Golf Course Property Restoration





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Golf Course Landscape and Opportunities for Restoration

Golf courses contain many areas of grass in the form of highly managed turf grass. The managed turf takes away from the natural ecological diversity of a landscape, fragments these areas from the surrounding landscape, takes away wildlife habitat and travel corridors, and can alter the water and soil chemistry and quality of a landscape. Infiltration rates of turf grass are the lowest compared to forest and agricultural fields. This low infiltration rate causes overland runoff, and flooding (Price, 2010).

In my study, I looked at 13 different golf courses in the northwest. Currently, there are 72 golf courses in the Seattle, Tacoma, Everett areas (Golf Link, 2013). There are 39 located in the Bremerton, Kitsap and Olympic Peninsulas and Washington Coast. In Olympia Washington, there are 34 golf courses. This adds up to a total of 145 golf courses in these areas alone. Washington State has 327 golf courses. With an average of over 150 acres per course, this adds up to over 21,750 acres of land that has been removed from natural systems in the Puget Sound area and over 49,000 acres statewide (Golf Link, 2013). These areas are within forests, rivers and streams, wetlands, coastlines, uplands and grasslands. I picked the courses in this study based on type of landscape, ecosystem function alterations, proximity to natural areas, and wildlife populations. In addition to analyzing these courses, I also examined alternatives for restoration.

The landscape that the golf course is in has an influence on the type of restoration activities that may or should be performed. Care has been taken to pick courses that encompass an inclusive array of northwest landscapes. Golf courses chosen represent landscape types, ranging from wetland to highland areas. Emphasis will be on wetland areas. These are among the most valuable ecosystem types. They provide services such as water quality improvement, flood attenuation, ground water recharge, wildlife habitat, and are critical in supporting biodiversity (Mitsch, W. and J. Gosselink, 2007).

A golf course that is in close proximity to natural areas will present the greatest opportunity for restoration and the reconnection of fragmented eco-zones. Therefore, care was taken to select courses that have this characteristic. I used satellite imagery and Google Earth along with my on the ground tours of the landscapes, in my selection process. These remote sensing tools enabled me to get a sense of the overall landscape, and to target restoration areas that have the greatest chance of promoting ecological succession of the areas restored along with the surrounding landscape.

Wildlife habitats and travel corridors are critical to the ecological function of a landscape. Seed dispersal, vegetation control and diversity, and soil and water quality are influenced by wildlife. In some cases, wildlife patterns allow for passive restoration and present a better likelihood of long term success than does manual labor intensive restoration. Wildlife patterns will be looked at, as well as what the wildlife populations are in and surrounding each of the golf courses selected. Restoration techniques will also take into account the hydrology, soil properties, vegetation, wildlife, and topography of the area.

Alternatives for restoration will also take into account the overall experience of the golfer. Natural areas crossing fairways improve ecological function, and also enhance the beauty and character of the course to the golfer. An informal survey of golfers was used to determine key factors of enjoyment. One restoration alternative is to close the golf course and restore the area completely. Two of the courses selected are shutting down and have been, or are in the process of being, purchased with the intent of restoration. This method is the best environmental

alternative, and a review of proposed land use for each of these closed golf courses will be conducted. Converting managed lawns to natural areas will increase biodiversity, reduce pesticide and herbicide treatments and increase areas for wildlife habitat and travel corridors. Complete restoration is not an option in most cases however, since there is a demand for the game of golf, and some areas cannot be restored without affecting business and residential owners in the area. Compromises need to be made that will maximize enjoyment to the golfer and the health of the ecosystem in which they are part of. Ways to accomplish this will be discussed.

The Economic Conditions Influence on the Game

Prior to the recent increased popularity of golf, golf courses were built on high ground. This enabled better draining, runoff to buffer areas was enhanced, and water entered ground water and streams. In the economic boom of the early 1990's up until 2010, many golf courses were built. They were built in conjunction with residential, business and vacation resort property. According to sources in the real estate industry, land is more valuable when close to a golf course (Realtor.com, 2013). These values came from average amounts paid for homes, businesses or vacation packages, when golf course property is involved. Builders worked with golf course architects on the combination of golf courses and property development for sale. This was a successful partnership all over the country, and followed the real estate market boom years. This boom in courses tied in with the real estate markets, and provided a selling point for homes, services, and other business (Realtor.com, 2013).

With this increased popularity, golf courses have been built in all ecosystem types. Courses were built in areas where the land could not support them, such as wetlands and flood zones. Also,

with increased land development downstream and adjacent to golf courses, flooding, erosion and decreased water quality have resulted (Catchpole, 2009, Ladwig, 2011). This is now the case even when courses are built on high ground. Buffer areas are no longer available to detain and breakdown sediment, nutrients and pathogens prior to entering the water table, rivers, streams, and lakes.

Since 2010, however, we are seeing a decline in the popularity of the game. This is due in part to tough economic times. According to the US Golf Association, 107 golf courses around the country closed in 2010. In 2011, 154.5 courses versus only 13.5 opened. That number is expected to go up to between 150 to 180 closures annually versus 20 openings. The year 2012 marked the seventh straight year with more closers than openings, and has been deemed a market correction. This is forcing clubs to reduce costs or increase revenue sources. This, as well as having so many golf courses to play, has caused many golf courses to close down, and many others to begin the process of closing (Holmes, 2013, National Golf Foundation, 2012).

Some Puget Sound area golf courses are partnering with local hotels to offer "stay- and- play" packages. This practice was normally done at vacation resorts where golf courses are the centerpiece of the vacation. Due to reduced demand, this practice is becoming more prevalent in city areas in an attempt to fill tee time slots to at least get some revenue.

Most golf course closures are 9 hole courses, comprising 57% of the total. Non-regulation courses such as executive par 3 courses and the shorter 18 hole courses comprised 26 % of the total (National Golf Foundation, 2012). My interviews with golfers also suggest that an additional reason for these closures is better golf course alternatives elsewhere. These complete

closures serve as the best restoration opportunities, since a complete re connection to the surrounding ecosystem can be made.

Up to now, these closed courses have been converted to cemeteries, sports parks, business and residential developments, or have been restored to natural settings. Unfortunately, return on investment plays a big role in the land use decision. Some landscapes can attract 10 times the revenue that a golf course can produce (Windish, 2013).

Environmental Conditions Influence on the Game

As a consequence of the high demand for the game, many courses were built in areas that made it impossible to keep the course playable, and the resulting conditions have caused the loss of environmental function. Many wetland golf courses are wet or under water for the majority of the year. Keeping these courses playable has resulted in high maintenance costs. Other courses that were built by changing the land to fit the course have failed due to high initial building and continuous maintenance costs involved. The highest success rate for golf course property is when the course is built to incorporate the natural land topography, vegetation and hydrology of the ecosystem it is in.

Another reason for closing is loss of environmental function. I have included one such course in Shelton Washington, a coastal wetland system. Southern California has lost over 70% of coastal wetlands. As a result the flood holding capacity during coastal storm surges and shore bank erosion control functions have been significantly reduced. A 40 year old golf course in Santa Barbara is in the process of being purchased for the purpose of restoration back to wetland, as is the Shelton course discussed in more detail in this study. This will increase the ecological benefits that the area originally provided such as providing a buffer to storm surges and the predicted rise of the sea level, improve water quality, and provide wildlife habitat and corridors between lands to the east and west of the location. Public benefits will include more environmentally protected coast line, and provide educational opportunities for the community (ESRP, 2013).

The combination of economic and environmental factors has proven to be too much for many courses, and they have had to close.

Golf course development/ upkeep/ maintenance

Over the last 20 years, ecological implications have become a major consideration in the design and maintenance efforts on and around the golf course facility. Most golf course superintendents and agronomists are required to have advanced college degrees in the environmental and wildlife sciences. Specialized degree and certification programs aimed at golf course agronomy and horticulture are offered as well (EIFG, 2013, GCSAA, 2013).

Some golf courses use treated waste water and reclaimed water for their irrigation and watering needs. The high nutrient content of this treated waste water reduces the need for chemical fertilizers. This reduces maintenance expense on the golf course, conserves well water and water from nearby rivers, creeks, ponds and lakes. Consequently, wildlife populations and habitat are improved (Addison, 2011). Over- watering the grass lawns on golf courses is an issue. I noticed several golf courses had over watered their fairways over the summer months of 2013. Druids Glen in Covington, WA and Horseshoe Lake in Port Orchard both had areas of soggy fairways during a period of over 30 days of no rain. This practice is done to assure green fairways. There is a very fine line between too much and just enough watering. Since Druids Glen sits in a

wetland environment, it is very difficult to keep the grass green without creating standing areas of water.

Fertilizers, pesticides and fungicides also can cause health issues to wildlife, and to people playing the course (The City of Bloomington, 2013, GCSAA, 2013). These chemicals can get on hands when picking up the golf ball and touching the mouth when eating food without washing. Golf shoes can track in the chemicals when placed in vehicles and when stored in the home. These things are in addition to the runoff into streams and other bodies of water. Although these fertilizers, pesticides and fungicides are tested extensively in order to avoid these dangers, and only qualified personnel are authorized to apply them, their consequences are still a concern. Time of day makes a difference as do the amounts and locations of the application (Stephen Speidel, 2012, GCSAA, 2013). There are records of these chemicals being applied in excessive amounts. This is to keep the golf course appearance looking perfect. A golf course in Lynnwood Washington has been in the news recently for this type of over application, and for using pesticides that are not EPA approved (Robert, 2013).

Sand capping fairways is the practice of applying anywhere from 15 to 30 cm's of sand over the top layer of a poor draining soil. This allows for better infiltration through the sand resulting in a dryer surface to play on. Under the sand, the soil would still collect the water, so piping is laid underneath to divert it to collection areas where it can be recycled around the golf complex for reuse, or delivered to areas where there targeted compounds are broken down, and the treated water re –enters the streams, and rivers. Getting the growing medium just right during the process may necessitate the addition of organic matter to facilitate the growth of healthy grass. The consistency of the sand, as well as thickness throughout the course is an issue. Maintaining natural slopes, rolling of the hills and character of the course all need to be taken into account.

This is a very costly endeavor, and hard to maintain. This can also disrupt ecosystem functioning, if not done correctly. Groundwater recharge activity can be disrupted as well. Having stated these drawbacks, several courses in the northwest area have done this and improved ecological function. This allows for playability improvements during the wet mild winters. It has also been shown to improve ecological processes in disturbed wetland areas (Danneberger, 2013, Miltner, 2013, Scott, 2013).

Different Types of Grasses on Golf Courses

Golf courses require a grass that can withstand heavy traffic and repair quickly.

Bentgrass, *Agrostis palustris* – most common type used for golf courses. It is the preferred grass due to it thick mat like quality. It is best suited to the north east and northwest areas of the United States. It is best for cooler evenings and not too high a temperature (Duble, Bent grass, 2013).

Bermuda grass, *Cynodon* spp.– Most prevalent in the south and can withstand high temperatures and prefers high humidity. Temperatures under 30 degrees Fahrenheit will most likely kill the stem of this grass (Duble, Bermuda grass, 2013).

Annual Blue Grass, *Poa annua*– is the most common on the west coast. It is viewed as an invasive grass in other parts of the country. It has shallow roots, and typically needs to be hand watered. It is good for greens, which require the close shaven, shallow root characteristics.

Zoysiagrass, *Zoysia spp.*– is a good hot weather grass for poor sandy soils can become invasive and a fire hazard.

*Chewing's Fescue, *Festuca rubra commutata* – Found on links style golf courses found in Scotland, and have been incorporated on some coastal/ dune ecosystem golf courses in the

northwest. It is a very durable drought resistant grass requiring the least maintenance of all the grasses found on golf courses (Koski T. , 2012). Once established, it out competes other vegetation. Fescue requires a well-draining soil, and does not grow as quickly as the bent and blue grasses. It also does not repair as quickly from divots taken by golf shots or wear caused by golf carts (Vavrek, 2009).

*Development of sedge lawns – look like regular lawns, but are more in common with native grasses, require minimal mowing, fertilization, or chemicals. They can tolerate wet moist areas, and can thrive in the shade. It has compact growth, a good green color, and most are evergreen. The sedge plant requires less watering then a more conventional golf course grass. Five sedges that have shown excellent promise as substitutes for traditional turf grasses are catlin sedge(*Carex texensis*), Texas Hill Country sedge (*C. perdentata*), Baltimore sedge (*C. senta*), Pennsylvania sedge (*C. pensylvanica*), and California meadow sedge (*C. pansa*). Some varieties of sedge are considered weeds and are not a good fit for golf courses. Care should be taken to choose the optimal species of sedge for fairways, rough, and green complexes (Greenlee, 2001).

* Buffalo Grass *Buchloë dactyloides*– takes a couple years to establish, and does not look as green as other types. It is a perfectly suitable grass for playability however, but is a bit intolerant of shade. It is native to the North American Great Plains and Colorado. It does have a wide range of adaptability. It goes dormant in the colder months, but still playable (Koski T. a., 2013).

Rye Grass, *Lolium* - has a fine texture and is a clumping rather than running grass. This grass must be heavily planted for tight, hole-free turf.

Asterisked grasses are characterized for minimal maintenance, pesticide, and herbicide use. If used in the appropriate environment, they complement the ecosystems they are within (Chi, J.D., 2013).

In my interviews with agronomists and golf course superintendents, the bent grass is the most prevalent in the Pacific Northwest. More research needs to be conducted on the sedge lawn concept, as most seem to be appropriate for the hotter southern United States with a temperature range of 55 - 90 degrees Fahrenheit (FAO, 2013).

Turf-type perennial ryegrasses, fine-leaved fescues, turf-type tall, and bent grasses are welladapted to Western Washington (Shake n Seed, 2013).

Current USGA Projects

The USGA indicates that they have a strong commitment to the environment. Everything from grass used, natural areas incorporated, wildlife protection efforts and water conservation and quality are areas of further study by the USGA (Nelson, 2013). Current projects are aimed at providing the optimal ecological and game playability functions.

A description of these projects and the USGA natural area establishment section are shown in more detail in the appendix section.

Objective of this Study

My common objective with the 13 courses described in this report is to recommend ways of reducing the large areas of managed lawns on the landscape, reduce the effects of the herbicides and pesticides used, and reconnect as much as possible the natural hydrology and native vegetation of North Western Washington's lowland wetlands and forests, urban forested areas, coastal wetlands and grass lands, and the montane ecosystems. I do realize that much of the managed lawn area of golf courses needs to remain intact. This is due to the natural vegetation that compliments the surrounding ecosystems will promote the connection of wildlife habitat and native vegetation of the ecosystem in which these courses are found. If done correctly, this will also enhance the golfer's experience and increase diversity and ecological function of the landscape. According to my interviews of golfers, natural beauty and observation of wildlife are just as important as playability of the golf course.

In the pages that follow, I make suggestions on appropriate vegetation to use, and the placement of that vegetation with the purpose of connection to the surrounding ecosystems and the enhancement of the golfer's experience. Suggestions on pathways for golf carts and foot traffic are made in order to protect the natural vegetation, wildlife corridors and habitat. Also, as the Bayshore Golf Course plan illustrates, areas outside of the golf course may have been disturbed in order to accommodate the course and other residential and business activities that benefit from the land use. Restoration activities performed to minimize these disturbances are looked at.

As part of the design/ modification of golf courses, playability needs to be considered. Managed lawn areas need to be incorporated on all the golf holes. This is to preserve the basic strategy and

integrity of the game. Good golf shots need to be rewarded by hitting the low cut lawn areas. Manicured turf allows the ball to roll, it is seen easier, and to be hit again. The green complexes of golf courses need to be smooth and with a lower cut then the fairways. This is so the ball rolls in the specific direction and speed intended. These green complexes are regarded as the areas that need to be the smoothest surfaces on the golf course.

Care needs to be taken in the design of the course to account for these game playability requirements, and to penalize the bad shots. This is where the native vegetation, creeks and ponds come in. Areas within golf holes, to the sides of holes, and over the greens can be used for connection to surrounding ecosystems. Riparian zones, forested areas, and native taller grasses are just some of the options available depending on ecosystem type. Individual playing abilities also need to be factored in to the placement of these areas. Depending on the skill level of a player, starting locations on each hole can be determined by location and distance to the hazards. Landing zones for good shots will be the determining factor in the positioning of starting points. The higher level skilled players will have longer distances and narrower pathways to the optimal landing zones. The lower the skill level, the easier it will be to hit the optimal landing zones. Golf courses do have these ideas factored into the design. The difference is that these hazards are not developed for ecological health reasons. Since there are so many golf courses that take up significant amounts of acreage, ecological health needs to be a primary consideration.

To conclude my study, I look at how the development of new golf courses can be done by incorporating natural ecosystems. This will include the minimization of lawn area by the planting of native vegetation in golf course boundaries, areas between holes and cutting across holes. Water hazards for wildlife habitat will also minimize lawn areas. It will also add to the golfers

experience by creating character, uniqueness to each hole, aesthetics, and provide wildlife observation opportunities while playing the game.

There are ways to motivate golf course property owners to restore specific parts of golf course property to natural areas. These incentives can be in the form of subsidies from the government, much like farm and agricultural lands. With the increased awareness of ecological function loss nationally, this could have a chance. For this to work, however, the course still needs to be playable. There is a cost to restoration activities other than financial. Costs include loss of playing area, reduction or loss of golf holes, and damage to golf clubs and balls caused by rocky ground. This can result in loss of revenue to the golf course. If these costs take away from the quality of the golf course, then subsidies would not be as effective. Regulations on chemical use and amount of natural area incorporation on golf course property could also be set up. Compliance with these regulations can be verified on a set time frame. Audubon certification has such a program, but it is not a requirement, and not many courses are certified.

Proposed restoration strategies need to factor in enjoyment of the game. Strategically incorporating natural areas into a course design will enhance the golf course making it more appealing to the golfer. This could result in increased green fees being charged to golfers, and possibly more golfers wanting to play. Also, golf courses could serve multiple uses. The Trophy Lake and Casting golf course is an example of that. People are allowed to fish in their ponds (Griebel, 2013). Other examples could be nature and wildlife observation walks around the course boundaries, such as Jackson Park and Chambers Bay. Boardwalks and other pathways could be constructed that complement the golf course, and provide free observation and word of mouth advertising. Other forms of advertising could be that the course is eco - friendly. Educational signs could be posted that highlight the environmental benefits provided, wildlife to

be seen, and environmentally sensitive areas to keep out of. Using golf course property as science labs for students can also provide education and appreciation for our environment (Glendale Country Club, 2013, Newcastle News, 2010). This activity can also be a means of getting grants and subsidies for performing this service, and a way of monitoring ecological function within the golf course property.

Description of Ecosystems and Restoration Activities:

The Northwestern Washington landscape varies from the coast to the mountains. Although some of these landscapes have similar ecosystem characteristics, others do not. An understanding of how a golf course property and a particular ecosystem influence each other is a critical consideration for ecological restoration, preservation, and sustainability. Presented in this section are descriptions of these ecosystem types, restoration alternatives for each, and where the golf courses I studied fit within these systems.

