neurological diseases—had come out that year (Kross et al., 1995). National conferences, workshops and small meetings have continued these environmentally conscious talks. Every new golf resort boasts the obligatory eco-friendly claims but an article in golf digest says, these boasts amount to nothing more than "self-congratulatory hyperbole from the golf industry about environmental sensitivity, sustainability and stewardship" (Barton, 2008). The biggest problems are regarding where golf courses are built, how they're built, and how they're maintained (Barton, 2008).

Chemical Toxicity

Research studies compiled by Beyond Pesticides inform their list of the most common chemicals used in golf course management and managed turf areas.[4] Chlorpyrifos, glyphosate, and 2-4, D acid are some of the most common herbicides used for weed control. Chlorothalonil was the active ingredient in most of the fungicides applied in cited studies, and the most heavily used fungicide in the Long Island study. Chlorothalonil was found in the groundwater. It is classified by the EPA as a possible human carcinogen (Attorney General of New York, 1995). Chlorothalonil leaves dislodgeable foliar residues (DFR) in concentrations up to 5.83 μg/cm^3, only declining 37% for the first hour and remaining at high levels for five hours after application (Doherty, pg. 104). These DFRs are easily picked up by players, 30% of which is transmitted via the hands and legs (Doherty, 2017). This demonstrates one of the most common ways to be exposed: pesticide drift. When pesticide particles and vapors become airborne during or after application, these chemicals absorb into the skin, clothing, and objects of nearby people and their homes leading to long-term exposure of carcinogens.

The EPA has identified chlorpyrifos as inhibitive, organophosphate insecticides that overstimulate the nervous system. Their use on food crops was banned by the Obama administration in 2015 but was reinstated under the Trump administration, who instead opted to implement buffer zones to reduce human exposure (Garris, 2018). These zones were maximized at 0.25 miles from the application site, even though studies have found pesticide drift of chlorpyrifos 0.375 miles from application areas (Garris, 2018).

Glyphosate, the active ingredient in Roundup, was added to the World Health Organization list of possible carcinogens in 2015 (Yan and Drash, 2019). Glyphosate is carcinogenic, mutagenic, and reprotoxic and works by damaging plant DNA (Garris, 2018). It

[4] See Appendix 1, "Health Effects of 30 Commonly Used Pesticides" from Beyond Pesticides for a summary of health effects from pesticides.

has demonstrated the same effects on human cells and in vivo (Garris, 2018). Roundup tested on human embryonic and placental cells showed that a dose as little as 0.01% reduced estrogen production, required for fetal development, by 19%. (Garris, 2018) Picture pregnant women who reside next to or within a golf course compound being exposed to low levels of toxins over an extended period. Many of these pesticides are endocrine disruptors that have extensive negative effects on the female reproductive system (Garris, 2018). Pregnant women and their unborn children are the most vulnerable cohort since these toxins can cross the placental barrier (Garris, 2018).

> Though these studies might sound banal or overtly-scientific, they make evident that there is no shortage of literature illuminating the correlation between exposure to these chemicals and adverse developmental impacts. While many of the observed effects were from experiments on lab rats, it would be shortsighted and egocentric to conclude that chemicals capable of inducing significant developmental delays in rat fetuses would have no impact on humans. (Garris, 2018)

What remains unstudied is the effect of low level, long-term exposure to golf course residents. As stated previously, golf course chemical application is greater than that of agriculture (Attorney General of New York, 1995). In combination with the fact that golf course homes tend to be located less than 100 yards away from the application site, the potential for constant exposure increases exponentially (Garris, 2018). With the linkage of the golf and real estate industry in the past 30 years, more golf communities were built using courses as attractive amenities. These communities also have higher property value, experience less crime, and are often located within close proximity to entertainment hubs, shopping centers, and schools (Avid Golfer, 2017). This attracts a large population of people to over 3 million golf-course-adjacent homes, amplifying the number of people effected by constant low dose exposure (Napton and Laingen, p. 36).

Institutional Deficiencies

The regulatory process in evaluating the health outcomes of products and pesticides has deficiencies (Barton, 2008). For example, there is scant information on endocrine disruption due to pesticides.

> Endocrine disruption changes the hormonal balance in the body and can affect disease outcomes later in life, it can affect development, it can affect a range of organ development, developmental senses that have an impact on illness, cancer, reproductive effects, developmental affects, sexual development. (Barton, 2008)

Endocrine disruptors are not tested for in classic toxicological models that determine poison level by the dosage. Endocrine disruption happens at low dose exposure, especially if it is prolonged. EPA risk-assessment protocols leave out highly vulnerable cohorts because of a series of wrong assumptions (Barton, 2008). They assess each chemical separately assuming no synergistic effects! (Barton, 2008) 2-4, D combines with 2,3,5-T to create Agent Orange, a known carcinogen (Garris, 2018). Though their combination has been banned, 2-4,D is still in use as a common herbicide (Garris, 2018).

Garris, in her 2018 article, highlights a key question. “It functions by spurring incessant division of the cells that transport water and nutrients in a plant, thus inducing a cancer-like process that slowly kills the pesky weed (2, 4 D, 2016). *If it intentionally induces a cancer-like process in plants, what does 2,4-D do to humans?”* (Garris, 2018)

Dursban, active ingredient chlorpyrifos, is an insecticide that impairs the neurological system to kill worms, insects, and other pests. It was banned for household use in 2001, but its use on agricultural crops and golf courses has continued (Beyond pesticide daily news blog pesticide manufacturer sued over golf course superintendent’s death). The EPA risk-assessment for Dursban has tight parameters in their exposure toxicity assumptions. For example, those who golf a lot or children who golf do not fit within the assumptions which lowers the chemical’s risk when in fact those specific cohorts are most susceptible. The EPA narrowed its definition of

children to omit those aged six and under in the Interim Tolerance Reassessment and Risk Management Decision for the Organophosphate Pesticides in 2006, even though junior golf regularly starts as young as four (Beyond Pesticides: Response to EPA Criticism, 2008).

A profound statement by Jay Feldman, co-founder and director of Beyond Pesticides, reveals the mechanisms that have stalled environmentally friendly changes to the golf industry.