Lowland Wetlands:

Golf Courses studied in this ecosystem: Lake Ballinger, Blue Heron

The Army Corps of Engineers defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Indicators used to determine the presences of a wetland are hydric soils, hydrophytic vegetation, and wetland hydrology.

These wetland characteristics combined with the impermeable nature of manicured lawns, increase the potential for runoff into streams and rivers. Restoration activities around golf

course property in wetland areas of the Northwest should be aimed at slowing down overland water flow by increasing infiltration rates, directing runoff to riparian buffer areas, or increasing interception by above ground canopy. These ecological functions would allow sediments and pathogens to settle out of the water prior to hitting streams and rivers, and increase playability of the course.

Methods to accomplish this would be to build leaky berms, impoundments, install woody debris, and create riparian and buffer zones.

Leaky berms are low dikes that create a blockage of the water flow across the soil surface. A gravel trench through the dike would allow water to trickle out slowly. On golf courses, there can be hills and mounds that act to serve this purpose, and also to create variation of terrain to enhance the golfer's experience. These slopes and hills will also serve to create drier areas on the golf course which will improve playability. Additional berms can also be placed down the line of water flow for further blockage. This technique can be accomplished by installing gravel mounds with soil and grass on the top layer. Water flow is reduced, pathogens from fertilizers and excess nutrients and sediments are filtered out, and the filtered water runs into the surrounding waterways. Erosion and flooding potential will also be reduced with this technique, as overland water flow detention prevents hillside deterioration and stops large amounts of flowing water from hitting water ways too quickly.

Impoundments of water can be created by using hills and slopes to divert water into collection areas. Collected water can be stored, reused, or diverted to areas needed. Examples of impoundments would be underground tanks and pipes that use gravity to move the water to buffer zones where water is slowed and filtered before entering the creek and river systems

surrounding and within golf complexes. This stored water can also be used for irrigation or it may be recirculated to create man- made water hazards. Waterfalls can be created to enhance beauty, function, and wildlife habitats and corridors as well. These hazards will be more natural in the wet months, and can also be sustained in drought conditions using reclaimed water.

Sand capping fairways was discussed in an earlier section of this report. This will improve infiltration and allow for the control and direction of excess water.

Care is needed when creating or restoring a wetland area. Sand capping and creating mounds and slopes to facilitate hydrological processes involves the addition of organic matter to the sand. Organic matter allows nutrient cycling and development of nutrient pools, which will then support root growth (USGS, 2008). Other factors to take into account are oxygen level in the soil and how thick of a layer of sand. If not done correctly, more ecological disturbance can be caused, and lawn areas will not survive. Invasive seed and insects in the sand piles, low organic matter, poor drainage underneath the sand, or ventilation issues can promote disease and invasive plant species growth (Reichard, 2012). Also, this practice can be costly, and maintenance can be challenging if the initial implementation is not carried out (Danneberger, 2013).

For both the leaky berm and impoundment techniques, use of the natural terrain should go into the original design of golf courses to allow for these functions.

Woody debris is a critical component of rivers and streams. This debris allows for the slowing of water, creation of wildlife habitat, and vegetative seed dispersal. Meandering characteristics of streams and rivers are also enhanced by the installment of large woody debris. The ecological benefits are similar to those of leaky berms in terms of sediment removal, and water quality improvements. In the wet months this woody debris serves to minimize erosion downstream,

creation of pools, and areas of vegetative growth. In the dry months, habitat areas are created, as well as shade and to crowd out invasive species development (Naimon, 2012). Woody debris can be set up in the water hazard areas and will add to the character of the golf course. My interviews with golfers confirm that this is the case. Descriptive signage throughout golf course property has also proven to educate the golfer and instill an appreciation for this added diversity (Skorulski, D. et al. 2006).

Emergent vegetation is comprised of wetland plants that have leaves and stems above the water surface. It provides nesting areas, food, and cover for fish and wildlife communities. They also provide oxygen and remove carbon dioxide from water systems (DES, 2010). My interviews with golfers confirm that this ecological benefit adds to the golfing experience through wildlife observation, better water quality, and increased vegetative diversity.

Aquatic plants are rooted below the water surface and extend out of the water. They cannot be planted during the wet months, but can be planted in the drought season when wetland water levels are low. They can be planted underneath woody debris, behind rocks, or other secure areas. For the man-made bodies of water that are fed by water from detention tanks, planting periods can be controlled. Enabling this emergent vegetation to receive adequate moisture and submersion is critical to the survival of the species (Mitsch, W. and J. Gosselink, 2007). Therefore, activity should be conducted in conjunction with the leaky berm, impoundments and woody debris techniques in order to create this environment.

Buffer areas occur around the edges of wetlands and streams, and are also around areas of valuable habitat. They are critical to a functioning wetland system, filtering out sediments and pathogens prior to entering the streams and rivers. They also add beauty and diversity to a

landscape. Buffer area vegetation should be installed on shore banks, and other areas where runoff collects. Preferably, they should be areas that are left natural when initially building a golf course. If this is not the case, buffer areas can be constructed. Reduction of managed lawn areas, especially in a wetland environment, will improve ecological function and character improvement for a golf course. Natural areas cutting across and in between fairways will reduce maintenance expense and provide wildlife habitat corridors as well.

With any restoration project, interpretive signage needs to be displayed and it must instruct golfers to keep out of sensitive areas. Educational/ descriptive signage should be there as well.

Lowland Forest:

Golf Courses studied in this ecosystem: Horseshoe Lake, Trophy Lake, Druids Glen, Washington National, Gold Mountain.

In most cases, lowland forests are in the same ecosystems as wetland areas. Several of the golf courses described in this report have both elements. Restoration techniques for lowland forest systems will have effects on the wetland systems down the line.

Edge features and corridor restoration require the establishment of natural areas that cut across fairways and connect to the forest edges on the sides of the fairways. Good edge species will also crowd out invasive plant development, and spread along the edge habitats. Salmonberry, *Rubus spectabilis,* snowberry, *Symphoricarposalbus,* red -osier dogwood, *Cornus sericea,* and pacific ninebark, *Physocarpus capitatus* are all good corridor species that do not get taller than about 12 feet high. They can be planted through fairways and not impede shots to greens. These areas will serve as wildlife corridors and vegetation pathways to re-connect fragmented areas. Edge features need to be established since golf courses do fragment/ isolate

forest systems, leaving small patches/ islands susceptible to invasive species penetration. A selection of native species that can establish and spread throughout the golf course is the goal. Also, creating mounds and hills to compliment the vegetation will reduce the runoff effects from the managed lawns. The goal here is to reduce the edge effect for fragmentation. Forest fragmentation is one of the greatest threats to biodiversity in forests (Beirregaard, 2001). Edge effects that alter the outer edge of the forest can permeate the inner forest area, and greatly reduce the inner forest composition and habitat quality (Harris, 1984). Several of the golf courses I visited had invasive plant populations on the forest edge. Further into the forest, it was not as bad. In the golf course description sections that follow, I mentioned the degree of infestation and maintenance needed.

Habitat structures such as bat boxes can be placed within forest areas. These bats can eat invasive insects from managed lawn areas. Downed woody debris and snags can be placed close to forest edges as a barrier to entry, and as places for seed to collect. Bird boxes are another idea that will help attract wildlife and perpetuate seed dispersal.

Ecotonal vegetation is the vegetation in the transition zone between two different plant communities, such as forest and grasslands (Smith, 2000). The key strategy for this vegetation is to crowd/ shade out invasive plant species from developing and spreading to the inner forest. Since managed lawns are fertilized, and have low infiltration rates, the propensity for invasive species spread can be quite high. A good species to make a less dramatic transition would be tall fescue, *Festuca arundinacea* and some native shrubs. These can be planted near the edges in much the same manner as edge feature and corridor restoration. Maintenance and monitoring activity is needed, and some courses do better jobs than others.

Protection from the elements In addition to the beauty, character, and ecological function, trees provide shade and shelter from wind. This keeps the golfer cooler in the summer months and warmer with less wind in the winter. On hot days during summer, a good golf alternative is to play a course with ample shade. This also provides protection from wind, and be a good golf alternative rather than a wide open course. Wide open courses do have their place, when not too hot and windy. Creating shelter from the elements is also important for wildlife and vegetation. This is to reduce the threat of some invasive plant species that thrive in open exposed sites, and to give the native vegetation a chance to develop and fill in an area.

Coastal Grassland -

Golf Course studied in this ecosystem: Chambers Bay Golf Course

Golf courses within a coastal grass land are similar to those that existed where the game of golf began. The soils in such an environment are typically sandy and drain well. As discussed in the golf course examples section, this area is between the ocean and the more productive agricultural lands. Golf courses were originally built there since nothing else could be done with such landscapes at the time.

Links style golf courses that exist in Scotland, and in some parts of the U.S., are only ecologically beneficial in a landscape that they are suited to. These areas would be along coast lines that include sand dunes, fine fescue, *Festuca rubra ssp. Commutate* and tall fescue, *Festuca arundinacea* with no trees (Vavrek, 2009). The soil is sandy with little vegetation other than tall sea grasses and gorse. They were originally designed that way due to lack of machinery to shape a course. They were built within the existing ecological environment, using the native vegetation and naturally occurring conditions. The bunkers were natural wind- swept dunes. This made for much less disturbance of the area.

This coastal grassland acts as a buffer that filters runoff before it enters the ocean. It also provides critical habitat for vertebrate and invertebrate species, particularly birds (Metzler K.J., 2006). Another important ecological function that it provides is to store carbon and can help offset carbon dioxide emissions that drive global warming (U.S. Fish and Wildlife Service, 2011, Brilman, 2013). These grasslands are also important for maintaining hydrological and nutrient cycling services for both terrestrial and aquatic ecosystems. The preservation and restoration of these systems is critical as global climate change continues. As shorelines decrease due to rising sea levels, these systems will continue to provide a buffer to the upland areas. They have been lost, however, due to changes in land use, being converted to primarily to agriculture and to residential uses. This transformation has resulted in the production of excess sediment and pathogens, threatening the aquatic and marine systems down slope (U.S. Fish and Wildlife Service, 2011).

Ground habitat in this system is associated with the bunchgrasses that are native to the system. Bunchgrasses provide nesting habitat, foraging, and hiding spaces for insects, birds and small mammals. They also provide stabilization, nutrients and organic matter to the sandy soils (PNNL, 2013). As mentioned in my coastal golf course examples, native fescue, wildflowers, and bunchgrasses provide ecosystem function and character to the golf course. It is the one system that requires the least maintenance and is the most self- sustaining. Invasive species are naturally crowded out by the native vegetation once established.

Micro- topography is an issue when creating these ecosystems as well. Getting the texture, porosity, organic matter and oxygen levels to correct levels can be challenging (Danneberger, 2013).

Coastal Wetland -

Golf course studied in this ecosystem – Shelton Bay Shore Golf Course

Coastal Wetlands are some of the most valuable ecosystems in the country. This ecosystem consists of biologically sensitive and culturally significant estuary, near shore, and riparian habitat. It is also critical to shoreline stabilization, storm abatement, and water quality functions. These systems are home to hundreds of birds, fish, and other terrestrial and aquatic wildlife. Diking of flood plains and marshes has had significant effects on ecological processes and wildlife (ESRP, 2013). These systems have been deemed to have the highest habitat values and are critical to ecological processes encompassing other ecosystems. Tidal flow, nutrient cycling and other functions permeate through the northwest (Environmental Science Associates, 2012, Brennan, 2013, Tanner, 2012).

Buffers in these systems are critical to the functioning of this coastal wetland area. They provide the cleansing of runoff prior to contact with marine ecosystems and are home to a diverse set of vegetation and wildlife (Tanner, 2012).

Golf course property restoration activities that are the most critical are restoring the natural tidal inundation by removing dikes and planting salt tolerant vegetation. Riparian vegetation would be planted to create a closed canopy and multi layered understory to allow for diversity, wildlife habitat, and crowding out invasive species (Tanner, 2012).

Golf Courses built in such areas need to take into consideration the natural flow and tidal activity of an area. If built far enough away, the course can provide ecological and golf course patron benefits.

Montane Forested Systems:

Golf Course complex studied in this ecosystem: Suncadia Resort

The montane forested ecosystem in Washington State ranges from elevations of 1,500 to 3,000 feet above sea level. In other areas of the Cascade and Olympic Mountains, this range is up to 5,700 feet above sea level. Plants in this ecosystem experience a short growing season due to the dark and cold winters (WNPS, 2013).

This system is characterized by low nutrient soils, hard rock and tough growing conditions. Mountain vegetation is hardy and spectacular in beauty and diversity. The soil is thin, the growing season is short, and the system is slow to respond to disturbance. These systems affect climate, water, soil, nutrient, pollination, and habitat that filter down to all the other ecosystem types. Changes and disturbances to these systems can have a substantial ripple effect. Vegetation plays a key role in the barrier effect that impedes the movement of airborne substances such as dust and aerosols, enhances air mixing and mitigates noise (SEQ, 2013). The removal of such vegetation for large areas of manicured lawns can disrupt these functions, and have a ripple effect down to other ecosystems.

In restoration of these functions, as well as wildlife habitat, natural areas need to be incorporated into the golf course design, or renovation activities. Edge protection is an issue, due to the large amounts of managed lawn areas that fragment the landscape. By incorporating hills and mounds on the sides, and due to the well –draining, low nutrient mountain soils, protection of edge

species can be achieved. Also, these edge areas need to be marked by signage as sensitive areas. Access to these areas need to be prohibited. The signage should explain why. Edge species to consider should be both for ecological value, and act as a barrier to entry. A thorny bushy species such as Nootka Rose, *Rosa nutkana* should be considered.

Buffer construction in such an environment is vital due to the sensitivity of this ecosystem. Although a hardy system, trampling by feet, and runoff of chemicals can cause long term disturbance. Rosa nutkana can also act as a buffer zone, contributing to soil stability and water quality. Natural areas crossing fairways will serve as habitat corridors and buffer areas as well. Erosion control, water quality protection, flood attenuation, and storm abatement can also be provided by these natural area dissections, and edge protection strategies. My interviews with golfers indicate that these activities, along with interpretive signage will add to the character and beauty of a montane ecosystem golf course.

Urban Forested Systems-

Golf Course studied in this ecosystem: Jackson Park, Newcastle

Urban forests, being in the middle of residential, business, and roadway developments, are susceptible to numerous disturbances. Runoff from pavement and other impervious surfaces threatens water quality, storm abatement, and flood attenuation functions. Encroachment on wildlife habitat and travel corridors is also an issue.

Land use changes in these urban areas, clearing of native vegetation, and contamination of soils by weed seeds have caused invasive plant species dominance, and the crowding out of the native plant species in these areas. Golf courses in these areas present opportunities to re connect fragmented areas. The large green areas present opportunities to create a natural environment to play golf, observe wildlife, and enjoy the native vegetation. Community involvement in the development of these areas, along with paths for the public to walk around, can foster ownership and pride in the environment. Corridors between fairways can be used to connect fragmented pieces of forested areas. Native plant species should be planted along the sides, and in the middle dissections of the golf course property. These plantings can be spread via wildlife, wind, and water and shade and crowd out invasive species re growth.

Buffer areas along the sides of the golf course can mitigate the entrance of pathogens from street runoff prior to entering the course property. These buffer areas can also provide beauty and diversity along with ecological function. They can be public natural gardens along the course boundaries. These gardens can also represent barriers to entry and protection from errant golf shots, along public walkways. Interpretive signage should be displayed as well in order to foster appreciation of these features.

Incorporated within the course property natural areas and habitat corridors should be habitat features such as bird and bat perches, downed woody debris, snags, water collection areas and topography variation. These will provide nesting and foraging areas for wildlife. Downed woody debris provides shelter from predators as well as habitat, thermal protection, and areas for seed to plant. This woody debris often falls off of dead trees called snags. Snags, also called wildlife trees are standing dead trees that provide nests, shelter, nurseries, storage areas, foraging, roosting and perching areas for birds and small mammals. These snags are sometimes more important to wildlife then a live tree. Snags can be created when signs indicate that a tree is about to die. Portions of the tree can be cut to prevent it from falling on houses, to add woody

debris, or to plant additional snags elsewhere. Too often these dead trees are cut down and removed from the landscape, and the wildlife potential is lost (Washington Department of Fish and Wildlife, 2013).

Wild life sanctuaries can be created on golf course property and in back yards of housing along golf course property. These can be bird baths, bird houses, bird feeders, snags, and garden ponds. Domestic pets such as cats and dogs need to be controlled in order to protect this sanctuary (Washington Department of Fish and Wildlife, 2013). As mentioned throughout this report, some golf courses are Audubon Certified wildlife sanctuary areas. Only 12 Washington State golf courses are however (Audubon International, 2013).

Butterflies and other flying pollinators can be attracted to golf course property and residential yards. Creating a butterfly garden with nectar producing single flowered species has proven to be the best choice for attracting these flying pollinators. A variety of shrubs, flowers, trees and ground cover should also be used to account for all stages of the butterfly's life cycle (Washington Department of Fish and Wildlife , 2013). A list of plant species to choose from is included in appendix A of this report.

Depth of rough along the fairway edge can also play a role as a buffer prior to runoff hitting forest edges. This rough should be a native grass or sedge species. Tall fescue, *Festuca arundinacea*, along with bull rushes for the wetland areas within urban forested systems, could be used to act as buffer areas and provide character to the golf course.

Interviews Conducted

In order to get a better understanding of golf course maintenance and development I interviewed four golf course superintendents, one agronomist, one horticulturalist, two architects, and five pro shop staff members and city and county personnel. The names and titles of these employees are listed in appendix B. The questions that I administered to each of these groups are listed below, and are incorporated within my individual golf courses analyzed in the examples of regional courses section.

Questions asked of golf course staff:

- 1. What types of grasses are used on the golf course?
- 2. What other types of vegetation are on the course property?
- 3. What invasive plant species do you deal with?
- 4. What are your fertilizer and pesticide use procedures, and how does that usage affect waterways nearby?
- 5. Where do you get water for irrigation needs and for the water hazards on the course?
- 6. What wild life us the course property for habitat and travel corridors?
- 7. If natural areas are within the golf course boundaries, how does the property usage affect these areas, and how do maintenance efforts change with the natural area component?
- 8. If there are renovation efforts scheduled for the course, and do you plan on having natural areas included as part of the playing area of the golf course?
- 9. What issues do you run into in terms of golfer expectations for golf course condition?
- 10. For your club house, entrance, and banquet facilities, how does vegetation type differ from the golf course playing areas?

I was not able to reach golf course personnel at all of the locations I visited. Those that I did reach are listed in Appendix B.

Questions asked of golfers

For the perception of golf course layouts and enjoyment, I interviewed five to seven golfers at each of the courses I visited. My interviews with people playing golf were informal, and no names were taken. They were conducted on the golf grounds while playing the game, just before, or just after. All of these individuals showed interest in my project. A summary of responses are provided after each of the questions below.

1. What factors enhance the enjoyment of a game of golf?

The majority of those interviewed indicated that golf course condition and beauty of the surrounding landscape are the most important factors. Other factors mentioned were the people that they are playing with, how long it takes to play a round, and weather conditions influence enjoyment of the game.

2. What makes you like one course over another?

The most popular responses to this question were value for the money and being out in nature. Challenge and difficulty were also indicated as important factors for choosing one golf course over another. Three quarters of those interviewed prefer an 18 hole par 72 golf course over the nine hole and shorter 18 hole varieties. Their reasons were because the 18 hole courses provided more variety and challenge. 3. What are your views of wildlife sightings while playing the game?

All of those interviewed enjoy wildlife observation on the golf course, provided that this wildlife does not present danger to the golfer, or interfere with golf shots. Other responses to this question were in regards to animal waste. Several golfers indicated that duck and geese feces are a problem at some golf courses. Golfers indicated that deer and elk observation provided the most enjoyment.

4. How do you feel about the uniqueness of golf holes within a golf course?

All golfers interviewed expressed that uniqueness of individual golf holes is important. Where some answers varied was in how the golf holes are unique. Some golfers prefer views from the golf course, and others prefer how the golf holes differ on the landscape.

5. How do you define character of a golf hole, and a golf course?

Golfers indicated that character is comprised of beauty and uniqueness of golf holes and the surrounding landscape. Also indicated was that wildlife sighting provides character to a course. Two thirds of those interviewed indicated that a golf course that looks like it is part of the natural setting is an important factor in defining character of the golf course as a whole. These individuals also indicated that variation of landscape type within the course provides character.

6. In terms of expectations of golf course condition, what areas of the golf course need to be the best maintained?

All of the golfers interviewed indicated that fairways and greens are the most important areas to be maintained.

7. If there was interpretive signage around a course explaining wildlife and ecological processes, would that enhance the golf experience, and/or modify expectations of upkeep and maintenance?

All of the golfers interviewed indicated that interpretive and descriptive signage would add to the enjoyment of the game. Expectations of perfection would be lowered as long as the greens are smooth and no rocks are in the fairway turf grass.

Examples of Regional Courses

A review of 13 golf courses in the Pacific Northwest area was conducted as part of this research. For some of these courses, I have interviewed patrons, golf course agronomy and superintendent personnel, architects, and city and county personnel. For others, I have reviewed documents and course layouts. I have visited each of these courses and have played most of them. For each course summarized, I indicated who I interviewed and how I gathered my information. Also indicated for each golf course, were the ecosystem within, and the specific restoration/ renovation activities that would improve ecological function and enhance the golfer's experience.

For further information on ecosystem description and general restoration techniques for golf courses in those ecosystems, please refer to the description of ecosystems and restoration activities section.

Full Restoration of Closed Golf Courses



Shelton Bayshore Golf Club

Mapquest satellite photo, retrieved from http://www.mapquest.com/maps#a021f2504947a257506b840d, accessed on April 10, 2013

The satellite image above shows Bayshore Golf Club, the marine shoreline to the south, and salt marsh to the west. St Johns creeks can be seen splitting the marsh and shoreline. This visual makes it apparent how easy it is for sediments, nutrients and pathogens to runoff directly into these critical areas as overland flow.

This golf course is located in Shelton Washington in Mason County. It is a nine hole course located within Oakland Bay in the South Puget Sound Sub-basin. The course is currently open, but is scheduled to be purchased by Capital Land Trust and converted to a natural area.
Restoration is scheduled to begin in the summer of 2014 (Guthrie, 2013). Full restoration encompasses 121 acres. A review of the restoration plan has been forwarded to me (Tanner, 2012, ESRP, 2013). These documents show a thorough site assessment and restoration plan that takes into account the ecosystem type. The plan serves as an example of how to restore not only the golf course area, but also the surrounding areas that were affected by the golf course and residential property around it. The plan also serves to point out that a golf course property has far reaching environmental implications.

The Shelton Bayshore Golf Course property, an adjacent salt marsh to the west, and associated tidelands to the south are all in the process of being purchased by Capital Land Trust and Squaxin Indian tribe. Their proposal is to acquire, restore, and permanently protect 74 acres of biologically sensitive and culturally significant estuary, near shore, and riparian habitat on the vestigial alluvial fan/ stream delta of Johns Creek, which discharges into Oakland bay, in Mason County. Included on the site is a key stretch of marine shoreline with remnant dendritic channels and emergent salt marsh, as well as the mouth and lower part of Johns Creek, all of which provide important fish and wildlife habitat. Dikes in the area will be removed, reestablishing the tidal inundation and near shore function. Also proposed for restoration is the 47 acre golf course to a native estuarine marsh, oligonaline transition wetlands, tidal freshwater wetlands, and forested buffer. The whole project restoration total is 121 acres and is contingent on the acquisition of residential property in these areas. Two hundred fifty acres of nearby property has already been restored, and this effort will further the overall goal of restoring the entire Oakland Bay watershed. This project involves the continued partnerships between Washington Department of Ecology, US Fish and Wildlife Service, Taylor Shellfish Farms, Mason

Conservation District, Mason County, the Salmon Recovery Funding Board and The Trust for Public Land.

The reports go further to explain how this site is critical habitat for hundreds of bird and aquatic species, and for the provision of clean water. Also discussed are the trends of increased residential and commercial land use, and the implications and degradation caused by this activity. The golf course has also added to the degradation, adding over 1,275 pounds of nitrogen into Oakland Bay annually from fertilizer use. Pesticide use is 4 to 7 times higher on a pound per acre basis then that used in agriculture. Johns Creek fails to meet in stream flow requirements, due to high water usage for the commercial, residential, and golf course uses. This has caused a reduction of salmon spawning, infringement of wild life habitat and corridors. The area that the golf course is on was originally a heavily forested area and salt marsh. The restoration of this area has been deemed critical to restoring the sites natural resiliency to climate change, allowing the salt marsh to migrate inland with sea level rise and buffer storm surges from upland infrastructure. If restoration were not to occur, sea level rise would likely outpace the rate of sedimentation of the salt marsh, thus destroying wildlife habitat by clogging the gills of fish and invertebrates. Contaminants from urban and rural areas binding to sediment and washing into waterways unfiltered (Brennan, 2013). The ecosystem services provided by coastal wetland systems such as water quality improvements, flood attenuation and erosion control would also be compromised. Dikes have been constructed to divert fresh water around the shellfish beds and to prevent tidal flooding of the golf course. The dikes inhibit the free flow of tidal and fresh water across the estuary and the natural movement of sediment responsible for maintaining estuary habitats. Restoration of the John's Creek estuary would involve removing dikes, planting native vegetation, and conserving the salt marsh habitat (Brennan, 2013).

The proposal also discussed passive recreational activities and public support for restoration, which are important for ecological succession, and continued passive restoration. Educating the public on ecosystem services provided, and how to enjoy and appreciate a healthy ecosystem will provide more assurance of continued restoration efforts.

The restoration area is comprised of a lowland western hemlock forest and a coastal tidal marsh. Restoration of the forest area will be a long term endeavor do to the slow growth of tree species. Restoration of the marsh area will take less time due to salt marsh and estuary vegetation growth rates. Puget Sound lowland vegetation is generally classified in the Western Hemlock, or Western Hemlock/ Sword Fern Zone. This is due to the dominant canopy of the Western hemlock, and the forest floor dominated by Sword Fern. The late successional phase of the Puget Sound lowlands is a dense conifer forest of Western Hemlock/ Western Red Cedar climax communities. Large woody debris will be installed within the estuarine and oceanic habitats to provide potential roosting, nesting, refuge and foraging opportunities for wildlife; foraging and refuge and spawning substrate for fish and aquatic invertebrates. Logs high in the intertidal zone may become imbedded and form beach berms and the eventual establishment of beach vegetation. Vegetation planted will establish riparian buffer zones through canopy interception, build absorbent soils with their litter, bind soils with their root structure, and retain moisture. Erosion control, maintenance of water quality, storm abatement, and flood attenuation ecosystem functions will be restored and self- sustaining once the riparian vegetation is established. Microclimate features are also created for the aquatic fish and wildlife with protection from the elements and shade (ESRP, 2013, Environmental Science Associates, 2012, Brennan, 2013).

Salt marshes are among the most productive ecosystems on earth (Wener, 2010). In eleven major Puget Sound estuaries, only 52 percent of the original salt marsh and mudflat habitat

remains. In urban areas such as Seattle and Tacoma, the loss of salt marsh habitat is close to 100 percent. Along Puget Sound, a few estuaries are protected as refuges; Skagit Bay, Nisqually Delta, and Padilla Bay (Department of Ecology, 2013).

The plant species list below includes some of the more common species found in marine riparian areas. This list came directly from the Brennan report for this restoration project.

Western hemlock, Tsuga heterophylla

Douglas fir, Pseudotsuga menziesii

Western red cedar, Thuja plicata

Pacific madrone, Arbutus menziesii

Bigleaf maple, Acer macrophyllum

Vine maple, *Acer circinatum*

Red alder, Alnus rubra

Salal, Gaultheria shallon

Oceanspray, Holodiscus discolor

Oregon grape, Mahonia spp.

Indian plum, Oemleria cerasiformis

Salmonberry, Rubus spectabilis

Snowberry, Symphoricarpos spp.

Sword fern, Polystichum munitum

Huckleberry, Vaccinium spp.

Nootka rose, Rosa nutkana

Below are the Salt tolerant species listed by (Brennan, 2013), that are typically associated with salt marsh, beach strand, or other wetlands. The report did not go into salinity levels appropriate for low salinity salt marshes. A plant species with too high a salinity level is not a good choice for low salinity areas.

Gumweed, Grindellia integrifolia

Saltweed, Atriplex patula

Saltgrass, Distichlis spicata

Pickleweed, Salicornia virginica

Fleshy jaumea, Jaumea carnosa

Seaside arrowgrass, Triglochin maritimum

Seaside plantain, Plantago maritima

Dune wildrye, Elymus mollis

(ESRP, 2013, Environmental Science Associates, 2012, Tanner, 2012, Brennan, 2013)

Another source did confirm the presence of these salt marsh species on the Puget Sound shoreline. In the intertidal zone, they are pickleweed, *Salicornia virginica*, sand spurry, *Spergularia macrotheca* and arrowgrass, *Triglochin maritimum*. Higher up the beach are

gumweed, *Grindellia integrifolia* and salt grass, *Distichlis spicata* (Department of Ecology, 2013).

Other salt marsh vegetation to consider for this site would be saltmarsh bulrush, *Scirpus robustus*, big cordgrass, *Spartina cynosuroides*, black needlerush, *Juncus roemerianus*, and saltmarsh or smooth cordgrass, *Spartina alterniflora* (VIMS, 2013).

The subjects discussed in the Shelton Bayshore Golf Course Restoration proposal are useful in the analysis of restoration alternatives for partial restoration of other golf courses in coastal wetland ecosystems that are still in operation.

Ballinger Lake Golf Course



Mapquest satellite photo, retrieved from <u>http://www.mapquest.com/maps#c4cfa8272cd12743abbf4ff3</u>, *accessed on April 10, 2013*.

The satellite photo above shows the golf course, lake, residential and business development in the area. It is virtually surrounded by impervious lawn areas that runoff into the lake.

Located in Mountlake Terrace Washington, Ballinger Lake Golf course is closed and is being scheduled for restoration to a natural area as well, and it is also a 9 hole course.

Nine hole courses face stiff competition from the many golf courses available to golfers. My interviews with golfers indicate that most golfers prefer an 18 hole course, and these nine hole courses suffer as a result. As stated in the economic influence section of this report, 57% of closures were nine hole facilities (National Golf Foundation, 2012). Though these nine hole

courses are only half the size of the 18 hole layouts, they do present the greatest chance for complete restoration to natural areas, and re- connecting fragmented landscapes.

As discussed earlier, this course has been closed, and the property will be converted to a natural area/ passive park. This area sits next to a lake in Mountlake Terrace and has been used as a golf course for more than 50 years. The natural condition of this was a wetland basin and shoreline area (Khan, 2013). This characteristic has always been a factor effecting playability of the course. During the rainy months, the course was permanently damp and swampy, making it very difficult to maintain. The course was renovated in 1999 with substantial alterations made to mitigate for this condition. These alterations did not help and the improvements made were did not account for the wetland characteristics of the land. Runoff issues are a major reason for the soggy, swamp like conditions of this course. Residential and business dwellings surround the lake. Lake Ballinger receives considerable storm water runoff during rain events, primarily from the urban areas of Lynnwood, Edmonds, Mountlake Terrace and northern King County. The lake has been a popular spot for boating and fishing. It has been listed on Washington State's 303(d) list for failing to meet the U.S. Environmental Protection Agency human health criteria for total phosphorus and is classified as a eutrophic lake. The runoff from urban use described above has added to this condition. Eutrophication may occur naturally as a lake ages, due to sediment, nutrients, and silt added over time. Human use has accelerated this process, known as cultural eutrophication, caused by fertilizer runoff and sewage discharge (USGS, 2013). The impervious surfaces of concrete and managed lawns create overland flow into the lake. These excessive nutrient inputs have fueled the growth of algae and other vegetation that make it unsuitable for human use, or viewing enjoyment. Aquatic habitat is impacted as well, as oxygen demand at the bottom of the lake has been increased while extremely low levels of dissolved oxygen levels

exist (Mountlake Terrace, 2012). The input into Lake Ballinger is Hall Creek, with storm water outlets contributing to the remaining inflow. There is one outlet into McAleer Creek, which drains to Lake Washington.

As part of the City of Mountlake Terrace Shoreline Master Program Update Final Restoration plan, December 2012, to the Washington State Department of Ecology, impairments are listed. At the watershed and lake scale, loss or disturbance of wetlands in the basin eliminates essential storage, recharge, and water quality improvement functions. The increased impervious surfaces carry pollutants to the lake, decreasing water quality. The loss of sub -surface flows and basin storage has resulted in a change in the timing of peak storm water flows. This has caused flashier system with higher peak volumes (Halvorson, 2013, Mountlake Terrace, 2012). Flooding of lakeshore properties and downstream areas has occurred. This is in addition to the water quality impairment caused by the maintenance of residential landscaping and the golf course contributing excessive nitrates, phosphorus, and pesticides and herbicides to the lake. The native aquatic vegetation populations have been threatened due in part to the removal by residential and recreational property owners surrounding the lake. The loss of woody vegetation along the shoreline and streamside riparian zone impacts near shore shading, large woody debris recruitment, and riparian wildlife habitat. Invasive plant species have taken hold of these areas as well, adding to the ecological degradation. Docks and other hard shore armoring disrupt the natural connections between the lake and riparian habitats. These events have impaired water quality, biological, aquatic vegetation, hydrologic, hyporheic and riparian habitat ecological functions.

The city of Mountlake Terrace does have several restoration projects underway to mitigate these disturbances. The most recent of these does include the golf course, and the plan is in the

development stage. Restoring woody vegetation to the shoreline, that the golf course is next to, will provide some buffer prior to runoff into the lake. Restoration of that part of the golf course back to a basin will allow for groundwater recharge and basin storage. This will improve the flood attenuation properties, water quality, and wildlife habitat. Restoration activities in this area will have ecological successional effects downstream, by way of the flow patterns described earlier. Adding the complete restoration of the golf course area will allow for reconnection of the shoreline, riparian areas, and connecting streams and fit in with the existing restoration plan. These restoration goals will also improve passive recreational activities and the boating, swimming and fishing activities as well.

In the course of my study of this golf course property, I attended public meetings. These meetings occurred on June 11, July 9, August 12, and the next one scheduled for September 10, 2013.

The conversion of the previous golf course property to a passive park was the subject of two public meetings held at the old club house on the property. The property is not in use. The only activity currently is mowing of the grasses to prevent the spread of invasive plant species. The down side of that is that geese frequent the area. If there is no mowing, and the grasses grew higher, then the geese would have gone elsewhere. There is no more irrigation or fertilization activity. The grassy area was still green on July 8, even after no rain or irrigation in over a month. This is typical of wetland areas. In the first meeting, held on 6/11/13, the site history, operational issues, and ecological disturbance issues were discussed. A tour of the land was also conducted. The second half of the meeting was a brainstorming session on what activities and functions are desired for this site (Council, Public Meeting, 2013). Many ideas were presented, and were the topic of the second public meeting held on 7/9/13.

The most popular choices were discussed and are as follows:

- 1. Board Walk/ trail system with interpretive signage
- 2. Pea Patch gardens
- 3. Wetland area: allow the creeks to meander naturally and re connect to the waterways.
- 4. Rain gardens
- 5. Invasive control and re-plant native wetland species
- 6. Farmers Market
- 7. Dog park
- 8. Picnic tables, kayaking, docks for fishing
- 9. Café/ Restaurant
- 10. Use of goats for maintenance/ low maintenance
- 11. Use of volunteers for re planting and maintenance
- 12. Wildlife observation activities/ sanctuary
- 13. Fencing around perimeters
- 14. Keep natural buffer zones around streams and lake to stabilize banks, water quality enhancement and to prevent access.
- 15. Senior Center
- 16. No overnight camping or homeless populations.

The meetings concluded with these top ideas in mind. The main thing that is to be done is control the spread of invasives, and to restore the wetland ecosystem function in the area. Some of the ideas could be implemented within a month, with others needing city approval. Boardwalks and trails will take time, study of high flood zones, and prevention of access until these longer term goals are reached. After the discussion of these ideas, we took another tour of the area. During this tour we looked at potential hazards, flooding zones, vegetation, and feasibility of ideas. Shoreline and erosion control issues were also discussed. Short term things we can do right away versus long term goals that need approval and coordination with other departments were discussed. Interpretive signage directing people to stay on trails, to respect the wetland areas and wildlife, to educating the public on ecological functioning, and to delineate boundaries are all issues to get the community support on (Shaw M. , 2013).

Wildlife occurring on the site includes Canadian Geese, Mallard Ducks, American Coots, Killdeer, re-wing black birds, barn swallows, tree swallows, hummingbirds, great blue heron, turtles, otters, bass, trout, and salmon stocked by WDFW(Halvorson, 2013, Council, City Council Public Meeting, 2013).

Nutria concerns were discussed (Council, City Council Public Meeting, 2013). This is a rodent that can get to over 10 pounds, and has damaged wetland areas in the southern United States. They are more prominent in southern wetland areas, but a concern here as well. They reproduce rapidly, and eat the roots of wetland vegetation, and their burrowing behavior negatively affects shoreline stability.

The third public meeting held on August 13th went over progress towards these goals and the development of a master plan. The next meeting is on September 10 and it is anticipated that approval will be given for opening the park on a temporary basis by then. (Council, City Council Public Meeting, 2013). The property could have been converted without having any public meetings. By involving the public, giving them a say in the potential uses, and establishing relationships with the officials, a sense of ownership and responsibility for the property has been

established. This will improve the chances for a successful restoration and stewardship of this property.