> I think the golf course superintendents feel at some risk—they're the ones delivering the toxic chemical to the site and are therefore at risk of litigation. They're saying 'Look we're doing what's legal, we can't be subject to litigation here" … there's nothing in the world that should preclude litigation against the users or manufacturers of pesticides, because we know full well that the regulatory system can be deficient in so many ways…any corporate entity is opening itself up to litigation liability when it uses these chemicals. (Barton, 2008)

The relationship between the chemical companies and the golf industry, namely the GCSAA, is obvious. It would be hard for two industries that go hand in hand not to become entangled with each other, and "the chemical companies have always had their hand in the trade associations. There tends to be an alliance and because of this it becomes a pro-pesticide industry", says Jay Feldman, "…because there's a tremendous pressure from chemical companies to maintain the registration of these products. After a company has invested in the development of a product, it's going to invest a tremendous amount of money in lobbying for the allowance of that product" (Barton, 2008). Chemical companies are some of the largest donors to the GCSAA's Environmental Institute for Golf (Barton, 2008). Their director of environmental programs, Greg Lyman, submitted the following statement for Golf Digest's article:

> The GCSAA has never shied away from communicating its relationship with industry partners that produce golf course management products. These companies provide funds that help enable us to deliver programs and services to our members in the golf industry…it behooves us to work cooperatively with these manufacturers so that we can gather and distribute reliable and accurate information to members. We believe we have a healthy and appropriate

> relationship that does not impact the impartiality or objectivity of our efforts to distribute accurate information about pesticides to our members (Barton, 2008).

Superficially, chemicals have become less toxic over time, even though chemical corporations in America still use the 'innocent until proven guilty' theory to govern their chemical allowances.[5] The EPA bases its risk assessments on research done by companies seeking to register their pesticide (*Johnson v Monsanto,* 2018). Feldman goes on to explain how the EPA is at a disadvantage because they're constantly trying to catch up. New chemicals come out to replace outdated, toxic versions then studies come out that find increased levels of danger and a variety of effects from things the EPA never considered due to all their faulty assumptions (Barton, 2008).

The Turfgrass Research Committee was founded in 1983 after drought scares in the 70's that decimated golf courses. With their guided research, there are many innovations with the capability to have huge impacts on how we maintain courses; for example, the discovery that seashore paspalum is a salt tolerant grass that can be watered with sea water. Research programs have developed cold tolerant Bermuda grasses that reduce the need for irrigation and over seeding (Barton, 2008). Blue iris can naturally filter out toxins in runoff. Studies from University of Massachusetts researchers found that it reduced chlorpyrifos by 76% and chlorothalonil by 94% after three months of growth (Beyond Pesticides Daily News Blog, 2008).

Genetic modifications to grasses could help expedite the change and be more cost effective but introducing a new species could bring with it a host of problems. Brent Blackwelder is the president of the US division of Friends of the Earth. In an interview with Golf Digest,

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[5] See Legal Information Institute, 2020, "Presumption of Innocence", *Cornell Law School,* https://www.law.cornell.edu/wex/presumption_of_innocence
for their definition if this idea: "A presumption of innocence means that any defendant in a criminal trial is assumed to be innocent until they have been proven guilty."

Blackwelder describes genetically engineered plants as a powerful technology that adds something wild to the equation[6].

> We're pretending we know what we're doing but we're at a stage of incredible ignorance…It's potentially at biological pollution that you put out into the world. The big selling point for genetically engineered plants in agriculture was that they need less herbicide use. They also said there would be increased yields. That's not been the case (Barton, 2008).

At present, we are locked in an arms race with evolving diseases, pests, and weeds trying to come up with a universal cure. When improvements are made for the environment, golfers demand more—darker, faster greens and tighter fairway lies. Managers appease by mowing lower and watering more (Beyond Pesticides Daily News Blog, 2010). Over-watered grass a tenth of an inch from the start of its roots is weak and more susceptible to disease and fungal infections Beyond Pesticides Daily News Blog, 2010). Like our own immune system, healthy soils and turf are less hospitable to pests (Beyond Pesticides Daily News Blog, 2010).

> In a perfect world you would be playing an organic course. The maintenance equipment would be charged by solar power. Recycled water would be used for irrigation and used efficiently and sparingly. That we have a great variety of wildlife habitats. This idea that you've got to make everything look like a miniature golf course with a green carpet is crazy. —Brent Blackwelder (Barton, 2008)

In their book, Millington and Wilson craft a beautifully worded explanation of why the environmental movement never crossed over to golf and why organic golf is not being pursued as vigorously as chemical-intensive forms of management. They illuminate important questions as to why organic golf remains on the fringe.

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[6] It should be noted that the full extent of potential side effects of introducing GMOs in the environment is not fully understood. As explained in this report, there are many factors that warrant further exploration. See Janet Carpenter. 2011. "Impact of GM crops on biodiversity". *GM crops, 2*(1), 7-23. for an example of issues with genetically modified plants.

> Why has the golf industry settled on strategies that are intended to reform the industry, but not *transform* it through more radical health- and environment-friendly measures? Why are there not more regulations in place promoting the development and adoption of organic practices, thus 'evening the playing' field for those already moving in in organic direction? (Millington and Wilson, pg 189)

Golf is considered a "crucial leisure and tourism activity", but it stalled out before it reached 'eco-tourism' (Millington and Wilson, pg 177). Using science, technology, and natural practices as solutions for environmental problems never gained enough traction in the golf community to inspire the formation of an organized collective, movement. Traditional management styles rely on chemicals that are not sustainable, and as more people realize it's not feasible, we will have to adapt rapidly or risk the industry's collapse. In the wake of extreme climate change predictions, it is *the* moment to mobilize resources to advance organic golf.

Seemingly, the more difficult part of changing management styles is changing perceptions about the sport itself. It's vital that players as well as managers understand that golf is not a game of perfect. Golf does not always need to be played on green grass or maintained to the same extent as the "freakishly green wall-to-wall grass on a life-support system of too much water and toxic chemicals" of Augusta National (Barton, 2008). A 2008 survey from Golf Digest revealed that 64% of golfers would play under less-manicured conditions to minimize pesticide use and 85% of golfers are willing to sacrifice some level of golf course "perfection" to prevent groundwater pollution (Barton, 2008). There seems to be some recognition that blemishes on the golf course are charming, characterizing conditions like those of St. Andrews or Hoylake (Barton, 2008).

Other sports are realizing the same issues. Millington and Wilson quote an expert in their book who explains why 70% of soccer fields (football pitches) in the UK are organic. They are forced to because if players were to get any infected injuries while playing on chemically

maintained turf, the managers would be sued. As stated before, public concern drives decision-making. With 66.6 million golfers worldwide, it should be an easy fix once organic golf gains momentum (Golf Educate, 2022). Later parts of this report will explain the golf industry's necessity to act quickly since we have reached a similar level of litigation concern as soccer players in the UK.

> [we should consider] what golfers 'could do' if public and environmental health concerns were widely known, and if we're going to golf was widely available (and mandated). In the same way, mandating 'organic-only' golf courses would undoubtedly inspire the development of a culture of more environmentally knowledgeable, innovative, and motivated course owners and superintendents. (Millington and Wilson, pg. 188)

In this chapter, Millington and Wilson's main points were that organic methods work for the superintendents who use them. The level and type of success with organic management depends on the local climate, communication with club membership, and commitment to the process of transforming their course. As organic management techniques continue to develop, it requires time for their experimentation and investment. The best natural products might be yet to come, but strict regulation of chemical usage is necessary for superintendents attempting to implement a successful organic program. They list some alternative techniques for courses to get started in organic management: focusing on dew accumulation and drainage, managing micro-climates, monitoring pH levels of the soil, and hand-weeding.

The use of non-pesticide pest control has been increasing incrementally over the last 30 years. The 'mainstream' approach to golf course management has always been innovation. Both organic and chemical solutions are developed through experimentation with different combinations of techniques. (Millington and Wilson, pg 194) Adopting anti-chemical practices is a transformative process that is imperative for the future of golf, returning it to its pre-modern roots (Millington and Wilson, pg 195).

Time and money seem to be the biggest issues in the transformation of golf. Organic management and cultural practices can be more labor-intensive and costly. If the EPA were to ban cosmetic pesticides, there would likely be political backlash from leisure and tourism corporations and negative economic implications (Millington and Wilson, 2016).

Instead, we require a post-politics view to modernize our perceptions and practices within the golf industry. The rise of golf in the Roaring 20's, when golf was played in clubs with a wealthy and opulent constituency, produced around 600 new courses a year that did not have a large environmental footprint (Hueber, 9-10). In golf's Golden Age of Architecture, courses were shorter due to lack of development in golf equipment, and they took up less land because holes were stacked next to one another with adjacent fairways (Hueber, pg 10). With the help of monumental players like Jack Nicklaus, Arnold Palmer, and Gary Player on the PGA Tour in the 1950's and 60's, golf was popularized as a recreational activity for the burgeoning middle class (Hueber, pg 11). Subsequently, golf course design became longer and larger to accommodate technology advances in golf equipment and add more space amongst holes to allow for real estate development between them (Hueber, pg 11). The real estate and golf industries collaborated to design spectacular golf courses as the main attraction for real estate developments (Hueber, pg. 14)

> Since real estate developers considered the golf courses to be an amenity that increased real estate values and increased sales turnover, it made business sense to subsidize the operating costs of the golf course in order to maximize the sales prices of the lots within the community. But the real estate developers' primary interest was in selling real estate and not in operating the golf course as a going concern so most had an exit plan to dispose of the golf course once they sold the real estate. The problem with this business model was many of the golf courses were not economically viable so the golf industry was left with a large inventory (supply) of golf courses that did not meet the golfing needs of the industry's ultimate consumers as they were too difficult and expensive for the average golfer to play. —Hueber pg. 14

The golf industry inherited golf courses with expensive maintenance requirements, debt-ridden, and economically unviable enterprises (Hueber, pg. 17). Compounding this problem is that these golf courses are not affordable or fun for the average golfer, they take too long to play, and they are detrimental to the environment.

Therefore, the golf industry now has a large inventory of golf courses that are unsustainable, which calls into question the conundrum of whether or not an industry can be sustainable, if its products/services (golf courses) are unsustainable. Therefore, in order for the golf industry to be sustainable, it needs to foster the transformation of its inventory of unsustainable golf courses into sustainable golf courses (Hueber, pg 17).

Jeff Carlson is the property manager at the Vineyard Golf Club on Martha's Vineyard, Massachusetts, one of the only fully organic golf courses in the United States (Phillips, 2018). The course does not use any products whose active ingredient was synthetically synthesized (Phillips, 2018). They use natural turf management styles like using microscopic worms—nematodes—to control pestilent white grubs. They utilize many cultural practices at the club to maintain the course, like hand-pulling weeds, sand top-dressing the greens, and whipping the greens and fairways to minimize the duration of wetness (Barton, 2008). Carlson explained that as the grasses were given time to adapt, only the strongest, disease-resistant grasses survived. They supplement any pesticide use for organic products like Waipuna from New Zealand, a weed-control system that kills plants using hot water and a sugar extract from corn and coconut, or Organic Materials Review Institute (OMRI) listed products (Philips, 2018). Kevin Banks, the Vineyard Club superintendent since 2015, admitted that it requires a lot of effort and communication with the members to manage a course without any pesticides (Phillips, 2018).

Management styles are not cookie cutter designs for every course. For instance, courses in the South or in the transition zone might have to adopt a balance of occasional synthetic additives with organic management because of their local climate. Although golf courses will not

have the same type of management, the Vineyard golf club proves that tailored, organic practices work.

Golf courses can get certifications for their eco-friendly practices and voluntarily opt-in to organizations that promote organic management. Programs like the Audubon cooperative sanctuary of Audubon International, headed by Ronald Dodson. This organization certifies golf courses in six different categories of conservation such as water quality management, wildlife habitat enhancement, chemical use reduction, and safety outreach in education. There are more than 2,300 courses in the program and 622 of which are in the US (Barton, 2008). Dodson illuminates an important part of advancing the environment movement within the golf industry.

> The only way we're all going to make a difference, long term, is if this becomes part of the free enterprise system. So it's no longer some cute, nice thing to be environmentally friendly, or something that we do every once in a while. It becomes part of the way we do business. The golf course industry has an opportunity to be the leader. If they do it in the right way, they could be motivators for people who build shopping malls and parking lots and subdivisions (Barton, 2008).

It's vital that we have something to unify our governing body of golf management under so that treated turf managers can make the most responsible decision. Golf courses are burdened by a hodgepodge of rules and regulations from federal, state, county, city, municipality etc.—it is virtually impossible for any golf course superintendent to get to know all the rules governing their function. Outreach initiatives have not been emphasized enough. Public concern drives decision-making. There have been incremental improvements, but large steps are needed to transform the industry ethic. That's why it's incumbent upon the GCSAA to unify these to come up with explicit standards.