Invasive species:

There are several invasive species on the property including scot's broom, *Cytisus scoparius*, yellow flag iris, *Iris pseudacorus*, himalayan blackberry, *Rubus armeniacus* english ivy, *Hedera helix*, common european hawthorn, *Crataegus monogyna*, european mountain ash, *Sorbus aucuparia*, canada thistle, *Cirsium arvense*, creeping buttercup, *Ranunculus repens*, reed canary grass, *Phalaris arundinacea*, english holly, *Ilex aquifolium* and tansy ragwort, *senecio jacobaea L*. The banks of Hall Creek are almost exclusively covered in non-native vegetation. Yellow flag iris, *Iris pseudacorus* and Himalayan blackberry, *Rubus armeniacus* have both begun to spread across the greens throughout the property and are the two most prevalent invasive species in the project area.

Wetland Delineation

The Army Corps of Engineers defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Indicators used to determine the presences of a wetland are hydric soils, hydrophytic vegetation, and wetland hydrology. This poses a particular problem on the Ballinger Lake Golf Course site because all three categories of indicators have been drastically altered. Vegetation was removed and replaced by species that were not originally there, drainage systems were set in place to alter the natural hydrology, and soils had been modified by grading, sand fills, and soil additions to create small hills and rises. Because the site has been disturbed and is not in its

natural state, historic documents and cadastral survey records were examined. These records indicate that the site had been a wetland before European settlement (Halvorson, 2013).

This course is shown as an example of how site characteristics were not incorporated into the design of the course. It also shows what can happen when the landscape is altered when building a course. The site history showed that the area is a wetland. The course struggled to stay in business because of the high maintenance of trying to use the land in a manner for which it was not intended. The course closure also serves to point out the varying types of restoration options available, and the support needed from the public.

<u>Closing Golf Course – conversion to a business park</u>

Sumner Meadows

Sumner Meadows has become a financial burden to the city (Plog, 2013). It is scheduled to be sold and to become an industrial park. The Sumner golf course has been experiencing financial hardship for many years, and is in debt to the city. Ten times the revenue of that which the property can generate as a golf course can be earned as an industrial park. The city is required to establish a 200 foot buffer zone along the White River that runs adjacent to the property (Windish, 2013). This course is an example of the wrong type of golf course built for the area. It is a in a wetland area, and a links style course was built there. The course was wet for nine months out of the year and alternative courses were available. This example illustrates the potential revenue stream preventing full ecological restoration, and the ecological requirements still necessary when converting to business use.

Open Golf Courses – partial restoration efforts fitting into golf course facility operations

Chambers Bay Golf Club



Chambers Bay Golf Club, retrieved

from<u>http://www.google.com/imgres?imgurl=http://www.chambersbaygolf.com/kemper/images/232/h</u> ome_flash.jpg&imgrefurl=http://www.chambersbaygolf.com/&h=521&w=819&sz=225&tbnid=aJ8i7uzq mDE_qM:&tbnh=90&tbnw=141&zoom=1&usg=__IEMg_

<u>7uhFF9YCAjHg8IrXkvBWBc=&docid=HCYCSjuB2bH9XM&sa=X&ei=lr8eUtH8CuvoiwLnhIGQAg&ved=0CC0</u> <u>Q9QEwAA&dur=181</u>, accessed on August 5, 2013



Seattle Daily Journal of Commerce, retrieved from <u>http://www.djc.com/stories/images/20071002/ChambersBay_AidanBradley2007_big.jpg</u>, accessed on August 5, 2013

Chambers Bay Golf Club is a links style golf course with no trees except for those on the north side of the course boundaries. It is located along the coast of Puget Sound, built in 2007. Unlike other links style courses in the area, this one does fit with the ecosystem in which it is located. It was built in the Scottish tradition, among wind swept dunes with native fescue grasses. Water quality and wildlife habitat are protected and the golf course management is committed to ongoing environmental stewardship. The original Scottish links style courses were built on land that was not good for agriculture, or grazing. It was on land just off the ocean and ended at the more valuable pasture and agricultural lands. The soil, being sandy and hard, was nutrient and organic matter poor. Play was on whatever grass grew, and the bunkers were naturally occurring wind swept dunes, gathering sand in big depressions. Maintenance was done by grazing animals, and the natural conditions.

Fine Chewing's Fescue, *Festuca rubra commutata* is used on the greens and fairways and requires minimal maintenance and irrigation. Drainage is good due to the sandy soil. The fescue does exclude other species from establishing in the area. The rough areas are Tall Fescue, *Festuca arundinacea*. These fescue grasses are the most suitable choice for links course in a coastal grassland ecosystem. Otherwise the natural look and ecological function are not achieved, and the beauty of the landscape is not realized. Fescue requires well-draining sandy soils to thrive (Vavrek, 2009).

Water used is from a well, but with the sandy soil and minimal fertilizer use, infiltration is good and ground water recharge is occurring. This is a self- sustaining facility. The course does stay fairly dry year round, and goes dormant in the dry season. Water usage is minimal.

It is a walk only facility, as golf carts would disturb the fescue (Johnson E., 2013).

This facility has been Audubon certified for over 6 years. A large variety of birds, coyotes, rabbits, deer, raccoon, skunks, and chipmunks live on or in close proximity to the course. Wildlife on the shore includes sea otters, seals and other marine wildlife. There is currently a project underway to revitalize shoreline environments and habitat. Pierce County owns the Chambers Bay course and received a grant from the Washington State department of ecology called "Model Toxics Act". This act is funded to remove the 500 derelict creosote pilings along a 2.5 mile shoreline of Chambers Park. These pilings were created by the prior use of this site of over a century of gravel and sand mining. This project will remove approximately30-40 tons of creosote from the shoreline environment, with the remainder being removed with additional grant funding in the future. Removal of the creosote coated pilings will lead to further restoration of the shoreline and overall improvement of water quality in Toliva Shoals for intertidal and near

shore habitat. Additionally, removal of the derelict pilings will provide a safer and more attractive environment for those using the beach (Pierce County WA, 2013).

There is a five mile trail around and through the golf course so others can appreciate the beauty. There is a waste water treatment facility on the site, so even though irrigation is well sourced, they are looking into reclaimed or recycled water for irrigation needs.

It is a 950 acre facility with the golf course area being about 250 acres. Over the last 200 years, the entire Chambers Creek Properties area has been used as a location for a paper mill, a proposed match company, a major industrial center, multiple lumber companies, a railroad center, a county gravel mine, a bus barn, a regional wastewater treatment plant, a preservation and recreational area. The quarry history stems as far back as the Steilacoom Indian Tribe and the first European settlers in 1832 (Kemper Sports, 2013). The boundaries of the course are forested, indicating that this was the original ecosystem type prior to the wood/ paper/ rock mill activities. The site was abandoned for 10 years prior to development as a golf course. Residential property, parks, and soccer fields surround the complex. A gravel mine still is in operation on the south side of the property.

On my tour of the facility I noticed how the topography and contours of the area seemed natural and as though it has always been there. In the original design, the landscape was significantly altered. These alterations were done with sand already on the site, and large piles of sand were moved in order to connect the course so it can be walked (Kemper Sports, 2013). The difference with this course design and construction was that no ecological processes were altered, and the site was designed with the ecosystem type in mind. The design is such that nature and the elements are the key component of the course design. In 17th century Scotland, goats and other

livestock were used to maintain the course. On Chambers Bay, lawn mowers are used as the primary maintenance. They are looking into natural livestock for such a task. This would add to the image of this course. In my interviews with patrons, and those that walk the trail, it is as though we were in old Scotland. Seeing goats in the grass fields would add to this.

Suitability for links design on this property was established due to the sandy soils, adjacency to the sea, a nearby estuary, appropriate grasses, lack of trees and ponds, and a suitable climate.

This site had all of these requirements to assure success and the self –sustaining goal. It is natural, and golfers appreciate the beauty, and challenge.

The walk only requirement for this course enabled the use and success of the natural grass, and allowed for unique site features to be incorporated into the golf design. The dunes and natural hillsides, valleys and peaks, would be disrupted otherwise. So beauty and function are attained by not having golf carts. Each hole is unique with its own character. The natural slopes and mounds create the unique characteristics, and make the experience more memorable. The trail walking patrons and golfers indicated that the beauty and awe of the place are apparent.

Invasive plant species observed are Himalayan blackberry, *Rubus armeniacus* and reed canary grass, *Phalaris arundinacea* down by the shoreline and railroad tracks situated between the shore and the course. A larger amount of invasive species are noticeable up the hill from the course around the walking trail. These species were scot's broom, *Cytisus scoparius*, gorse, *Ulex europaeus*, horsetail, *Equisetum arvense*, poppy, *Papaver somniferum*, and yarrow, *Achillea millefolium*.

Restoration efforts in these areas would entail the removal of these invasive species, and planting more variations of Fescue. Hard Fescue, *Festuca longifolia*, Creeping Red Fescue, *Festuca rubra*

subp. Rubra, and tall fescue, *Festuca arundinacea* would complement the golf course site and add bank stabilization, erosion control, and will crowd out invasive re -emergence. Vine Maple, *Acer circinatum* could be added to provide bank stabilization, wildlife habitat and a biodiversity. Serviceberry, *Amelanchier alnifolia*, provides some color, bank stabilization, food for wildlife and improves soil properties. Beaked Hazelnut, *Corylus cornuta* can establish quickly, crowd out invasive re-emergence, provide wildlife habitat and form a dense understory to act as a barrier to entry. These plantings would be visible from the 5 mile trail surrounding the course for the added diversity and beauty for those walking the trail. Chambers Bay is the site of the United States Open Golf Championship in 2015. There will be many people from all over the world walking the trail. This is an opportunity to showcase a diverse combination of native species and wildlife that add beauty and ecological function to this coastal grassland ecosystem. Appendix B has a more comprehensive list of species to consider.

This restoration activity could compliment the piling removal activity, restoring the shoreline ecological function, biodiversity, wildlife habitat, and beauty for those walking the trail and playing the golf course.

Druids Glen Golf Club



Google earth, retrieved from 47 degrees 19' 57.93" N 122 degrees 03'57.02" W, accessed on August 18, 2013

Druid's Glen Golf Club is a course carved out of second generation forest. It is another course that is a good example of making use of the ecosystem that it is in. There are many areas of connection between and across golf holes. These connections minimize ecological fragmentation and maximize the character and beauty of each golf hole. There are areas of the course with environmentally sensitive area signage. These were highly wooded areas, and habitat for elk and other wildlife. It is truly a walk through nature, and memorable. It also utilizes four different tee boxes to accommodate all levels of player ability. It is located in Covington, Washington.

One issue with this course is that it sits in a wetland area. It is a poor draining golf course. Many lakes and ponds are scattered throughout the 18 hole course. The course remains wet most of the year. During the summer drought season is the only time the course is naturally dry. In these summer months the staff tends to over- water the fairways to keep them green. This has caused many of the areas to be too wet, spongy and soggy. This makes it harder to hit golf shots, than if playing on a drier, harder surface. The maintenance staff needs to water the course in a more selective fashion. This course has wetland areas, and keeping the grass green during the summer months is not natural. All of the fairways, greens and tee boxes are bent grass, *Agrostis palustris*. Perhaps a hardier type of grass would minimize irrigation needs, and prevent dead spots. Other techniques to keep the area better drained would be the sand capping technique used on many golf courses in the Northwest area.

Areas between golf holes are fairly long stretches of paths through forested areas. These areas have a thick deciduous canopy cover with minimal invasive plant species. However the natural areas next to the managed lawns are infested with himalayan blackberry, *Rubus armeniacus*, and broadleaf weeds, *hypochaeris*. Areas of tall fescue, *Festuca arundinacea* and soft stem bulrush, *Schoenoplectus tabernaemontani* that once defined the sides, next to ponds, and next to bunkers, have been invaded by these invasive plant species. This has taken away from the diversity and beauty of the landscape. It has also had an effect on wildlife in the area. More watering during the summer months needs to be done in the areas that were once filled with soft stem bulrush

which thrive in moist soils (Agrilife Communications), and water is not getting into the natural areas. This, along with replanting, would have increased the amount of these native species in these areas, and minimized the spread of the Himalayan blackberry, *Rubus armeniacus*, and broadleaf weeds, *hypochaeris*. It did seem apparent that golf course maintenance and upkeep need to be improved. Certain areas need more attention, rather than a broad irrigation technique that concentrates on the manicured lawns exclusively. Watering in the early morning hours and less often, would help minimize soggy areas. Interviews with golf course patrons indicated this opinion as well.

On my tour of the course, I did notice some Elk roaming around the forest edge, and interviews with those on the course indicate the love of wildlife sightings while playing the game.

The entrance to the course is a long stretch of road with views of a few of the golf holes, and of Mt Rainier. The entrance sign, the roadway medians on the way to the club house, and the restaurant are good areas for colorful native vegetation that can serve as a garden area and to provide re-connection of fragmented forest areas. These areas are just soil and grass currently. Appendix B has a listing of vegetation that would fit these requirements. More could have been done with interpretive signage throughout the course. In fact most of the courses I reviewed could have used much more of this.

Horseshoe Lake Golf Course



Google earth, retrieved from 47 degrees 24'19.68" N 122 degrees 40'11.76" W, accessed on August 22, 2013

Horseshoe Lake Golf Course is located in Port Orchard, Washington, just west of Gig Harbor. It an 18 hole course carved out of the forest and is in a lowland forest ecosystem. This course uses the existing landscape as part of the design. The golf holes have character and are different from one another. A golf cart has to be used on this course, as it is very steep terrain, and there are long distances between holes. Since the course is built within the forest, and the managed lawn areas are dissected by native vegetation and water features. There is minimal fragmentation of the landscape. Wildlife was observed on the course and deer are a common sighting. Minter Creek, a salmon bearing stream, runs through the course. There is a sign posted that indicates that it is a Salmon bearing creek and that it is a protected area. The creek is surrounding by a diversity of vegetation providing good ground cover. It appears to be well shaded and insulated from temperature fluctuations. Minter Creek Hatchery draws from this creek, providing potential for research and educational opportunities along with the Salmon habitat. The signage on the course was minimal. More could be done to emphasize the importance of this creek.

Also, during my tour of the course, I noticed a few invasive plant species. Himalayan blackberry, *Rubus armeniacus* and knotweed, *Fallopia japonica* were growing along the edges of the forest as I entered woody areas. These were minimal, as it appeared to be an old growth forest throughout. Western red cedar, *Thuja plicata*, douglas fir, *Pseudotsuga menziesii*, sitka spruce, *Picea sitchensis* and western hemlock, *Tsuga heterophylla* comprised the forest. In between holes, golf carts wind up and down paved paths that dissect the forest. This made for a beautiful ride. The golf holes, being within this forest were pleasant as well.

By being carved out of the landscape, and having the fairways dissected by vegetation, playing there made for a memorable day. The course is difficult as a result as well. There are many elevation changes throughout the course. It is not to be played by beginner golfers, or those that

can't hit the ball very far. This would be the case for any golf course carved out of a forest setting, utilizing the natural elevation changes.

The one negative aspect that I noticed on my tour was wet fairways on some of the holes. Being that my tour was during a time that there was no measurable precipitation in over a month, this should not be the case. The maintenance staff over- watered the fairways, as this course is known for staying relatively dry over the wet months. These wet spots were next to bodies of water on the golf course, sloping towards the water. This area would have been in danger of grass loss if not watered. My other tours of this facility during the wet months of the year did not show indications of this issue. Infiltration appears to be good in the wet months. With all of the slopes and topography changes, the course is playable year round.

This course is carved out of the woods. This does provide travel corridors and fragmentation is minimized. This contributes to ecological functions, and provides tremendous character for the golfer as well. All of my lowland forest ecosystem examples share these traits. As compared to other areas of Puget Sound, it is not as built up with residential and commercial property. Many forest areas still remain, and as a consequence, are much more scenic and beautiful areas. In the forested courses, there is shelter from some of the weather; shade from the sun, and canopy for the wind and rain.

Jackson Park Golf Course



Mapquest satellite photo, retrieved from<u>http://www.mapquest.com/satellite-maps/#a15e2a25d94380b32b93360d</u>, *accessed on April 10, 2013*

As seen on this satellite photo, I -5 runs adjacent to Jackson Park Golf Course. Also seen in this photo are urban areas surrounding the course. The patches of vegetation where Thornton Creek runs offer connection areas, and the ponds offer wildlife enhancement opportunities and groundwater recharge. Also evident are the large areas of managed lawn. Minimizing these areas by having strips of vegetation across fairways as corridors and by day lighting of portions of Thornton Creek will provide landscape diversity improving the ecosystem and the golfer's experience. This golf course, being surrounded by urban area development, provides a large area that can initiate autogenic recovery and ecological succession to surrounding green spaces.

This course is located in the Seattle area in the middle of an urban forested ecosystem. It is an 18 hole, 130 acre golf course. Renovations have been made to three of the golf holes, and three other holes were modified to fit this renovation. A driving range will be completed by Winter 2014 (Wilkinson, 2012). Meetings with architects and managers involved with the project provided me with information on the care taken when designing and renovating golf course property. Standards for herbicide and pesticide use are strict, and provide for the least damage caused to nearby streams and wildlife. The water used on the coursed is recycled, and topography of the course is used to divert runoff from the course to underground storage (Stephen Speidel, 2012). The range and hole changes were done with minimal disturbance to the environment. The natural properties of the existing canopy cover were incorporated in the redesign of three of the golf holes. These three holes were designed to make use of the existing land, keeping natural vegetation between and through the holes, minimizing managed lawn area, and incorporating natural terrain and canopy to add character (Maddox, 2012). These renovations did not involve any tree removal (Farrell, 2012, Eastberg, 2012). Those that have played these holes say that it is like playing a new course. Players indicate that it is an improvement. Holes that were previously viewed as forgettable now have character. On the driving range, soil compaction and runoff issues will be minimized by the use of special turf. There has been an addition of a walking trail around the golf course property that has been well received by the public (Farrell, 2012, Eastberg, 2012).

This golf course renovation provides support to the idea that ecological function and enjoyment of the golf course can both be improved. Using the natural landscape, and fitting the golf course into that, is the best way to maximize ecological function, player enjoyment, to minimize maintenance expense, and maximize revenues. The new walking trail also gives the general

public a chance to appreciate the property, and increases the likelihood of community support for the golf course activity. Golfers also indicated that strips of vegetation between fairways would enhance the experience as well as improve ecological function. Wildlife sighting are important to those interviewed as well. Interpretive signage would provide even more support for the property, and patrons of the golf course and walking trail showed interest in the idea.

Two branches of Thornton Creek meet on the golf course property. There are also hills and mounds that allow for varying types of restoration activities. Vegetation and ponds are mixed in the layout. Opportunities for day lighting portions of the creek, as well as creating strips of vegetation across fairways, can create diversity, reconnect fragmented areas, and restore hydrologic cycles. These efforts will increase flood attenuation, and groundwater recharge. It will also improve wildlife habitat quality in the streams and ponds. These efforts will also create character and uniqueness of golf holes for the player.