Go Green or Go Home

There were an estimated 25 million golfers in the United States according to the most recent Sports Survey in December 2021 (Golf Educate, 2022) and that number may have gone up slightly thanks to Covid 19.[7] There are also 300,000 golf course workers in the United States (IBIS World). And there are millions more who live along golf courses to consider in the mix. All of these people are being exposed to the chemicals, herbicides, and pesticides used to maintain a golf course's clean, green look. When you compound that by each of the 16,000 courses in the US, the widespread effect is extreme.

The demand that courses adopt non-toxic methods of maintenance has not been met and thus requires the addition of legal standards to hold the industry responsible for keeping up with the best management practices available (i.e., being as organic as possible). The literature supports strong recommendations for the Golf Course Superintendents Association of America (GCSAA) and what they should do going forward given the evidence of adverse effects of pesticide use for both humans and the environment (Beyond Pesticides).

While there have always been organic models for golf course operation and management, it has not been adopted as the industry standard. The recalcitrant attitude of the GCSAA defies the logic that the courts have laid out. These legal decisions have established a new standard in liability for those using the chemicals identified as carcinogenic. In other words, it puts golf courses and the GCSAA on notice to change their policies regarding pesticide, herbicide, fungicide, and fertilizer use. It is no longer about Monsanto's culpability for their manufacture it is now about the liability for those who continue to use it.

[7] Hueber puts the total number of golfers at 30 million in his article, *Code Blue* (p. 3), but that was in 2010 and the number of golfers was on a downward trajectory until recently. Because golf is a sport that can easily accommodate COVID modifications—social distancing, sanitary precautions, etc.—more people have joined the game of late. According to the National Golf Foundation, 3.2 million Americans played on a golf course for the first time in 2021.

The GCSAA is very careful in their statements not to identify or recommend specific chemicals in golf course maintenance. They only state that conventional chemicals can be used safely. They outline the official Best Management Practices (BMP) for golf courses in each of the 50 states but fail to identify any compliance measures. They obfuscate and allude to the existence of environmental management programs that can help courses "preserve the natural heritage of the game" (MTBMP).

Regarding the GCSAA as an accrediting agency, they are willing to accept state oversight, but it remains unclear *who* in the state is responsible. The enforcement is under state and federal law. So, it's a slight-of-hand card trick. GCSAA encourages a BPM, states are responsible for setting it up, but there is no direct oversight….so, it's impossible to pin the liability on anyone! If there was an overarching agency that tried to assert their authority, golf courses would likely sue for government interference. This issue requires collaborative efforts to set a new industry standard to further enforce regulation of pesticide use, since there are clear defects in the governmental regulation process.

As stated previously, chlorpyrifos was banned by the EPA for homeowner use in 2001 due to its neurotoxic effects but its uses on agriculture and golf courses were allowed to continue. Knowledge of potentially lethal effects should be legally binding, but the agriculture and golf industries were not obliged to change their practices since the EPA risk assessments were not considering synergistic effects of chemicals in repeated lose dose exposure, therefore declaring them 'okay' for commercial use.

The gap in oversight needs to be addressed. This report aims to add more comprehensive management practices in line with the GCSAA's view that BMPs should be "based on sound science supported by credible peer reviewed data and university recommendations" (GCSAA).

State university extension services (and wildlife biologists) should have a specific role in BPM. At present, there is too much reliance on "turf management" schools, which are subsidized by corporate interests (Nietzel, 2022). Now that courts have accepted the cancer-causing link, this opens a new possibility of starting an oversight agency within each state, giving jobs to wildlife biology and environmental science majors.

The general literature surrounding this subject is negative and does little to highlight the positive effects golf courses can have when built and managed properly. One of the world's preeminent golf course architects, Mike Hurdzan, said, "I'll refute anybody who is not willing to accept that a golf course is a good environment if it's properly designed constructed and maintained" (Barton, 2008). In the same interview with Golf Digest, Hurdzan explained that golf course maintenance would be much easier if we changed "the perception that all golf must be played on green grass" (Barton, 2008). People like Kevin Banks and Jeff Carlson of Vineyard Golf Club have found alternative approaches to be quite successful when quality communication to the membership is used in tandem.

Sustainable development requires the consideration of multiple sociopolitical factors, three key components of which are outlined by Hueber: environment, economy, and social equity (Hueber, pg 19). These three factors must be balanced to satisfy all the stakeholders of the golf industry. Hueber's goal in his paper is to "educate and inspire golf course sustainability for not only the right reasons of protecting our limited resources for generations to come but also because it makes business sense to make this commitment to sustainability" (Hueber, pg 4). Groups with vested interests in the golf enterprise will more readily welcome changes for the purpose of environmental sustainability when they also add to the bottom line. This report

suggests environmental changes to be added to state BMPs and a remediation plan for the courses that may not survive if they don't change.

While the creation of The Environmental Institute for Golf (EIFG) and their initiative to get all 50 states on BMP program should be applauded, the GCSAA should be further challenged to be more specific. It would be prudent to make a stronger pronouncement forbidding the use of what the courts have clearly identified as cancer-causing agents. We are not just talking about the golfer's safety; we are talking about the safety of the general public many of whom live adjacent to golf courses and the good of the natural environment.

It should go without mention that any land use strategies for properties near tribal lands or in ecosystems long inhabited by aboriginal people should consult sources of Traditional Ecological Knowledge[8] and aim to incorporate the major principles within their management. One such example can be found on page 1253 in the article "Rediscovery of Traditional Ecological Knowledge as Adaptive Management" by Berkes et al. in 2000. The specific application of these principles warrants further explanation in future studies.

It is the author's main recommendation that the GCSAA institute fundamental change to golf course management in light of recent lawsuits and stop promoting chemical intensive golf course management. They should instead adapt their process to fit more of the practices listed by Beyond Pesticides in the Environmental Principles for Golf Courses in the United States (Beyond Pesticides, 2022). Beyond Pesticides outlines and discusses seven main areas that structure the overall principle, making it a holistic ecological approach.

[8] The golf industry's relationship with aboriginal people is beyond the scope of this paper, but many golf courses in the desert Southwest are located on or near tribal lands and could benefit from the sustainable principles tribal people have developed over centuries of lived experience. See, *Rediscovery of Traditional Ecological Knowledge as Adaptive Management*, by Fikret Berkes, Johan Colding, and Carl Folke; in *Ecological Applications*, 10(5), 2000, pp. 1251–1262, Ecological Society of America.

1. Precepts (foundational purposes)
2. Planning and siting
3. Design
4. Construction
5. Maintenance (local environment management)
    a. Plant Protection and Nutrition
    b. Water Usage
    c. Waste Management
    d. Wildlife Management
6. Facility Operations
7. What Golfers can do to Help

A study by researchers at the University of Massachusetts (funded by the USGA) found that a 1-hour wait time post-application irrigation of chemicals significantly reduced the exposure to golfers. This should be adopted as the standard policy effective immediately to reduce golfer exposure to chemicals while the GCSAA updates their policy. They also concluded that using reduced risk compounds for fertilization and pesticide application signicantly lowers the risk to humans and the environment because they are not as easily absorbed dermally and have less likelihood of entering groundwater via runoff or absorption. (Doherty and Clark)

Because of climate variation in the United States, golf courses will have to be attended to based on their specific circumstances. By way of example, the Montana BMP (MTBMP) was analyzed in order to identify any oversight. While recognizing the organizational constraints in policy changes, the author offers alternatives to ameliorate vagueness. The proposed list of

changes is not exhaustive, but it does provide examples of how management practices should be framed going forward.

In some instances, we may have limited knowledge of the absolute best option for the ecosystem, but that does not preclude the possibility of taking new management actions given that the "old" approach has obvious detrimental effects. We can make adaptive management plans based on inferences from other successful organic courses.

GCSAA's Best Management Practices are a comprehensive template for environmentally adapted strategies. Throughout the MTBMP, they list suggestive courses of action to improve wildlife habitat, restore native plants in out-of-bounds areas, and reduce runoff. What is now required is flexibility within the institution to reform management strategies under continually changing circumstances using the best available science.

Communication is less emphasized but still included in the report. Courses are required to communicate the report to the proper permitting agencies when constructing the course (MTBMP, pg 13). Communication is likely one of the most challenging areas because of the potential negative reactions but also one of the most important so that water managers, ownership, golfers, and the public are all aware of the need for certain organic management strategies and cultural practices (MTBMP, pg 23). It outlines responsibilities of golf course owners to contact government agencies at the appropriate level to determine the requirements and permitting guidelines of their course construction (MTBMP, p 22). "In general, construction activities which disturb more than one acre may require a National Pollutant Discharge Elimination System (NPDES) Permit. Contact the Montana Department of Environmental Quality to determine any requirements" (MTBMP, pg 17)

Specific wildlife considerations were listed on pages 19-20, with additional considerations throughout the document when applicable. BMPs could include many more measurable objectives, however the Montana BMP does highlight a few key ways to enhance wildlife habitat (MTBMP, pg 17).

- Maintaining wildlife habitat on golf courses better maintains biological diversity, which is especially important in the urban environment (pg 17)
- As much natural vegetation as possible should be retained and enhanced through the supplemental planting of native trees, shrubs, and herbaceous vegetation to provide wildlife habitat in non- play areas, along water sources, to support fish and other water-dependent species. By leaving dead trees (snags) where they do not pose a hazard, a well-developed understory (brush and young trees), and native grasses, the amount of work needed to prepare a course is reduced while habitat for wildlife survival is maintained (pg 112-113)

'External Certifications' is the only section that directly discusses environmental concerns of golf course management. However, it is incumbent upon the golf course to seek out those environmental certifications to develop a sustainable management plan. Much like LEED certifications (which they ask courses to consider in Montana's BMP), golf courses have the option to be organic or not. They use language like "explore potential use of alternative energy from natural sources, such as solar, geothermal, and wind energy" (MTBMP, pg 117). Doing this on a voluntary basis is obviously not working; mandating these certifications may be the only option.

- Golf-centric environmental management programs or environmental management systems can help golf courses protect the environment and preserve the natural heritage of the game. (pg 19)
- These programs help people enhance the natural areas and wildlife habitats that golf courses provide, improve efficiency, and minimize potentially harmful impacts of golf course operations. (pg 19)
- Golf courses can gain valuable recognition for their environmental education and certification efforts. (pg 19)

Overall, the MTBMP does not identify any compliance officers or regulators that will affirm these practices are being done properly. Nor can users of these Best Management Practices point to a specific governing body or authority that oversees their implementation and enforces adherence to them. As such, it is important for golf course managers and operators to take responsibility for ensuring that these practices are being followed appropriately and to regularly monitor and evaluate their effectiveness in maintaining the health and sustainability of the golf course ecosystem. There seems to be a gap in the management structure that will hold golf course owners accountable for using these 'responsible practices'. The GCSAA offers free compliance counseling and access to information from OSHA, Labor guidelines, EPA updates, and WOTUS rules but does not take further steps to make sure golf courses apply best management practices (GCSAA, "Advocacy").

Additionally, the founders of these BMP's should collaborate with state agencies to create a position that serves as a mechanism for best practices compliance while also keeping up with the best available science to create adaptive techniques for golf course management. This position would ideally be filled by a wildlife biologist or individual trained in sustainable management. They will work with the golf course owners and operators to modify treatment processes in accordance with environmental standards, both legally and scientifically based.

Within the Beyond Pesticide principles and amongst other turfgrass research, there are many simple, cost-effective measures that courses can phase in gradually, while weaning off pesticides. Golf courses should develop the ecosystem around the course so that the animals are all in concert, making the round a more natural experience and getting back to roots of golf.

This list of management practices is an example of the type of policy changes required to update the Best Management Practices (BMPs).

1. Testing the pH levels of the soil and water quality. Ideal pH levels should be between 6.5-7.0 (Beyond Pesticides).
2. Mowing above 1.75 inches (Beyond Pesticides).
3. Making sure that turf is consistently aerated to avoid compaction (Beyond Pesticides).
4. Use natural fertilizers like compost or products certified by the Organic Materials Review Institute (OMRI) (Vineyard Golf Club).
5. Use wetting agents, whip/roll greens and fairways, and remove leaves to reduce the time grasses are saturated and prevent fungal diseases (Vineyard golf Course).
6. Rely on cultural practices, like hand weeding, to maintain the turf (Vineyard Golf Club).
7. Use natural pesticides in moderation or as a last option because natural/non synthetic inputs can still be poisonous if not used properly (Millington and Wilson, pg. 185).
8. Establish an open line of communication with club members, greens committees, and management (Phillips, 2018).
9. Since both bats and birds naturally control insect populations, courses should install at least 1 birdhouse per acre (~8 per hole) and at least 10 bat houses on barns, sheds, and buildings as long as food and human safety is considered (Mass Audubon, 2022). Alternately, bat houses can be placed on poles erected in the middle of fields (Ingram, 2014).
10. Coordinate with local wildlife groups or the state Fish, Wildlife, and Parks organization to identify which parts of the property can be utilized for wildlife refuge areas, protected habitats, or stopovers for migrating animals.