Examiner slideshow, retrieved from <u>http://www.examiner.com/slideshow/jackson-park-golf-course-flooding-april-17-and-april-18-2013#slide=4</u>, accessed on May 29, 2013

Infiltration is still an issue on this course. Reducing areas of managed lawn by creating natural areas across fairways would reduce the flooding events that occur. The photo above shows the course in April of 2013 after a period of heavy rains. This type of flooding did not occur in other areas of the city at that time, and illustrates the low infiltration rates characteristic of managed lawn areas.

Creating natural areas across fairways requires plant species of a height of less than 12 feet. Also, a plant species that provides beauty and wildlife habitat should be preferred. This will allow golf shots to go over the vegetation, and provide scenery for the golfer. It will also reconnect fragmented areas and provide wildlife travel corridors. Promotion of seed dispersal to nearby disturbed areas and park areas in this urban forest environment is also a goal. Choices of plant species should incorporate these factors, as well as bank stabilization and flood attenuation benefits. Buffer and riparian zones attributes of a plant species should also be a consideration.

These plant species include:

For bank stabilization, flood Attenuation, and buffer/ riparian zones:

- 1. Oemleria cerasiformis (Indian Plum)
- 2. Rubus spectabilis (salmonberry) part to full shade
- 3. Berberis nervosa, B. aquifolium (Oregon grape) part to full shade
- 4. Symphoricarpos albus (snowberry) full sun to full shade

These species will provide function in removing excess nutrients and pathogens for the runoff, and beauty at different times of the year. They will also crowd out any potential for invasive plant species. They also grow to a height of 10 feet or lower, allowing for the flight of golf shots and views of the course.

For thicket forming plants, *Rosa pisocarpa* (swamp rose) is my suggestions. It is a full sun to partial shade preference species.

For habitat diversity functions:

- 1. Cornus sericea (red osier dogwood) full sun to full shade
- 2. Lonicera involucrata (twinberry) part shade
- 3. Philadelphus lewisii (mock orange) full sun to part shade

These species will provide limited wildlife habitat and add diversity to the landscape. The combination of these species will increase the crowding out of invasive species that could potentially come in from nearby disturbed areas (Dawe J., 2012). Wildlife features such as snags and woody debris that were described in the urban forested ecosystem section would apply here.

The Golf Club at Newcastle



Mapquest satellite photo, retrieved from http://www.mapquest.com/maps#dc1d5ed3885840b7d3248a64, accessed on April 10, 2013

The Golf Club at Newcastle is an upland golf course. It is located on top of a hill in the city of Newcastle south of interstate 90 on the eastside of Puget Sound area. It is 36 hole golf complex that provides panoramic views of Lake Washington, Mt. Rainier, the Olympic and Cascade Mountains, and the Seattle skyline (okigolf, 2012). The facility also includes a large restaurant, club house facility and driving range. I have met with the golf course superintendent and toured the facility. Great care is being taken to assure that runoff does not go into the streams. They used the existing topography of the area to design a facility in which it could divert runoff to collection tanks and continuously recycle the water. Parts of the golf course are surrounded by houses. These privately owned residences do contribute to excess runoff, as they are situated above the course grounds. Other parts of the course are surrounded by vegetation and forest areas. Opportunities do exist that would reconnect fragmented areas in strategic portions of the two courses that would promote some autogenic recovery and ecological succession to surrounding areas. The golf holes are very similar to each other, with the same Puget Sound area views. These views are quite spectacular, but more could be done to both add character to the course and restore some natural ecological function to the area. In my informal survey of golfers, the view is a big part of the experience, but having golf holes that have different scenes and layouts is also important. This adds character to the course and makes each hole more memorable. Creating areas of appropriate ecosystem native plant species across some of the managed lawn areas would minimize the ecological disturbance and create more character and beauty for the golfer.

This facility is on a hilltop in the city of Newcastle, situated between Renton and Bellevue. It encompasses 350 acres of hillside. The site was once a timber town until coal was discovered in 1863, with mine operations beginning in 1867, and ending in 1929. In 1878, the Seattle and Walla Walla Railroad hauled 400 to 800 tons of coal from Newcastle to Seattle daily. To this day, there is still a danger of many old coal mine holes underneath Golf Club Road, leading to the golf complex. One of them was filled in with logs, soil, and black top in 1950. Additionally,

independent coal miners dumped coal mine waste from 30 to 50 high all along Golf Club Road. The city residents at the time had piles of waste sitting in their yards. By the end of the coal mining days, over 13 million tons of coal had been extracted. Most of the holes have been filled in, but this area has gone through significant disturbance. The names of the two golf courses that comprise The Golf Club at Newcastle are Coal Creek and China Creek. These were named after the primary areas of where coal was mined, and those that mined it (Oki Golf, 2013).

Through the years, restoration efforts have been conducted to mitigate for these mining disturbances. The 350 acres are comprised of 22 acres of native grassland, 12.5 acres of freshwater wetlands, ponds and lakes, and an additional 102 acres of undisturbed areas that include shrubs, as well as grass lands and forests. The complex is also a certified Audubon Cooperative Sanctuary, and has a strong commitment to the environment. Every two years, as part of the certification, the facility must meet strict environmental standards. These include wildlife and habitat management, outreach and education, chemical use reduction and safety, water conservation, and water quality management. Environmental science workshops on the golf course in regards to the wetland functioning, gardening techniques, and wildlife are conducted periodically. Boy Scout and Girl Scout troops helped build bird houses, and plant bee, butterfly and hummingbird gardens. The Eastside Audubon Society conducts monthly bird species surveys, cataloging 62 different bird species. These species include red tail hawks, bald eagles, hummingbirds, quails, and great blue herons (Newcastle News, 2010). This information was pointed out in my tour of the facilities with the golf course superintendent (Phelps, 2012).

In my interviews of golfers, I did find one common complaint. This course is overpriced for the value provided. There are many alternatives, and this course is not busy very often, mostly holding corporate and social events, and those are in the dining areas and club house. Although

there are spectacular views on every hole, all the holes look the same. There is a bit more diversity on the China Creek course due to having more trees, ponds and natural areas. Thus, more people that I interviewed preferred that course. This result confirms part of my contention that the golfers will enjoy natural areas mixed in between and across golf holes. This adds more character and uniqueness to each hole, and provides improved ecosystem function and health. Homeowners will also appreciate the addition of diversity to the landscape. Care is needed on how restoration activities will affect homeowner rights. Cooperation of this group is critical to success. Views cannot be obstructed, so appropriate vegetation choices need to take this into account. Buffer areas outlining the course could separate the home property from the course. This will also provide some buffering from home chemical use, and provide a natural boundary for the course. It will not impede the view, as all the homes are above the course. Appropriate plants will provide diversity and function. Like the other restoration strategies, they will also add character for both the golfer and homeowner.

Plant species could be added much like those mentioned for Jackson Park described earlier. These species should be a diverse mix of wetland to upland, depending on where on the course planted. The long history of disturbance discussed previously should be considered in the selection of restoration techniques and strategies. The soils disturbances by excessive mining all along the course, requires a stabilization and erosion control species. Also to be considered would be a buffer and riparian zone type species that would detain excess nutrients and pathogens from the soil to settle out prior to hitting streams and rivers downstream. The wetland areas can be used for additional diversity for wildlife, flood attenuation, and groundwater recharge. These efforts will also benefit areas downhill from the course, as lakes and streams will not reach flood stage from uphill runoff. There will also be an opportunity for increased wildlife

diversity. Other wildlife could be attracted to the site with natural area corridors between and across golf holes. This benefits wildlife observation activities, as well as promoting passive restoration, autogenic recovery and ecological succession.

Both courses are used minimally during the winter months. By restoring the ecosystem functions described earlier, these areas have the potential for multiple uses, and bringing in additional revenue during these months. Ideas for use are nature walks and wildlife observation. Water from areas that collect runoff during high periods of rainfall can be diverted to buffer areas and enter a more permeable medium than the managed lawns, thus infiltrating through the soil and made available for groundwater recharge.

Fertilizers on the golf courses are a slow release, and for landscape purposes it is extremely low, therefore the issue of pests is minimal.

This course, along with Chamber's Bay, are good examples of how golf courses can be instruments of reconnection, restoration of a landscape, reintroduction of native grasses on an ecologically disturbed landscape, and both have earned Audubon environmental certifications.

There is also a 3 year old demonstration garden created for birds/butterflies as part of the certification process for Audubon International. This walk-through garden is planted primarily with Washington natives and wildflowers (White, 2011). These gardens illustrate both a native garden to promote ecological succession, and for beauty. The areas planted with the garden type plants are for the weddings, and other social functions that are conducted on the golf course property. This use is my example of how public gardens can be incorporated on golf course property, can be looked to for examples for the gardening public. Depending on where located, this vegetation serves both ecological function and beauty as both natural and public gardens.
This course is also a good example of incorporating wild life refuge areas, and providing educational workshops on the property.



The Blue Heron Golf Course

Mapquest satellite photo, retrieved from <u>http://www.mapquest.com/maps#f4d7b2d77648859f7340c1c1</u>, accessed on April 10, 2013

First opening in 1967, the site of the Blue Heron Golf Course course was formerly a sheep ranch. The course, being located in the Snoqualmie Valley, is topographically in the flood plain of the Snoqualmie River.

Formally called Carnation Golf Course, it recently changed names and is going through a substantial renovation. The course was struggling and was up for auction in August 2012. Subject to seasonal flooding, it is hard to maintain. It has a similar struggle to that of the Lake

Ballinger course describer earlier. It is wet for 9 months of the year, and often floods to the point of complete submersion by the Snoqualmie River. The previous owners cited tough economic times and competition from other golf courses as additional reasons for their struggle (Cascade, 2013). These struggles, and the challenge of making the course playable, are common ailments of any property that has been located in a flood plain, or wetland area.

As of July 30, 2013, the golf course is open for play. The club house was lifted by 11 feet and has a better view of the Carnation Valley, Snoqualmie River, and the Horseshoe Slough area. This renovation also provides more assurance that support facilities will not be flooded during the wet season. A grant provided by FEMA because of the frequent flooding enabled this renovation. The flooding in this area has increased over the years (Ladwig, 2011). In the 1970's the golf course rarely flooded. Part of the reason for the increased flooding was the work done up river by the flood reduction work at the Snoqualmie Falls area. This work upstream has had an effect on downstream activity (Ladwig, 2011). River flow has changed over the years as well, as population and land use upstream changed, increasing flood protection efforts for valuable business and residential structures. According to a 2007 county estimate, over \$7 million worth of business was built on the Snoqualmie River flood plain (Catchpole, 2009).

This course does have numerous areas where natural areas dissect fairways, and has potential. It would be an ideal course for the installation of boardwalks that fluctuated with the water level changes during the year. Also, interpretive signage educating golfers and walkers about the wetland processes and sensitivity of the area could be displayed in key areas of the course. Another use during the wet season could be for a science laboratory on the course grounds. Wildlife sanctuary certification could also be sought. Critical wetland area status could be used to enable the course to get Federal funding for ecological protection, as flooding is a critical

component of this wetland area. These activities could provide additional revenue through good will and word of mouth advertising that can help offset expenses during the wet months, and provide relief from some of the expenses incurred by the repeated flooding of the area.

This course provides an example of a course being sold to a company that has more golf course development expertise in wetland areas, and can commit resources to proper design and operations. This provides more evidence that courses built in wetland areas are very costly to maintain, and require a big commitment of time and expertise if they are to stay in business.

Trophy Lake Golf and Casting



Mapquest satellite photo, retrieved from <u>http://www.mapquest.com/maps#f5375ba03405c76020a9d607</u>, accessed on April 10, 2013



Okigolf, retreived from <u>http://www.okigolf.com/Courses/TrophyLake/Pages/AboutUs.aspx</u>, accessed on July 28, 2013

Trophy Lake Golf and Casting is an 18 hole course that provides additional activities on the grounds. It is nestled in a forested area of Port Orchard Washington with scenic views of the landscape. Opportunities exist for more connectivity to the landscape. The idea of multiple activities is important, as demand for golf goes down considerably during the winter months in the northwest. This course does have natural areas crossing fairways, in front of and behind greens, and on the course boundaries. It is a good example of how these attributes contribute to the character of a golf course. There are several golf courses in the northwest that have, or could potentially have these attributes.

Trophy Lake Golf and Casting has colorful natural gardens in the design around the club house and around the 18th hole green area. A good selection of colorful native plant species around the club house and in areas of the course in sight of the club house provides benefits for events and activities other than golf. These events are weddings, corporate meals and banquets, award functions, and for normal restaurant operations. The choice of this vegetation should complement existing native species around the course, and provide ecological benefits as well. These would include the provision of travel corridors for plants and wildlife.

This course did incorporate sand capping of about 10 inches into the design. Wetlands exist around and in the Trophy Lake complex. This sand capping technique has allowed for quick infiltration and slows surface runoff to the lake during storm events. Such influxes can disrupt wildlife habitat in the lake and in the stream that exits the lake. In addition to the sand cap, bioswales (mounded berms), wet cells (low-lying areas that seasonally hold water), constructed wetlands, and tall grass buffers were included at edges of fairways and in roughs. These features were designed to intercept runoff water and shallow subsurface flow, allowing for filtering of nutrients through the actions of plants, soil, and microorganisms. When the potential movement of water and dissolved nutrients from the golf course to surrounding areas is a concern, grass buffers, bio- swales, wet cells, and constructed wetlands can be useful tools in maintaining water quality. Increasing the residence time of the soil solution on the golf course is critical and can allow the grass root system, as well as other soil organisms, to effectively filter nutrients from the water before it leaves the golf course site (Miltner, 2013). There are several lakes and streams on and near this course. There are elevation changes as well. Do to the numerous environmental areas, these techniques were necessary in order to avoid disturbance.

The course was designed to incorporate numerous wetlands, streams, and ponds. It is also surrounded by forested areas. A thorough assessment was conducted and testing of features proved that the integration of natural and constructed drainage and filtration systems met EPA

water quality standards. These monitoring tests of water quality and effectiveness of design techniques occur at six sights within the golf course complex. These areas have flow gradients created by surface contours and directed water across slopes, into and through the filtering features previously mentioned. Thirty-six samplers were initially installed, and 15 more were added in critical areas as the study progressed. Samples were collected periodically and analyzed for nitrate-nitrogen and orthophosphate, two potentially important pollutants of water (Miltner, 2013). A thorough erosion and sediment control plan was prepared and implemented, along with a detailed BMP/ IPM plan to protect and enhance these natural features (Icon Golf Studio, 2013). This feature is a great example of how to improve ecological function and the golfer's experience. A round of golf at this facility allows not only the enjoyment of the game, but the observation of a variety of landscapes and wildlife.

As the name of the course implies, fishing activity is conducted at this facility. Periodic fishing lessons and guided fishing outings with meals are conducted. Individuals can also pay an hourly fee to fish if not in the group lessons. No license is required, and it is fly fishing only. Two ponds are stocked for this activity, and it has been extremely popular. The guided tours and lessons are conducted by Peninsula Outfitters. They supply the gear and expertise, and are in partnership with the golf course. (Peninsula Outfitters, 2013). This activity is not advertised on the golf course web site, it is strictly word of mouth (Okigolf, 2013, Griebel, 2013).

This course is a great example of the provision of other revenue generating sources. The club house, dining, and banquet facilities allow for a variety of functions on the property. This course and The Golf Club at Newcastle share these traits in common. Both have a good natural area component and a more ornamental garden type area for other functions.

Unique to Trophy Lake and Casting is the fishing aspect. This provides additional revenue year round, and supplements the revenue during the wet season when golf activity is slow. Interviews with fisherman on the pond indicated that not having to acquire a fishing license on this private facility is convenient, as some people do not fish that often and would rather pay by the hour. They also indicated that after a round of golf, an hour or two of fishing adds to the experience with nature. They also liked that the combination of golf and fishing cuts the total fee in half. Fishing classes and outings also add to the environmental education aspect as well as enjoyment. Although it sounds like the business is good, more should be mentioned on the golf course web site.

Like the Horseshoe Lake Golf Course and Gold Mountain Golf Courses, this course is built into a lowland forest and wetland ecosystem, and provides character and challenge. It is located on the Kitsap Peninsula in Port Orchard, WA. This course is a good example of using the landscape while minimizing fragmentation. There are numerous areas within the course that connect natural areas. Natural areas were also incorporated in the design. As a result, maintenance costs are reduced, and value is increased. This course also provides wildlife observation opportunities.



World Golf, retrieved from http://www.worldgolf.com/features/kitsap-peninsula-washington-golfmountain-trophy-lake-mccormick-woods-10363.htm, accessed on July 28, 2013



Golf Adventures, retrieved from

http://www.google.com/imgres?imgurl=http://www.golfadventures.com/img/courses/trophy-lake-golfand-casting-club_599.jpg&imgrefurl=http://www.golfadventures.com/courses/Washington/Port-Orchard/Trophy-Lake-Golf-and-Casting-Club.html&h=368&w=700&sz=32&tbnid=, accessed on July 28, 2013

The pictures of Trophy Lake above, illustrates an example of minimizing managed lawn area with the incorporation of vegetation, ponds and waterfalls. These attributes also enhance biodiversity, wildlife, and enjoyment of the game. More can be done in this regard, as is the common theme of all of the courses studied.

Suncadia Golf Complex



The Suncadian, retrieved from <u>http://www.suncadian.com/lodging/swing-your-sticks-unlimited-golf-package/</u>, *accessed on August 5, 2013*

The Suncadia Golf Complex is located in Cle Elum Washington, within the eastern Cascade Mountain range at 2,250 foot elevation, and is unplayable during the winter, as snow covers the terrain. During that time, it is used for snow skiing (Vinh, 2008). It is a 54 hole complex occupying over 450 acres of Ponderosa Pine mountain forest property. It is in the Montane Forested ecosystem, and is the largest golf complex in the state of Washington. The holes are situated between forest areas and do fragment the area in terms of wildlife and vegetation. Opportunities exist for establishing more wildlife travel corridors and habitat. Shrubby vegetation does not grow that big in a mountain ecosystem type, so height will not be a factor when crossing over fairways with proper species selection. Native montane species can be used. During the winter months, the terrain can be used as wildlife travel corridors and habitat, if connections between fairways are established. This would minimize the amount of managed lawn area; herbicides and pesticides used, and would add diversity and function to the landscape.

During the winter months, the Suncadia resort does offer ice skating, cross country skiing, guided snowshoeing, rope tow inner tubing, fishing, and guided wildlife observation activities (Suncadia Resort, 2013). This activity would be further enhanced by minimizing the area of managed lawns.

Although the golf courses of this facility are built within the ponderosa pine forest, there are few golf holes that have any natural areas dissecting the fairways. By including more natural areas within the Suncadia golf complex, these stunning vegetation types can be displayed, add character and beauty, and provide ecological function. The club house area is also lacking a native colorful plant component. Not having such a component takes away an opportunity to display a montane system garden display for the public. Interpretive signage could also be used throughout the coursed to educate the golfing and resort guest public about the ecosystem of which Suncadia Resort is part.