It is the author's recommendation that the GCSAA develop a remediation plan for courses that are not able to abide by the above requirements or fulfill their state BMPs. Every course could start by reevaluating their environmental impact, through Environmental Impact Statements or other qualified testing measures. Golf courses will have to measure and manage their carbon footprint going forward because of climate change and government regulations on carbon footprints. This proposal would save golf courses money in the future.

Over 50 years of using the same chemicals makes the turf reliant; some courses will not be able to completely wean themselves off chemicals. There are too many courses built in the wrong areas that require too much money to upkeep and are not meeting the demands of the average player, who is restricted by the location, length of course, difficulty of course, and expense of the round (Hueber, p 7-8). There are an estimated 2,000-5,000 courses that cannot be environmentally or financially sustainable (Hueber, pg 7-8).

Courses could consult with businesses like Handex, which offer full-service solutions for environmental remediation. They use tools like GIS (Geographic Information Systems) and soil testing to identify chemical remnants that need removed. Because golf course remediation can be an expensive and lengthy process, there may be a need for the GCSAA to look for government funding to subsidize these efforts.

The BMPs of each state may be a good start for the conversion of golf into an organic industry. The nagging question remains: *As a matter of best practices, how do we keep them (BMPs) up to date?* This report has identified the lack of enforcement mechanisms to make sure the BMPS are including all the best practices. To avoid false advertising and legal ramifications in the future given the trajectory of litigation against pesticide-using industries, the creation of a position at state level is required to keep knowledge fluid and updating.

Conclusion

While science does not dictate how we "should" act, it does inform our decision-making processes. There are many extraneous factors and variables that also affect this process. The author does use "ought to" language, not as a judgement of morality on the golf industry, but as examples of policy changes that would bring golf one step closer to a sustainable future and one step further from the increasing potential for legal consequences. The goal of scientific communication is to inform policy makers of the best possible option, it is ultimately our democracy that is in charge of changing things for the better.

In aiming to be an honest broker of this situation (Pielke, 2007), the author recognizes the limitations of her report: there is no way to present all the possible alternatives, she can only present some of the best available ones as some examples. What is required now is motivation on the part of the administrators (GCSAA and golf course owners) to make these changes. It is obvious that policymakers are lacking in motivation. The cheapest, easiest, fastest way to get results has always been through the use of pesticides…so why change now?

Having this knowledge since the inception of chemical management has still not stirred up much change. Rather than fully committing to a new regime, most administrators take the path of least resistance and make minute changes—only enough to free themselves of any liability or backlash. Fortunately for the environmentalists, a new paradigm has sprung on the scene: LAW. The recent pronouncement of the courts, that cancer-causing agents (like those used on golf courses) can be separated from other carcinogenic confounding variables and identified as the clear cause of an individual's cancer.

The golf industry has nowhere to hide! Their current environmental strategies (like those outlined in the MTBMP) have bought them enough time to make real, full-scale change. It is

easy to glance at state BMPs, identify some alternative energy options, environmental certification programs, or standard wildlife conservation tactics and conclude that the golf industry is “doing enough”. They aren’t all the way there. Pesticides continue to be dumped on our lands at an alarming rate. They bioaccumulate in the soil and cause long-term damage to the local watersheds, wildlife populations (trophic cascade upwards of increasing chemical levels), and humans alike.

This report is as much a call to action for the golf industry as it is for the lay chemical user and the industries that perpetuate the use of pesticides in their convincing advertising. (They better fix something before someone else does as the author of this report did and figure out the scheme). It is the author’s hope that this report inspires change. While it is not an “all-inclusive” report, in the sense that it does not include the entirety of the published literature nor does it begin to unwrap all the possible solutions to the problem, it does make clear the legal obligation for industry standards to adapt in preparation for the future.

Postscript: The Next Shot

Considerations

One of the fundamental pillars in wildlife and natural resource management is: objectives characterize desired future conditions. The goal of this specific section of the report is to provide a cost-benefit analysis of the proposed changes to golf course management to meet desired future conditions. The hope is to create a merchantable green signature for the golf industry portfolio. From an economics standpoint, there are glaring externalities affecting the health of players and the environment. It is seemingly yet another example of market failure due to the reliance of the industry on the "goodwill" of courses to use the best available management tactics Golf courses have never incurred the cost of the damage that their operation causes. There is no fine for loss of biodiversity, loss of habitat for wildlife, habitat fragmentation, human cancer, runoff, or bioaccumulation of chemicals caused by golf courses. However, in defense of the individual golf course, it is extremely difficult to operate with the best available management equipment when its financially unfeasible or when the policies are unclear what type of management is best (ex. should they focus on cheapest, easiest, fastest, most affective, or greenest management?). We need to make the policies more explicit to ease the burden of golf course superintendents and managers (who are pressured by their constituents and budget to use the easiest effective method of maintenance…chemicals/pesticides).

This report is also meant to highlight the dysfunction of environmental law and the flaws within our legal system that allows chemical companies to continue producing harmful products. In considering the future of the golf industry, we must weigh the importance of human health with the importance of the manicured landscape of golf courses. Organic practices are successfully used by courses like Vineyard Golf Club in Massachusetts.

The future of golf may require a return to traditional styles of course and a retreat from the stereotypical pristine golf courses that are expected by today's standards. However, organic and hybrid golf courses have had great success maintaining golfers' expectations of the course condition and playability. Golf courses occupy a vast amount of greenspace in the US. There is a tremendous opportunity for golf courses to transform into a sustainable industry and provide better habitat for urban animals and wildlife. Not to mention it would avoid any potential lawsuits for the continued use of carcinogenic chemicals.

It is germane to study and important to consider golf as a microcosm of larger society and culture, as it reflects and influences social norms, values, and economic trends. Golf has been a symbol of prestige and exclusivity. Studying its history and evolution can provide insights into broader social issues such as class, race, gender, and globalization. Furthermore, golf has a significant economic impact on local communities, and understanding its role in the larger economy is crucial for effective management and policymaking. By studying golf as a microcosm of society, we can gain a better understanding of the complex and dynamic relationship between sports, culture, and society.

Besides golf's socioeconomic impact, there is a need for more scientific research on how the chemicals used on golf courses may disrupt hormones. Given the literature I have read, it seems to me the endocrine disruption is more critical for women. Women have higher cell turnover because of the menstrual cycle. Overstimulation especially when you're on birth control causes higher turnover in mammary tissue and it keeps estrogen at high levels. This leads to more chances for cell mutation, meaning that women are more likely to have a deficient or mutant cell when they encounter chemicals that disrupt their (volatile, delicate, sensitive) endocrine system.

Categorizing Costs and Benefits

A cost-benefit analysis (CBA) is a useful tool for evaluating the financial and economic implications of different management actions for a golf course, especially when considering the information from this report and future proposed studies. When it comes to sustainable alternative management actions, one should follow a process like that outlined below in Table 1 so they can make the most informed decision. This process is a type of Structured Decision-Making used by wildlife professionals.

Table 1. Cost Benefit Analysis of five major factors to consider when deciding whether to switch to sustainable management on a golf course.

Management Action	Benefits	Costs
Implementation	Sustainable and organic management decreases the use of carcinogenic chemical exposure to golfers/staff, thereby reducing the likelihood of litigation. Golf courses can get funding/tax credit for implementing sustainable practices or having environmental certifications. Example: Audubon Cooperative Sanctuary Program certifies golf courses that demonstrate a commitment to environmental stewardship and sustainability.	Cost of any necessary equipment, materials, and labor required to implement the sustainable management action after funding, grants, or tax credits. Example: the action involves installing a new irrigation system, the cost of the system and installation is included in the analysis.
Maintenance	Continuing to provide the same amount, if not more, jobs with the need for cultural practices and hands-on maintenance approaches.	Maintenance is more time consuming. Managers are responsible for more workers. Regular inspections or replacement of certain equipment is still included in the annual budget.
Environmental	Sustainable management action created to reduce water usage, decreased use of	Potential for more human-wildlife interactions.

	pesticides and fertilizers, and improved soil health. Providing healthy greenspace for urban and rural wildlife. These benefits may have economic implications, such as reduced water bills or decreased need for fertilizer applications.	Must consider the cost to recreate these ecosystem services if they are damaged beyond repair.
Social	Sustainable management actions may have social benefits, such as improved aesthetics, increased biodiversity, and reduced noise pollution.	Requires a large part of the golf community to reevaluate their standards of "good golf" and what it should look like. (The report mentions majority support for changing to more eco-friendly management from Golf Digest surveys).
Revenue	The positive impacts of organic management on golf course revenue will depend on a variety of factors, including the specific practices used, the preferences of golfers, and the local market conditions.	Sustainable management actions may reduce the number of rounds played due to course closures or reducing the value of memberships.

By considering these factors, a CBA helps us determine whether a sustainable management action is financially and economically feasible for a golf course. For example, if the costs of implementation and maintenance outweigh the environmental and social benefits for a specific golf course, it may not be financially feasible to implement the actions. Of the 16,000 golf courses in the US now, roughly 2,000-5,000 courses may not be able to convert to organic management (pg. 45 of the report). Conversely, since the benefits outweigh the costs for most courses, the action may be a wise investment for the golf course. The benefit of avoiding a lawsuit is by far the most compelling piece of this argument for golf courses and the industry. Since we know that chemical fertilizers and pesticides can pose a risk to golfers and course staff,

there requires some action by the industry to mitigate that risk. By switching to organic management, golf courses can reduce their liability and potentially lower insurance costs.

The positive revenue impacts are also very important to consider. Organic management often involves using natural and sustainable methods, which can be less expensive than using chemical fertilizers and pesticides. This can lead to reduced expenses for the golf course, which can positively impact its bottom line. Organic management will improve course conditions. It can result in healthier turf and soil, which can improve the overall condition of the golf course for the entire length of the season. This can lead to better playability and a more enjoyable experience for golfers, which will encourage repeat business. As these environmental concerns continue to be voiced, companies are being pushed to adapt their brand image and adopt greener practices. Organic management can be seen as environmentally friendly and socially responsible. This can help to improve the golf course's brand image and appeal to customers who are concerned about sustainability and the environment. Rebranding can increase demand for golf courses, as people are less concerned about the health risks while playing at courses that are managed using organic practices. This may be more attractive to golfers who prefer environmentally friendly courses. This can lead to increased demand for tee times and other services, which can positively impact revenue. By implementing sustainable and environmentally friendly practices, golf courses can potentially improve their financial performance while also contributing to a healthier planet.

Estimating Values

I would like to emphasize the potential negative impact on the environment if we fail to take advantage of this opportunity to make a positive change and speak to the point made in the revenue cons section of Table 1. If golf courses fail to become sustainable, there could be

significant negative impacts on ecosystem services. These areas are critical for urban wildlife, performing many essential ecosystem services, such as carbon sequestration, water filtration, and habitat provision. If these services are lost, the costs of recreating them could be enormous. How much *would* it cost to recreate ecosystem services? Some reports value global ecosystem services in 2011 at $125trillion/year and $145trillion/year (USD) in 2007 (Costanza et al., 2014). The same report estimated the loss of eco-services due to land use change at $4.3–20.2 trillion/year (USD) from 1997 to 2011 (Costanza et al., 2014). Forbes magazine valued the golf industry at $84 billion in 2016 (Matuszewski, 2018). It has grown by 22% since 2011 (Matuszewski, 2018). The loss of ecosystem services could have severe economic and ecological consequences, leading to a decline in biodiversity, further environmental degradation, and increased expenses to recover the turf quality. Therefore, the loss of ecosystem services due to unsustainable golf courses could have a significant economic impact.

Recommendations

It is my recommendation to replace pesticides with sustainable cultural practices, update each state's BMP to restrict pesticide use and replace them with organic options. Weimer et al. (2009) provides the framework for contingent valuation to estimate willingness-to-pay for the continued production and use of harmful goods, with specific reference to cigarette consumption. They suggest "75% of the loss of the conventionally measured consumer surplus should be counted as social cost for policies that reduce the consumption of cigarettes". We could adapt a similar policy for this scenario requiring a percentage of the annual fees to go to a sustainability fund.