Montane vegetation that will provide corridors and habitats, re-connect fragmented areas, and provide beauty is listed below. Shrubs, forbs and grasses provide these functions and will not impede golf shots. A mixture of these plant species across fairways, on forest edges, and in

garden areas near the resort and club houses of the three Suncadia golf courses will present ecological function and beauty.

Idaho fescue, *Festuca idahoensis* as an important food item for elk in spring and summer months.

Elk sedge, Carex geyeri for moist forested and open slopes

Creeping Oregon-grape, *Mahonia repens* grows low to the ground and produces a blue berry shaped fruit. Its leaves stay green in the winter.

Saskatoon serviceberry, *Amelanchier alnifolia* is a low growing deciduous shrub that produces dark purple berries.

Common Snowberry, *Symphoricarpos spp* has a fruit like berry and grows in low to moderate elevation forests and open areas.

Woods' rose, Rosa woodsii woody shrub that produces pink flowers

Arnica, *Arnica spp.*, yellow flowering plant found in meadows and wet places from the foothills to the subalpine zone.

(Montana Fish, Wildlife & Parks, 2013)

Washington National Golf Course



Google earth, retrieved from 47 degrees 18'29.08" N 122 degrees 09'00.42" W, accessed on August 18, 2013

The Washington National Golf Course is an 18 hole course and is the home course for the University of Washington men's and women's golf teams. It was built in the year 2000, and is located in the Auburn/ Black Diamond area. The developers of this course obtained a conditional land use permit under the existing King County AR-5 zoning regulations. A review of the golf course master planning information indicates that the design of the course conforms to the natural terrain and character of the site and surrounding landscape. A minimum buffer of forested land, 100 feet wide, was retained around the perimeter of the site (R.W. Thorp & Associates, 2013).

As with Druids Glen, this course has a long entrance road into the facility. This area, along with the restaurant and banquet facilities, presents good opportunities for colorful natural vegetation and interpretive signage. Being a University of Washington themed course, an array of purple and gold vegetation is displayed throughout the entrance and club house areas. It is a good mix of natives that complement the golf course area vegetation. This course is a great example of colorful gardens, and multiple events on the property. I did not see any interpretive signage however. Golfers and homeowners would get much more enjoyment and knowledge of the area with this signage. Baskets containing floral arrangements are displayed at the beginning of each hole. These are supplied by a floral vendor and are an annual mix of petunias, *Petunia x hybrid*. A stream runs through several of the golf holes, and ponds and riparian zones are scattered in with the fairways. These water features make for a challenging and enjoyable day on the golf course. Around the course there are many plantings of native vegetation that add to the character and unique features of the course. There are many other spots where more native vegetation can be added. These areas dissect and run parallel to the fairways, and are bare and ripe for the spread of invasive vegetation. Several fairways can have sections converted into natural areas

and travel corridors. At least half of the golf course is wide open with managed lawn as the main landscape. Vegetation could be planted across fairways to reconnect forested areas on the sides. The last nine holes of the golf course do have areas with ponds, creeks and natural areas dissecting the fairways. According to several interviews with golfers, these features add value, beauty and challenge. These natural areas hazards add ecological function and excitement.

There are also a few houses on the sides of the course. Unlike The Golf Club at Newcastle, these homes do not have an influence on the landscape. They are nestled away from the playing areas, are not above the course, and do not detract from the feeling of being in nature. There are also roadways that go in between golf holes. Native gardens could be planted along these areas and in the median areas of the roads. These plantings could block the view of the roadway, reconnect fragmented areas, and provide beauty for the homeowners and golfers. They are mostly grass currently.

Of all the courses surveyed, this one has the most potential for native gardens on a large scale. Also, it is among the best maintained courses I have surveyed. The use of reclaimed water for a man- made creek through the last few holes also adds character, wildlife habitat, and ecological function. Water is pumped to inlet areas where gravity circulates the water continuously through those golf holes. The streams are lined with a plastic liner so there is minimal water loss in the system. Although this course was dry when I played it in July. As with all northwest area golf courses, it can get very wet during the winter months through May. Less impermeable managed lawn areas and more natural areas would help minimize this. Fairways could slope in to riparian and other buffer zones and natural areas.

As with many northwest golf courses, sand capping is used to increase infiltration and keep the fairways as dry as possible. According to Trevor Broersma, golf course superintendent, the fairways are capped with 8 inches of sand, and are top dressed twice a year. Over the last three years, they have been working hard to get better drainage on the property.

Grasses used for this course are bent grass, *Agrostis palustris*, on the fairways, annual blue grass, *poa annua*, on the green complexes, and chewings fescue, *Festuca rubra commutata* and perennial ryegrass, *Lolium perenne*, on the tee boxes, mixed in the fairways and collars just off the fairways. The tall grasses are a native fescue, *Festuca rubra*, with some bent grass, *Agrostis palustris* mixed in.

Invasive species were minimal, as the course was very well maintained. Scot's broom, *Cytisus scoparius* broadleaf weeds, *hypochaeris*, Clover, *Trifolium*, Goosegrass, *Eleusine indica*, and moss, *Bryophyta* are the main invasives that the course deals with (Broersma, 2013).



John Fought Design, retrieved from

http://johnfought.golfservers.net/index.php?mact=Album,m506cf,default,1&m506cfalbumid=31&m506 cfreturnid=27&page=27, accessed on August 18, 2013

This photo of one of the Washington National Golf Course holes shows how managed lawn area can be minimized with native areas dissecting the fairways, and connecting to fragmented forest areas on the sides. This makes the game challenging, adds beauty, and enhances ecological function.

Gold Mountain Golf Course



Google earth, retrieved from 47 degrees 31'01.95" N 122 degrees 45'03.54" W, accessed on August 23, 2013.

The Gold Mountain Golf Complex is a 36 hole complex located in Bremerton Washington surrounded by forested areas. Tree species observed throughout this location are douglas fir, *Pseudotsuga menziesii*, western hemlock, *Tsuga heterophylla*, white pine, *Pinus strobus* and western red cedar, *Thuja plicata*. The natural areas were filled with a tall fescue, *Festuca arundinacea*. The course was built on a sand pit, so the soil is sandy in this area and the course does stay dry most of the year. Sand capping is done as needed in the wet areas where water collects at the bottom of hills (Faulk, 2013). Of the golf courses visited, this one had the most natural area inclusions incorporated within the playing area, and with the most color. Fireweed, *Chamerion angustifolium*, provided most of the color in the natural areas. It does grow wild out in the natural areas and contributes to the beauty and biodiversity of the golf course grounds (Faulk, 2013). It provides a food source for mammals and provides nectar for hummingbirds. Butterflies also use the nectar and pollen from this species (Pavek, 1992).

Canada thistle, *Cirsium arvense*, and scot's broom, *Cytisus scoparius*, are the two most common types of invasive plant species found on the golf complex. Control of these invasive species is removal by hand. Minimal fertilizers and pesticides are used. Fungicides are used as needed on the green complexes. The grass used on the course is bent grass, *Agrostis palustris*, on the fairways and annual blue grass, *Poa Annua*, for the green complexes. Irrigation needs are supplied by well water. Wildlife surrounding the golf course includes bear, coyotes, cougar, bob cats, rabbits, deer, eagles and osprey. There are no other uses of this facility besides weddings, banquets and corporate events (Faulk, 2013).

This course is regarded as the fourth best public golf courses in the state. It is known for its scenic layout, wildlife and challenge (Golf.com, 2012). Interviews conducted on the course, and while at other courses, do support this rating. The combination of scenery, natural areas,

uniqueness of the golf holes, and wildlife are common factors that contribute to this rating. As with the other forested ecosystem type golf courses, there are some long distances between golf holes that meander through the forest area. This provides opportunities for wildlife and vegetation observation and enjoyment. More could be done with interpretive signage and alternative uses of the facility in order to enhance this rating further.

Ideas for Building New Golf Courses:

The BioIsland Concept/ Organic Golf Course

"BioIslands" are biocide-free, intentionally designed landscapes that are aesthetically pleasing, while also providing shelter, food and habitat for beneficial insects, frogs and other small animals (Pennington, 2010). In turn, the wildlife feed on pests, thereby reducing the need for pesticides throughout the area. Additionally, BioIslands reduce over-all landscape water consumption, prevent and control erosion and improve soil fertility.

In natural ecosystems marked by species diversity and interdependence, a continuously evolving balance enables the system as a whole to remain healthy. However, in constructed ecosystems such as farms and golf courses, this harmony is disturbed and the systems become out-of-balance. Pest insects and invasive weeds proliferate, often causing many problems. Our solution has been to control these problems with chemicals. Unfortunately, these chemicals create new problems that are even bigger and more complex. BioIslands, help to naturally control pest and weed problems.

These "islands" of relatively undisturbed landscape are designed to attract beneficial insect and animal species; control pest insects on turf grass and throughout development; reduce overall

water consumption and the need for toxic chemicals; increase fertility and biological activity in soils; and add aesthetic value to golf courses. BioIslands are strategically placed, sustainable, organic habitats that provide numerous benefits without interfering with the function of public parks and commons or the playability of golf courses.

In developing a BioIsland, wildflowers, shrubs and trees are planted which again, attract hungry, beneficial wildlife. These beneficial species, in turn, reduce the need for pesticides, herbicides and fungicides in numerous ways. For example, several species of safe, miniature wasps, attack the eggs of the cutworm moth and twenty other caterpillar pests; dragon flies, bats, swallows, and *Gambusia* fish control mosquitoes; selected weevils eat thistles; mycorrhiza in the soil attack soil pathogens. At the same time, nitrogen-fixing plants naturally fertilize neighboring plants. The BioIsland philosophy is to use organic alternatives first and chemicals only as a last resort.

Environmentally friendly golf courses and parks have significant public relations advantages. Especially in regards to golf courses, they provide marketing differentiation among the new generation of environmentally conscious golfers. Interpretive signage providing this information along golf courses, and walking trails surrounding them, is an effective way to educate the public.

Overall costs are approximately the same in the short term, but lower in the long term as the Bio Islands mature.

Beauty is enhanced. Many people appreciate the natural look and feel of a golf course teeming with wildlife.

Possibilities of health risks are reduce. By reducing the use of chemicals on the golf course, exposure of golfers, staff and maintenance crew to toxic pesticides and herbicides is minimized. Also minimized is the possibility of major, accidental chemical exposure.

All water conservation strategies will help to slow the depletion of this precious resource as well as provide a buffer of protection should drought conditions become a problem. BioIslands require much less water to maintain than traditional landscaping. As the BioIslands mature, their extensive root systems, and biologically rich soils act as large underground reservoirs, storing water that would normally be lost as run-off. They also serve as sponges, or buffer zones, during flash flood conditions.

By using organic methods the larger community will be receiving less surface and ground water contaminants from golf course chemicals.

A high-profile, well-promoted environmentally friendly project that is the size of a golf course facility can have a very positive ecological ripple effect in urban areas. An educational outreach program for a local environmental program or local schools becomes a natural extension of the Audubon certification requirements.

BioIslands and edible landscaping can help to offset the potential problems of adverse climate changes. By selecting the hardiest plants and placing them in self-reliant plant communities, building healthier soils that support biological activity, using mulches or living ground covers to protect soils and conserve water, and designing using plant diversity we can help provide strength and resiliency to the landscape and turf to ride out difficult times. Such a landscape will be more resistant to attacks by insects and related diseases (Perma Culture Design Services, 2013).

Other golf course design and management strategies to create more efficient/ sustainable courses:

Site selection has the greatest single impact on the eventual cost of building a new golf course since heavy earth-moving tasks are the most labor-and equipment-intensive. Selecting an appropriate site and developing a good design that requires as little earth-moving as possible will go a long way toward making the course truly affordable and sustainable. Agricultural lands usually are excellent choices for such courses. They typically have plentiful topsoil, good surface drainage, and a minimum of trees and brush. When combined with a design that requires only limited earth-moving, such courses may be unremarkable in their overall appearance. They also are far less expensive to build and maintain, and therefore less expensive to play. Also, agricultural lands, if farmed tend to have a minimum amount of invasive species. This is due to repeated cultivation.

Steep slopes created during construction are not just costly to build - they are also expensive to maintain. Slopes in excess of 3:1 (for every 3 linear feet the elevation changes by 1 foot) almost always require specialized mowing equipment or must be mowed by hand, using line trimmers or hover-type mowers. They also are more difficult to water and fertilize, adding further to the cost of maintenance. While softer slopes offer less dramatic visual accents to the course, they can be mowed with large, riding equipment. Since labor is the most expensive aspect of golf course maintenance, layouts that can be maintained properly with smaller crews result in long-term savings that can be passed on to the golfer.

Trim work is the most labor-intensive aspect of golf course maintenance. This is particularly true in the southern portions of the country, where Bermuda grass is the predominant turf grass used

on courses. Perimeters of lakes, creeks, bunker edges, sidewalks, and cart paths, and around the base of trees, signs, and ball washers, all require near-constant trimming. Bunkers and water features are particularly labor-intensive, so the more they can be kept to a minimum during the original design of the course, the greater the labor-savings will be each year thereafter.



Moore, J., retrieved from

http://www.usga.org/course_care/articles/construction/general/Building-And-Maintaining-The-Truly-Affordable-Golf-Course/, accessed on July 25, 2013

Although beautiful, these natural areas require minimal trim work, and when cutting across fairways, reduce fragmentation and are self -sustaining.

Keeping sand bunkers to a minimum is also a key factor in cost savings. They are not that expensive to initially install, but are very expense to maintain. Grassy hollows can be just as challenging to hit out of, and be made to be a more natural and a less maintenance intensive feature. Planting appropriate grasses for the ecosystem is key to minimal maintenance as well. Playing the game with the perfect grass is not economically or environmentally sustainable. Buffalo and fescue grasses are perfectly acceptable grasses to hit golf shots, and are ecologically beneficial. The grasses do turn brown and may not look as nice. However, a more natural look in strategic locations is appreciated. As long as golf clubs are not damaged, most golfers will not mind. Designing course that are easily walked will also save maintenance cost caused by the wear and tear on the grasses and natural areas caused by golf carts (Moore, 2013).

This is another instance of how interpretive signage can benefit the course, environment, and golfer. The use of native grasses and sedges can be explained as being beneficial to the environment. It can be further explained that the more ornamental grasses cause environmental harm. This information will be interesting, and appreciated by the golfer. At that point, expectations of perfection can be reduced to something more realistic. My survey of golfers did indicate an interest and appreciation for this information.

Conclusion/ Summary of Findings:

Golf courses provide people with the opportunity to walk through nature. Observing the beauty of the natural vegetation, rivers, streams, ponds, lakes, waterfalls and wildlife are things that add to the golfing experience. The impermeable nature of managed lawns that typify these courses does need to be minimized, however. This is especially the case since there are so many golf courses throughout the country. Some of these courses are built in areas that threaten environmental functioning of coastal and lowland wetlands. Others are built upstream that create stressors on these wetland systems.

With the market correction activity causing some courses to close, complete ecological restoration opportunities are available. In some cases, this is happening. I went over some of these scenarios. For others, the land is being converted to business parks, or other recreational facilities.

In the majority of cases, golf courses are staying open, or being bought out by companies that can commit more resources to keeping them going. In these cases, renovations can be made to improve ecological function, enhance the golfer's experience, and improve the financial condition of the golf complex. These enhancements can also be appreciated by the general public by adding walkways, educational workshops, and additional revenue generating activities on the grounds.

Subsidies for critical ecological services area protection, and wildlife observation and sanctuary area protection can also provide a financial buffer in slow periods.

Creating more natural areas improves ecological function, enjoyment of the game, and can reduce maintenance expense, and fertilizer and herbicide. The golf course development/

renovation strategy needs to fit the surrounding ecosystem. Too many alterations that are not conducive to that ecosystem will prove to be too costly to maintain, and can cause environment damage. Examples of this were discussed.

All of the golf courses studied could add more natural areas for wildlife travel corridors and reconnection of fragmented landscapes. Some did this more than others, but all could reduce the areas of managed lawns to a greater extent.

Interpretive signage providing education on the ecosystem, vegetation types, wildlife and ecological importance needs to be done more often. Although some did have keep out of environmentally sensitive areas signs posted, none of the golf courses studied elaborated more than that. Educating the public on environmental processes and issues decreases demands for perfection, thus increasing the chances of having more natural areas on golf courses. My survey of golfer did support these comments. It is analogous to experiencing a different culture. Golfers want to experience the ecosystem they are visiting.

More ecological education in the form of labs on the course and observation of ecological processes can be incorporated on golf courses. This could be in the form of classes, workshops, or community service. These activities will enhance environmental function, be potential subsidy or revenue generation sources, promote public awareness of environmental challenges, and educate future environmental scientists. Not many golf courses conduct these activities.

More public natural garden areas need to be developed on the sides of roadways, parking areas, sidewalks, and by the buildings and patios of the golf course buildings. These gardens should enhance the ecological functions of the ecosystem, provide connections to the golf course area vegetation, and be aesthetically pleasing.

Only 12 golf courses in Washington State are Audubon certified. This certification includes environmental planning, wildlife and habitat management chemical use reduction and safety, water quality management, and outreach and education (Audubon International, 2013). These functions are in line with the goals described on the USGA web site, and described in the appendices. The certification provides more assurance that the golf course operations contribute to healthy ecological functioning, and courses should be required to have it.

Of the courses I have studied, 5 are on the 12 best Washington State public courses list. Chambers Bay, Golf Mountain, Suncadia, Trophy Lake, and Washington National are the five listed (Golf.com, 2012). These courses share the common characteristics of natural beauty and scenery. They are also the ones that have the most character and uniqueness per golf hole. Four out of the five are forest ecosystem golf courses or that have a forest area component. This list is derived from opinions of golfers (Golf.com, 2012). This information supports my contention that incorporating more natural areas, and reducing managed lawn space enhances the golfer's experience. These are also the courses that have the least maintenance activities performed, and are the least fragmented from the surrounding ecosystems.

The current research on, and ideas for, more native grass species was reviewed. The goal of this research is to use a grass that is more ecologically beneficial, and still provide the qualities necessary for playing the game.

The United States Golf Association is committed to the environment, as indicated by my references to them throughout this report and in the appendices.

Implications/ Direction for Further Study:

Reducing managed lawn areas on golf course property, and using a more native ecologically beneficial grass needs to be explored in greater detail. The Bio Island concept is a good start to a self –sustaining facility using natural processes as maintenance tools and enhancing environmental function. The USGA have made strides in research on incorporating natural areas on the golf course. There have also been increases in studies on grass and soil medium used toward that end. Having toured most of the golf courses in this study, I have not seen enough of what the next step needs to be: implementation of existing research.

Golf course areas can also be sanctuaries for plant and wildlife species. Audubon certification programs go a long way in this regard. Golf course property could have endangered plant and wildlife species within the property. Interpretive signage could explain these species. The large areas within a golf course can give back habitat lost by urban development. This is another area that can produce revenue by way of government and plant and wildlife organization subsidies.