I also suggest creating a management position within each state agency (EPA agencies like Department of Environmental Quality or Department of Toxic Substances Control) to

oversee compliance to new regulations. This management position could be responsible for developing and implementing strategies to ensure that golf courses are complying with environmental regulations, and for overseeing inspections and audits to assess compliance.

The manager could work closely with golf course management to educate them on the new regulations and the steps they need to take to comply. This could include providing training and resources to help golf courses implement sustainable practices and offering guidance on the steps needed to achieve compliance. In addition, the manager could work with other stakeholders, such as golfers and environmental groups, to promote sustainability and responsible management practices. This could include developing outreach campaigns to raise awareness about the importance of sustainability in golf course management and working with golf courses to develop sustainability plans that align with regulatory requirements.

Overall, creating a management position within state agencies to oversee compliance to new regulations on golf courses could be an effective way to ensure that these regulations are being properly enforced, and to promote sustainability and responsible management practices within the golf industry.

Creating a homeowner association (HOA)-like organization for golfers could be an effective avenue for keeping their own courses accountable. This type of organization could be made up of golfers who have a vested interest in the sustainability and responsible management of golf courses. The organization could work with course management to establish guidelines for sustainable practices, monitor the implementation of those guidelines, and provide feedback to course management when necessary.

The HOA-like organization could also serve as a platform for educating golfers about sustainable practices and encouraging them to play an active role in promoting sustainability on

the course. This could include initiatives such as promoting the use of electric golf carts, encouraging the use of reusable water bottles, and promoting responsible waste management practices. By creating an HOA-like organization, golfers could have a direct impact on the sustainability of their own courses. This could lead to improved course conditions, reduced costs for course management, and a more enjoyable experience for golfers. Additionally, by promoting sustainable practices, golfers could contribute to the larger goal of reducing the environmental impact of golf courses and promoting environmental stewardship in the sport.
In these ways we will make large strides in the development of 'soft' forms of policy, such as the spread of norms and new standard setting in the golf profession (Stone, 2012).

In conclusion, this paper has highlighted the urgent need for policy changes in the golf industry to promote sustainability. By adopting environmentally friendly practices, golf courses can reduce their ecological footprint, while also benefiting economically and legally. While this paper has provided some valuable insights into this issue, it is clear that further research is needed to fully explore the potential benefits of sustainable golf course management practices. The suggestions made in this postscript fall outside the scope of the current research, however they provide some examples of what more in-depth study can yield. We hope that our findings will inspire policymakers and golf industry stakeholders to prioritize sustainability and to work together to develop effective policy solutions that promote sustainable golf course management practices. Ultimately, such policies can ensure the long-term viability of the golf industry, while also protecting the environment and promoting economic and legal sustainability.

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Appendix 1.

A Beyond Pesticides Factsheet – A Beyond Pesticides Factsheet – A Beyond Pesticides Factsheet – A Beyond Pesticides Factsheet

Health Effects of 30 Commonly Used Pesticides

Pesticides	Health Effects						
	Cancer	Endocrine Disruption	Reproductive Effects	Neurotoxicity	Kidney/Liver Damage	Sensitizer/ Irritant	Birth Defects
Herbicides							
2,4-D*	X[4]	X[10]	X[7]	X[8]	X[8]	X[1]	X[11]
Benfluralin					X[1]	X[1]	
Bensulide				X[2]	X[1]	X[2]	
Clopyralid			X[7]			X[2]	X[7]
Dicamba*			X[1]	X[2]	X[2]	X[1]	X[1]
Diquat Dibromide			X[12]		X[11]	X[1]	
Dithiopyr					X[1]	X[1]	
Fluazipop-p-butyl			X[1]		X[1]		X[1]
Glyphosate*	X[12]	X[8]	X[1]		X[8]	X[1]	
Imazapyr					X[7]	X[2]	
Isoxaben	X[3]				X[2]		
MCPA		X[6]	X[2]	X[2]	X[11]	X[1]	
Mecroprop (MCPP)*	Possible[3]	X[6]	X[2]	X[1]	X[9]	X[1]	X[1]
Pelargonic Acid*						X[1]	
Pendimethalin*	Possible[3]	X[6]	X[1]			X[2]	
Triclopyr			X[7]		X[9]	X[1]	X[7]
Trifluralin*	Possible[3]	X[6]	X[1]		X[2]	X[1]	
Insecticides							
Acephate	Possible[3]	X[6]	X[11]	X[9]		X[2]	
Bifenthrin*†	Possible[3]	Suspected[6,10]		X[8]		X[1]	X[9]
Carbaryl	X[3]	X[10]	X[8]	X[1]	X[11]	X[11]	X[7]
Fipronil	Possible[3]	X[6]	X[8]	X[8]	X[8]	X[8]	
Imidacloprid ‡			X[7]		X[2]		X[7]
Malathion*	Possible[3]	X[10]	X[11]	X[9]	X[2]	X[2]	X[2]
Permethrin*†	X[3]	Suspected[6,10]	X[1,7]	X[9,7]	X[9]	X[1]	
Trichlorfon	X[3]	X[6]	X[11]	X[2]	X[2]		X[2]
Fungicides							
Azoxystrobin					X[2]	X[2]	
Myclobutanil		Probable[6]	X[2]		X[2]		
Propiconazole	Possible[3]	X[6]	X[2]		X[1]	X[1]	
Sulfur						X[1]	
Thiophanate methyl	X[3]	X[1]	X[1]	Suspected[1]	X[1]	X[2]	X[1]
Ziram	Suggestive[3]	Suspected[6]		X[2]	X[2]	X[2]	
Totals:	**16**	**17**	**21**	**14**	**25**	**26**	**12**

**These pesticides are among the top 10 most heavily used pesticides in the home and garden sector from 2006-2007, according to the latest sales and usage data available from EPA (2011), available at http://www.epa.gov/opp00001/pestsales/07pestsales/market_estimates2007.pdf.*
† EPA lists all synthetic pyrethroids under the same category. While all synthetic pyrethroids have similar toxicological profiles, some may be more or less toxic in certain categories than others. See Beyond Pesticides' synthetic pyrethroid fact sheet at bit.ly/TLBuP8 for additional information.
‡ Imidacloprid is a systemic insecticide in the neonicotinoid chemical class, which is linked to bee decline.

Image was adapted from the Beyond Pesticides website.

Appendix 2.

Image adapted from Facebook.com