Using high resolution remote sensing as a way of determining suitability of a site is an option that can be used prior to setting foot on the site. Wetland delineation, hydrology, canopy cover, vegetation, and soil properties can be assessed using near infrared and LiDar technology (Omasa, 2006). Wildlife corridor and habitat information can also be analyzed using LiDar technology (Dalleau, 2010). This information can provide an initial assessment of suitability for a specific golf course layout, used to compare similar sites with the desired usage, or to choose the type of course to build. This technology is beyond the scope of my research, but there is an opportunity to conduct research in this area. My review of scientific literature indicated a lack of research on the use of these remote sensing techniques for golf course property.

Appendix A

Recommended plant species in different ecosystems

Choices of vegetation may be made based on wildlife habitat, foraging, and travel corridor value. Just as important is the ability of the species to thrive on disturbed sites, provide diversity and promote ecological succession. Erosion control, storm attenuation, flood abatement, and water quality maintenance functions are significant factors as well. Plant species that grow to less than 12 feet, and that thrive in multiple ecosystem types should be chosen for cross sections of golf course fairways. Tree species that grow much taller are appropriate for the sides of golf holes. The provision of color, beauty and attracting wildlife are also important considerations for the recreational uses of the landscape. A plant species that can make an impact within a couple years versus those that take 10 to 15 years might also be considered. With the exception of tree species, most of the choices listed below are those that take a relatively short time to grow, and can disseminate seeds or expand vegetatively over the landscape quickly. Most of the species selected can be planted as live stakes. This planting technique has shown the best root establishment and growth success (Darris, 2002). Most of these plant species listed below may be used in multiple ecosystem types, and are native to the northwest area.

Selected vegetation per	ecosystem type			
Lowland wetland	LW			
Lowland Forest	LF			
Coastal Wetland	CW			
Coastal Grassland	CG			
Urban Forested	UF			
Montane	М			
Latin Plant Name	Common	Wildlife Values	Structural	Ecosystem
	Plant Name		Functions	Туре
Acer circinatum	Vine Maple	Birds eat the seeds, is a good nectar source for bees. Deer, elk, beaver, squirrels and chipmunks eat the twigs and wood. Numerous birds use the leaves and seed stalk for nest building. It also provides good hiding cover.	provides slope stability, and soil structure maintenance.	LW,LS,UF ,CG
Alnus rubra	Red Alder	Multiple bird specieseat the seeds, use forcover and for nesting.The leaves are eatenby butterfly larvaeand tent caterpillars.Mammals eat thetwigs, leaves, orwood. These includesnowshoe hares,beavers, porcupines,deer, and elk. Alderscreate organic debrisfor soil organisms,and create goodriparian cover forfish. Deer and elkalso use for cover andshelter.	Provide organic matter in soils, provide erosion control on slopes, carbon sequestration, has the ability to symbiotically fix atmospheric nitrogen, aids in the development of other tree species. It is a fast grower in poor mineral soils	LW,LF,UF

Amelanchier alnifolia	service	eaten by	Used in re-	LF,UF,CG
	berry, Saskatoon	 woodpeckers, crows, chickadees, thrushes, towhees, bluebirds, waxwings, orioles, tanagers, grosbeaks, goldfinches, juncos, grouse and pheasants. Nectar is used by butterflies and foliage is eaten by swallowtail and other butterfly larvae. Mammals that eat the fruit are chipmunks, marmots, skunks, foxes, ground squirrels, raccoons, and bear. Deer and Elk browse the leaves and twigs. 	vegetation of damaged sites to improve soil nutrients, stability, erosion control, sediment control, and water quality. It also aides in binding and degrading specific pollutants.	, M
Atriplex patula	Saltweed	Helps to provide oxygen to water for aquatic wildlife. Also serves as food source and protection from predators.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root submersion. Helps to provide oxygen. Helps to provide bank stabilization and erosion control. Improves water quality, removes nitrates and carbon dioxide and other pathogens.	CW

Berberis nervosa	Oregon grape	Browsed by deer and elk, small mammals eat the foliage. The fruits are eaten by birds and the nectar consumed by hummingbirds.	Provides wintering areas for big game wildlife, and cover for small birds, and provide thermal cover. It is an important understory species in the northwest. It is also one of the most adapt at regeneration after ecological disturbance.	LW,LF,UF ,CW, M
Betula papyrifera	Paper Birch	Multiple bird species eat the seed on and under the tree. Other birds eat the insects that use the paper birch as habitat. The peeling bark is used as nesting materials for many birds and small mammals. The cavities of the birch are used by birds and small mammals as nesting and roosting sites. Deer, elk and moose also eat the leaves and twigs.	Paper birch is useful for long term re- vegetation and soil stabilization of severely disturbed sites.	LW,LF,UF

Carex obnupta	Slough Sedge	waterfowl,	Wetland plant	LW,CW
		shorebirds, songbirds	communities	
		and game birds eat	dominated by	
		the seeds. Muskrats eat the roots and seek	Slough Sedge provide the	
			-	
		shelter in the foliage. Other small	hydrologic functions of	
		mammals such as		
		turtles and snakes	maintaining river	
			or stream meander	
		seek shelter in foliage		
		as well. Waterfowl	patterns,	
		nest in the areas	provision of a	
		where the sedgesform	broad shallow	
		a dense cluster.	plain where	
		Amphibians lay their	streamflow velocities slow	
		eggsat the base of	and sediment	
		these plants and the		
		young are protected	deposition	
		from predators.	occurs,	
		Moose depend on	stormwater	
		sedges to provide them with the sodium	abatement,	
			mixing zone where brackish	
		needed when calving. Predators such as	and freshwater	
		bald eagles, otters,	meet, and	
		herons, and raccoons	providing a nutrient rich	
		hunting areas are also provided by this	habitat for	
			wildlife. This	
		sedge.		
			sedge also provides erosion	
			control and bank	
			stabilization and	
			contributes to	
			water quality	
			improvements. The dense swards	
			of this sedge	
			provide sediment retention and	
			nutrient uptake.	

Castilleja miniata	Red Paint Brush	Flowers provide nectar for hummingbirds	This plant is a generalist parasite and root hemi parasite. Introduction of this species can have the effect of crowding out a dominant species on a monoculture site, and help to increase diversity, thus improve bank stabilization, soil organic matter composition and stability of the ecosystem.	LW,LF,UF ,CW,CG, M
Cornus sericea	Red-osier Dogwood	Berries are eaten by numerous bird species, nectar is used by butterflies, wood is browsed by deer, elk, skunks and chipmunks. Beaver and muskrats use twigs to repair and build dams.	Good for early establishment on sites, and can form dense clumps.	LW,LF,UF
Corylus cornuta	Beaked Hazelnut	The nuts are eaten by numerous bird species. The dense sprawling structure of the hazelnut provides good habitat for low nesting birds. Squirrels, chipmunks, raccoons, and red foxes eat the nuts as well. Rabbits and beavers eat the wood.	Forms a dense understory. It emerges early and the dense understory crowds out invasive establishment, giving the native species a chance to develop.	LW,LF,UF ,CW,CG
Distichlis spicata	Saltgrass	Important food source and habitat for waterfowl and sea birds. It is also an important food source and cover for fish and invertebrates. Seeds are a food source for	allows for gas exchange under wet and submerged conditions. It grows where most other plant species cannot survive. Excellent	CW
		small mammals. The grass is also utilized when other food sources are unavailable.	source for wind and water erosion control.	
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Elymus glaucus	Blue Wild- rye	Forage for domestic stock and wildlife.	Good for re- vegetation and establishes rapidly. The rooting system provides soil stability.	LF,CG,UF ,M
Elymus mollis	Dune wildrye	Provides good habitat for seabirds on coastal dunes and sandy or gravely beaches.	Forms dense clumps that will crowd out invasive species development. As with other salt tolerant and tidal inundation species, it provides for water quality maintenance, and bank stabilization	CW, CG
Festuca idahoensis	Blue bunchgrass, Bunchgrass fescue, Idaho fescue	Elk, deer, cattle, horses, sheep and goats graze on this grass. It is also a known deer and big game habitat.	Slow growing, but once established it provides effective ground cover, and the fibrous roots improve erosion control and soil structure. It also crowds out invasive species establishment. This species becomes the dominant in restored salt marsh environments.	LW,LF,C W,CG,UF, M

Festuca rubra	Red Fescue	Elk, deer, cattle, horses, sheep and goats graze on this grass. It is also a known deer and big game habitat.	Slow growing, but once established it provides effective ground cover, and the fibrous roots improve erosion control and soil structure. It also crowds out invasive species establishment.	LW,LF,C W,CG,UF, M
Fragaria chiloensis	Coastal Strawberry	Birds eat the fruit, butterflies eat the nectar, deer and small mammals eat the berries.	Adds diversity and adds organic matter in sandy soils on coastal bluffs, beaches and dune areas.	CG
Gaultheria shallon	Salal	Bear, foxes, coyotes and other smaller mammals eat the berries. Several bird species, deer, elk and black bear eat the twigs as well. Salal provides cover from predators and the elements	This is a good species for restoring erosive banks and aids in stabilizing coastal dunes and protecting vulnerable watersheds. It forms impenetrable thickets, and acts a good riparian buffer zone by soaking up nutrients, and filters out sediments prior to entering streams and rivers.	LF, UF, CG,CW
Grindellia integrifolia	Gumweed	Helps to provide oxygen to water for aquatic wildlife.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root	CW

			submersion. Helps to provide oxygen. Helps to provide bank stabilization and erosion control.	
Gymnocarpium dryopteris	Oak Fern	Forms dense herbaceous stands useful as a cover for forest wildlife. Grizzly bears and elk browse the oak fern fronds.	This fern can grow on disturbed sites before a canopy cover is established. The dense stands provide organic matter and bank stabilization.	LW,LF,UF
Holodiscus discolor	Oceanspray	During winter months, insect eating birds forage for insects in the shrub. The seeds persist through the winter. Dense branches provide songbirds with shelter and cover. Butterflies browse the foliage and harvest the nectar. Many species of insects live in the dense structure of ocean spray. Deer and elk also browse the foliage.	Good for colorful establishment on disturbed and open sites where it provides stabilization, crowds out invasives and enables autogenic recovery.	LF,CG, UF
Jaumea carnosa	Fleshy jaumea	Helps to provide oxygen to water for aquatic wildlife.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root submersion. Helps to provide	CW

			oxygen. Helps to provide bank stabilization and erosion control.	
Juncus ensifolius	Daggerleaf Rush	Seeds are eaten by waterfowl, muskrats feed on the rootstocks	This is a good wet soil species, supplying soil stability, bank stabilization, erosion control. Nutrient uptake and sediment detention provide water quality maintenance. This is a good riparian zone species.	LW
Lonicera involucrata	Twinberry	Flowers provide nectar for hummingbirds. Berries are eaten by various birds.	This is a good wet soil species, supplying soil stability, bank stabilization, erosion control. Nutrient uptake and sediment detention provide water quality maintenance. This is a good riparian zone species.	LW
Lysichiton americanum	Skunk Cabbage	The pungent odor of the flowers attracts pollinators such as carrion and blowflies. The flower heads are eaten by bear. The roots are eaten by muskrats	Adds diversity to gardens and natural areas. Does well in wet swampy conditions. It does help with increasing organic matter in the soil and erosion control.	LW, M

Oemleria cerasiformis	Indian Plum	Fruits eaten by numerous birds and mammals. Hummingbirds consume the nectar. Foxes, coyotes, deer and bear eat the berries.	It is a relatively fast growing shrub, and is one of the first to bloom. Water needs are minimal, and is reported to be disease free. This makes this species a low maintenance shrub that will establish quickly and crowd out invasive species penetration.	LW,LF,UF
Philadelphus lewisii	mock orange	Deer and elk browse the shrub. Numerous bird species eat the seeds. Butterflies harvest the nectar.	On rocky steep slopes this species provides soil stabilization and vegetative cover. It is also useful in transitional areas of degraded riparian zones.	LF,UF,CG
Phlox diffusa	Spreading Phlox	The nectar attracts a variety of insects.	Forms mats to prevent invasive penetration, adds organic matter to soils, provides bank stabilization and erosion control. This species will grow in spots that other species can't tolerate, such as dry rocky open places.	LF,UF,CG ,M
Physocarpus capitatus	Pacific Ninebark	Fruits are eaten by birds. The twigs, buds and foliage are browsed by herbivores.	Excellent soil binding properties.	LW,LF,C W,CG,UF

Picea sitchensis	Sitka Spruce	Birds: Nuthatches,	Provides canopy	LW,LF,UF
	Sitila Spi ace	grosbeaks, finches,	cover for	,CW,CG,
		chickadees, siskins,	understory	M
		goldfinches,	species, carbon	
		crossbills, and	sequestration,	
		sparrows all eat the	soil quality	
		seeds. Grouse eat the	improvements,	
		needles, sapsuckers	stabilization,	
		harvest insects from	flood and storm	
		the sap, and	abatement.	
		woodpeckers forage		
		on bark beetles. Bald		
		eagles and other		
		predatory birds use		
		the tree as a roost to		
		survey the shore for		
		prey. Some large		
		birds of prey may use		
		the mature trees for		
		nests. Cavity-nesting birds and other		
		animals use the tree		
		cavities. Mammals:		
		Deer and elk		
		consume the shoots.		
		Deer, squirrel,		
		chipmunks and		
		porcupines benefit		
		from the shelter of		
		the tree		
Pinus contorta	Shore Pine	The seeds are eaten	Provides edge	LW,CW,
		by grouse, crossbills,	habitat for	CG
		grosbeaks,	several	
		chickadees, band-	mammals. Has	
		tailed pigeons, quail,	helped to	
		mourning doves, jays,	stabilize sand	
		nuthatches, finches,	dune expansion.	
		and siskin's. Bushtits,	Very useful for watershed	
		kinglets, chickadees, and woodpeckers	stabilization.	
		glean pine beetles and	They absorb	
		other insects from the	excessive rainfall	
		branches and cones.	and regulate	
		Songbirds nest in	water flows. It is	
		most pines. Butterfly	also valued for	
		larvae eat the foliage.	rapid growth,	
		Porcupines depend	and providing	
		on it for winter	protection from	
		forage. Squirrels and	the elements to	
		chipmunks eat the	numerous	
		seeds.	understory	

			species.	
Plantago maritima	Seaside plantain	Helps to provide oxygen to water for aquatic wildlife.	removes saltfrom internalfluids. Toleratesfresh and saltwaterinterchange, tidalinundation, andgrowthcharacteristicssupportprolonged rootsubmersion.Helps to provideoxygen. Helps toprovide bankstabilization anderosion control.	CW
Plectritis congesta	Sea Blush	Helps to provide oxygen to water for aquatic wildlife.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root submersion. Helps to provide oxygen. Helps to provide bank stabilization and erosion control.	CW

Proudotavaa maniaii	Douglas Fir	Numerous bird	These trees	IWIETE
Pseudotsuga menziezii	Douglas FIr			LW,LF,UF
		species eat the seeds,	provide thermal	,CG,M
		and nest in cavities.	cover, the snags	
		Birds also eat the	and large woody	
		insects in the trunks,	debris provide	
		cavities, branches	habitat, and for	
		and twigs. Flying	contributing to	
		squirrels also nest	meandering	
		and roost in mature	patterns of	
		trees. Foliage is eaten	streams and	
		my butterfly larvae	rivers. They also	
		and numerous	provide organic	
		moths. Squirrels and	matter to soils,	
		chipmunks eat the	and contribute to	
		seeds. The foliage and	soil stability,	
		twigs are eaten by	erosion control,	
		deer, elk, beavers and	storm abatement	
		porcupines when	and flood	
		more preferred	attenuation.	
		sources are scarce.		
Rhododendron	Pacific	Songbirds nest in the	My corrhiza	LF,UF
macrophyllum	Rhododendr	larger plants,	promotes	
	on	bumblebees and	nutrient uptake	
		butterflies are	in nutrient poor	
		attracted to the	environments.	
		flowers, deer eat the		
		flower buds. Also		
		provides cover for		
		smaller mammals.		
Rosa nutkana and Rosa	Nootka Rose	Provides food,	It has been	LW,LF,UF
woodsii	and Wood's	habitat and shelter	successfully used	,CW,CG,
	Rose	for birds, and the	in restoration	Μ
		seeds are used for	projects. It is a	
		grit. The leaves are	dominant	
		eaten by butterfly	understory shrub	
		larvae. The leaves are	that can	
		also used by the leaf-	outcompete	
		cutter bee. Young	invasive plant	
		rose shoots are	species. It	
		popular with aphids	contributes to	
		which in turn provide	soil stability and	
		food for a wide range	water quality.	
		of predators		
		including ladybugs		
		and songbirds. Large		
		and small mammals		
		eat the hips. The rose		
		thicket provides		
		important shelter and		
		habitat for many		
		mammals.		
		mannal3.		

Rubus spectabilis	Salmonberry	Fruits are eaten by numerous bird species and is one of the first blooming plants visited by hummingbirds. The thickey structure is good for bird habitat. Bumblebees also consume the nectar. Fruit is also eaten by raccoons, chipmunks, and squirrels. Rabbit and deer browse as well. It also has a thorny protective cover.	Used in re- vegetation of damaged sites to improve soil nutrients, stability, erosion control, sediment control, and water quality. It also aides in binding and degrading specific pollutants.	LW, LF, UF,CW,C G,M
Salicornia virginica	Pickleweed	Helps to provide oxygen to water for aquatic wildlife.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root submersion. Helps to provide oxygen. Helps to provide bank stabilization and erosion control.	CW
Salix sitchensis	Sitka Willow	Helps to provide oxygen to water for aquatic wildlife.	removes salt from internal fluids. Tolerates fresh and salt water interchange, tidal inundation, and growth characteristics support prolonged root submersion. Helps to provide oxygen. Helps to provide bank stabilization and erosion control.	CW

Scirpus maritimus	Seacoast	Eaten by	Good	CW, CG
Scripus maranas	Bulrush	invertebrates,	regenerative	0.1,00
		provide food and	capacity, and can	
		cover for many	produce a good	
		aquatic birds. Also	canopy.	
		used for molting,	Formation of a	
		migrating, and	good riparian	
		wintering waterfowl.	buffer providing	
		It is used for cover	shoreline	
		and food for	stabilization,	
		muskrats and the	flood mitigation	
		endangered	and storm	
		saltmarsh harvest	abatement. This	
		mouse.	plant species can	
			be spread long	
			distances by	
			birds via	
			digestive tracts.	
Spiraea densiflora	Subalpine	attracts butterflies	Once established	Μ
	Spirea	and recognized by	it grows rapidly	
		pollination ecologists	and provides	
		as attracting large	moist mountain	
		numbers of native	soil with stability	
		bees.	and erosion	
			control on rocky	
			slopes. It also	
			soaks up	
			nutrients and	
			acts as a buffer	
			along mountain	
			streams and	
			rivers.	
Symphoricarpus albus	Snowberry	Berries are eaten by	Used in re-	CW,CF,U
		numerous bird	vegetation of	F,CW,CG,
		species when other	damaged sites to	Μ
		food sources are	improve soil	
		scarce. It is also a	nutrients,	
		nesting habitat for	stability, erosion	
		ducks. Bumblebees	control, sediment	
		and hummingbirds	control, and	
		eat the nectar.	water quality. It	
		Theleaves are eaten	also aides in	
		by moth larvae.	binding and	
		Leaves and twigs are	degrading	
		browsed by deer, and	specific	
		provides low shelter	pollutants.	
		and nesting area for		
		small mammals.		

Thuja Plica	Western Red	Birds eat the winged	This tree	LW,LF,UF
	Cedar	seeds and important	provides	,CW,M
		shelter and nest sites	important	
		are provided. Cavity	thermal cover	
		nesting birds also use	and habitat for a	
		this tree. It is one of	multitude of	
		the most important	small and large	
		conifer foods of deer	mammals. It is a	
		and elk. Tree	preferred choice	
		squirrels and	for re forestation	
		porcupines use the	and has good	
		fibrous bark strips	erosion control	
		for nesting material.	properties.	
		Black bear remove		
		the bark and eat the		
		exposed sapwood.		
Triglochin maritimum	Seaside	Helps to provide	removes salt	CW
	arrowgrass	oxygen to water for	from internal	
		aquatic wildlife.	fluids. Tolerates	
			fresh and salt	
			water	
			interchange, tidal	
			inundation, and	
			growth	
			characteristics	
			support	
			prolonged root	
			submersion.	
			Helps to provide	
			oxygen. Helps to	
			provide bank	
			stabilization and	
			erosion control.	

The information within this spreadsheet was assembled using the following sources:

(Kruckeberg, 1993, Pojar, 2004, WNPS, 2013, Henry, H. and K. Bergeron, 2005, nw plants, 2013, NRCS, 2013, The Olive Tree, 2013, Uchytil, 1989,Uchytil, Species: Betula papyrifera, 1991, Tirmenstein, 1990, Snyder, 1993, Fryer, 2010, Zouhar, 2000, Shaw L., 2013, State of Washington Department of Ecology, 2013, Johnson K., 1999, Gucker, 2012, Crane, 1990, Reed, 1993, Tesky, 1992, Fryer J., 2007, Uchytil, Species: Acer circinatum, 1989, Hauser, 2006, Cope, 1993, Tirmenstein D. A., 1990, Portland Nursery, 2013, USGS, 2013, 2013 Lady Bird Johnson Wildflower Center, 2013)

Appendix B

List of interviewed golf course related personnel

Golf Club at Newcastle

Horticulturalist - Carol White on 11/23/2011

Head Golf Course Superintendent - Scott Phelps on 9/15/2012

Jackson Park Golf Course

SPU/Parks Project Coordinator - Cheryl Eastberg on 6/19/2012

Parks Golf Manager - Paul Wilkinson on 6/05/2012

SPU Parks Project Architect - Garrett Farrell on 6/19/2012

Golf Course Superintendent - Bob Maddox on 6/05/2012 and 6/28/2012

Landscape Architect – Stephen Speidel, ASLA from R.W. Thorpe & Associates on 6/25/2012.

Chamber's Bay Golf Course

Director of Agronomy - Eric Johnson on July 8, 2013

Trophy Lake Golf and Casting

Golf Shop Assistant – Casey Griebel on August 6, 2013. Questions directed to this person were in relation to alternative uses of the facility.

Sumner Meadows Golf Links

Community Development Manager - Ryan Windish on July 17, 2013. Questions directed to this individual were only related to the closing of this course, and use after closed.

Gold Mountain Golf Complex

Golf Course Superintendent – Ed Faulk on August 22, 2013.

Washington National Golf Course

Golf Course Superintendent - Trevor Broersma on August 5, 2013

Lake Ballinger Golf Course

City of Mountlake Terrace – Mike Shaw at public meetings held on June 11 and July 9, 2013.

Appendix C

The information below was taken from the USGA website (USGA, 2013)

CURRENT PROJECTS

Physiology, Genetics, and Breeding

The Nobel Prize-winning chemist Robert F. Curl of Rice University spoke for many of his colleagues in science when he proclaimed that the 20th century was "the century of physics and chemistry. But it is clear that the next century will be the century of biology." Seventeen projects are ushering biotechnology into turfgrass species, along with conventional plant breeding improvements bentgrass and bermudagrass. The goal is to reduce water and pesticide use in the long term. The USGA continues to collect and evaluate other promising grass species, such as seashore paspalum and inland saltgrass, which will allow poor quality water to be used in coastal and desert climates.

Project Title	University
Buffalograss Breeding And Genetics	University of Nebraska
Development Of A Shade-Tolerant Bermudagrass	Oklahoma State
Cultivars Suitable For Fine Turf Use	University
Improving Our Understanding Of Salinity Tolerance In Perennial Ryegrass Through Transcriptome Analysis	Rutgers University

Project Title	University
Development Of Fine-Textured, Large Patch-Resistant Zoysiagrass Cultivars With Enhanced Cold Hardiness For The Transition Zone	Texas A&M University
Early Physiological Changes Associated In Cold Deacclimation Of Annual Bluegrass And Creeping Bentgrass	University of Massachusetts
<u>Development Of Seeded Zoysiagrass Cultivars With</u> <u>Improved Turf Quality And High Seed Yields</u>	Texas A&M University
<u>Molecular Characterization Of Chinch Bug Resistant</u> <u>Buffalograss</u>	University of Nebraska
Characterization And Validation Of Molecular Markers Linked To Heat And Drought Tolerance For Marker Assisted Selection Of Stress-Tolerant Creeping Bentgrass	Rutgers University
<u>Evaluation Of Curly Mesquite And Sprucetop Grama Fo</u> <u>Turfgrass Development</u>	r University of Arizona
Breeding And Evaluation Of Kentucky Bluegrass, Tall Fescue, Perennial Ryegrass And Bentgrass For Turf	Rutgers University
Development Of Seeded Turf-Type Saltgrass Variety	Colorado State University

Project Title	University
<u>Production And Maintenance Of Triploid Interspecific</u> <u>Bermudagrass Hybrids For QTL Analysis</u>	University of Georgia
Adaptation And Management Of Fine Fescues For Golf	University of
<u>Course Fairways</u>	Minnesota
<u>Genetic Improvement Of Prairie Junegrass</u>	University of Minnesota
Breeding And Evaluation Of Turf Bermudagrass	Oklahoma State
<u>Varieties</u>	University
Improved Understanding and Testing for Salinity Tolerance in Cool-Season Turfgrasses	Utah State University
Germplasm Improvement of Low-Input Fine Fescues	University of
	Minnesota

Integrated Turfgrass Management

The golf course superintendent and staff work diligently to provide the best playing conditions possible; however, proper course management today also requires conserving natural resources and protecting the environment. Thirty-two projects are underway to evaluate reduced pesticide use, increase our understanding of plant disease and insect pests, provide better plant resistance to both pest and climatic stresses, and improve overall management techniques for new and improved turf cultivars.

Project Title	University
Efficient Irrigation Of Golf Turf In The Cool-Humid New England Region: Evapotranspiration And Crop Coefficients	University of Massachusetts
<u>Reducing Watershed Scale Phosphorus Export</u> <u>Through Integrated Management Practices</u>	USDA-Agricultural Research Service
Long Term Nitrogen Fate Research	Michigan State University
<u>Development Of Phosphorous Filtering Systems For</u> <u>Environmental Protection</u>	Oklahoma State University
<u>Irrigation Requirements For Salinity Management On</u> <u>Perennial Ryegrass Turf</u>	University of California- Riverside
<u>Foliar Urea-Nitrogen Use Efficiency Of Warm-Season</u> <u>Putting Green Turfgrasses Under Salinity Stresses</u>	Clemson University
<u>Development Of Best Management Practices For</u> <u>Anthracnose Disease On Annual Bluegrass Putting</u> <u>Green Turf</u>	Rutgers University
Promotion Of Turf Health Through Early Pathogen	Rutgers University

Project Title	University
Detection-Development Of A Turf PathoCHIP	
The Development, Application, And Evaluation Of ANew System For Enhancing The Efficiency Of ControlAgents For The Management Of Sting Nematodes On	Clemson University
Golf Course Turf Use Of Silver Nanoparticles For Nematode Control On The Bermudagrass Putting Green	Texas A&M University
Investigations Into The Cause And Management Of Etiolation On Creeping Bentgrass Putting Greens	North Carolina State University
<u>Management Of Bacterial Wilt Of Creeping Bentgrass</u> <u>Caused By Acidovorax Avenae On Golf Courses In The</u> <u>Eastern United States</u>	University of Rhode Island Clemson University
Determining The Reproductive Phenology Of Emerging Overwintering Annual Bluegrass Weevil Populations For The Optimization Of Management Programs	State University of New York
Biological Control Of White Grubs In Turf With <i>Microsclerotial</i> Granules Of Metarhizium Anisophiae	USDA/ARS/NCAUR

Project Title	University
Integrated Pest Management Of Plant-Parasitic Sting Nematodes On Bermudagrass	University of Florida
Infection And Colonization Of Bermudagrass By Ophiosphaerella Species: The Causal Agents Of Spring Dead Spot Of Bermudagrass	Oklahoma State University
Occurrence And Identification Of An Emerging Bacterial Pathogen Of Creeping Bentgrass	Michigan State University
<u>Validation Of A Logistic Regression Model For</u> <u>Prediction Of Dollar Spot Of Amenity Turfgrasses</u>	Oklahoma State University
Optimizing Turfgrass Establishment on Sand-Capped Tees and Fairways	University of Arkansas
Development of Large Patch Resistant and Cold Hardy Zoysiagrass Cultivars for the Transition Zone	Kansas State University
Development of Large Patch Resistant and Cold Hardy Zoysiagrass Cultivars for the Transition Zone	Purdue University
Large Patch on Zoysiagrass and Spring Dead Spot on Bermudagrass as Affected by Establishment Method and Cultural Practices	University of Arkansas

Project Title	University
Novel Enzyme Technology to Alleviate Soil Water Repellency in Turfgrass Situations	University of Georgia
Effect of Glycinebetaine Seed Priming on the Tolerance to Abiotic Stresses in Turfgrass	North Dakota State University
Annual Bluegrass Response to Potassium and Calcium Fertilization and Soil pH	Rutgers University
Do Foliar Fertility Products Enhance N Uptake and Turfgrass Performance?	University of Illinois
Developing Management Practices and Prediction Models for Controlling Seedheads on Warm Season Turfgrasses	University of Georgia
Evaluation of Fertilizer Application Strategies for	University of Missouri
Preventing or Recovering from Large Patch Disease of	and Kansas State
Zoysiagrass	University
Development of Molecular Diagnostic Assays for Fungicide Resistance in the Dollar Spot Pathogen <i>Sclerotinia homoeocarpa</i>	University of Massachusetts
Do Management Regimes of Organically and Conventionally Managed Golf Course Soils Influence Microbial Communities and Relative Abundance of	University of Massachusetts

Project Title

University

Important Turf Pathogens?	
Advancing Integrated Management of Annual Bluegrass Weevil	Rutgers University
Benefits of Golf Course Naturalized Areas for Biological	University of Kentucky
Control and Pollinator Conservation	

Environmental Impact

There is increasing concern about long-term climate change due to an increase in greenhouse gases in the earth's atmosphere. What role do the turfgrasses commonly grown on golf courses have on greenhouse gases? These six USGA projects are among the first research studies to evaluate the amount of carbon dioxide stored in the soil each year by golf course turf, as well as the gases emitted by these plants while actively growing and maintained. At this time, the focus is on the amount of carbon dioxide (CO₂) and nitrous oxide (NO₂) that is released to the atmosphere or stored in the soil by actively growing turfgrass.

Project Title

University

Water-Use Efficiency and Carbon Sequestration Influenced by University of

Turfgrass Species and Management Practices	California, Riverside
Carbon Footprint and Agronomy Practices to Reduce Carbon	
Footprint of Golf Courses	University
Examining Turfgrass Species And Management Regimes For Enhanced Carbon Sequestration	Purdue University
Nitrous Oxide and Carbon Dioxide Emissions in Turfgrass:	Kansas State
Effects of Irrigation	University
Various fertilizer sources and cultivation practices for	
mitigation of greenhouse gas emissions and potentially	University of
mineralizable nitrogen on Creeping bentgrass and Kentucky	Minnesota
bluegrass.	
Nitrous Oxide Emissions from Stands of Cool Season Turfgrass Managed with Organic and Synthetic Nitrogen Fertilize	University of Wisconsin

Product Testing

Every year, golf course superintendents are introduced to new products in the marketplace. Without results from objective research, superintendents are asked to make buying decisions based on testimonials from colleagues based on previous experience. Several surveys indicate that golf course superintendents desire side-by-side product evaluations to assist them in making product purchases. The need for this type of information resulted in product testing research. Currently, USGA is funding ten projects that fall into this category.

Project Title University Evaluation of an Inorganic Soil Amendment to Reduce and Pennsylvania State Manage Fairy Ring Symptoms in Turfgrass. University Reducing watershed scale phosphorus export through **USDA-ARS** integrated management practices Plant Growth Regulator and Soil Surfactants' Effects on New Mexico State Drought and Salinity Stressed Bermudagrass and Seashore University Paspalum Product Testing Turf Colorants for Aesthetics and/or as an North Carolina State Alternative to Overseeding University Summer Interseeding and Aggressive Post-Seeding Herbicides University of Nebraska to Reduce Annual Bluegrass in Fairways Testing a Promising Herbicide to Control Annual Bluegrass University of (*Poa annua*) in Creeping Bentgrass Putting Greens Missouri University of Developing Weed Management Programs for Creeping Tennessee Bentgrass Fairways Using Low Environmental Impact

Herbicides

The Effects of Micro-Blaze Turf Care on Creeping Bentgrass	Oklahoma State
and Bermudagrass Putting Green Quality, Root Growth, and	University
Soil Moisture	
Evaluation of New Bermudagrass Cultivars for Golf Course	National Turfgrass Evaluation Program
Putting Greens	(NTEP)
	University of
Evaluation of Organic Amendments and Delivery	Missouri, University
Technologies for Control of Large Patch Disease (Rhizoctonia	of Arkansas, and
solani) on Zoysiagrass (Zoysia japonica) Fairways	Oklahoma State
	University
Evaluations of New Turfgrass Fertilizers - Field and	Auburn University

Regional Grants

The USGA Green Section relies on science for answers that will help ensure the long-term success of the golf course management industry. Regional grants were created to quickly answer applied problems to help superintendents meet the challenges of managing golf courses. The regional grants allow directors of all eight USGA Green Section regions to identify applied

problems and the appropriate researchers in their regions to solve those problems. Research projects funded under this program most often include cultural aspects of golf course management. Examples include what fungicides work best on a particular disease, or the management of new turfgrass cultivars, renovation techniques, safe and effective use of herbicides, insecticides, or fertilizers. These projects are usually of short duration (1 to 2 years), but can offer golf course superintendents answers to practical, management-oriented challenges that they can put into use quickly.

Project Title

University

Impact of Sand Size and Topdressing Rate on Surface Firmness and Turf Quality of Velvet Bentgrass	Rutgers
Eagle Video Camera Project at The Bear Trace at	Friends of Harrison
Harrison Bay	Bay
Proper Application Rates of Biostimulants on Turfgras Growth	s University of Arizona
Are Turfgrasses Capable of Inhibiting Nitrification?	Iowa State University
Evaluation of Water Use Rates Among Bermudagrass	Oklahoma State
Cultivars	University
Deficit irrigation programs for water conservation in	Lone Star GCSA

Project Title

University

the management of Bermuda grass fairways in Texas

Feasibility of Using Critical Soil Water Content to	University of
Determine Cart Traffic During Wet Periods	Georgia
Reseeding interval following methiozolin (PoaCure)	Washington State
applications	University
Evaluation of Warm- and Cool-Season Turfgrass	Purdue University
Species in Indiana	

Appendix D

The information below was taken from the USGA web site (Nelson, 2013).

NATURAL AREAS

Establishing Natural Areas on the Golf Course

Many articles have expounded the merits of golf courses in the overall scheme of environmental quality. Some of the environmental benefits provided by golf courses include wildlife habitat, water purification, noise reduction, temperature modification, atmospheric processes, and preservation of green space. Adversaries of golf courses cite rampant development, often in environmentally sensitive locations, potential pollution by pesticides and fertilizers, unwarranted use of potable water, and other threats posed to the environment by golf courses. Regardless of the exact ecological significance of golf courses, the fact remains that the approximately 15,000 golf courses in the United States constitute a sizeable acreage, particularly in urban and suburban areas. Opportunities to naturalize exist within many golf courses, and these will become increasingly significant in landscape conservation. This article discusses establishment and maintenance of three general types of natural areas commonly found on golf courses: (1) grasslands, including wildflower areas; (2) riparian areas, including streams, shorelines, and wetlands; and (3) forested areas.

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Grasslands

The value of natural areas on the golf course is generally acknowledged, but little has been published concerning the implementation of natural area plantings on golf courses. The use of native grasses to establish attractive, environmentally beneficial, low-maintenance areas is one of the most commonly desired types of natural areas. Stands of native grasses can result in water savings, reduced fuel use and labor, and improved aesthetics. Images of these areas conjure visions of some of the world's greatest courses - the Old Course at St. Andrews, Prairie Dunes, Shinnecock Hills, and National Golf Links. Unfortunately, not all sites are blessed with the soils, climate, and existing vegetation to make the establishment and maintenance of these areas as easy as the great courses make it seem. Most course officials do not understand the establishment process required for native grasses, and accordingly lack the patience to see the implementation of these areas through to fruition. Even more common is the failure to employ proper establishment techniques, which often translates into the development of an unsightly stand of weeds that receives strong criticism from the golfers.

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Establishment

When establishing native grasses from seed, minimum or no tillage is recommended when preparing the seedbed. This technique discourages the germination of weed seed present in the soil. Drill seeding is preferred, and seeding rates should be kept low to avoid establishing an excessively thick stand that reduces the quality of wildlife habitat and slows the pace of play. A rate of 25 lbs. of seed per acre is a common recommendation for sowing seeds of native grasses. Grasses such as fescues or annual ryegrass used as a cover crop can dominate the stand and hinder native grass establishment so cover crops usually are not recommended and, if used, should be kept to a very low seeding rate. Fertilizer is not recommended except for extremely poor soils and, if used at all, should consist of low analysis natural organic material. Fertility generally enhances weed growth over the native grass stand. The use of a non-selective herbicide prior to planting reduces competition with existing vegetation for nutrients, water, and light. An early fall planting date takes advantage of favorable soil temperatures and decreased weed pressure in most areas. Since most of these areas will be non-irrigated, seeding dates should be timed to take advantage of climatic patterns and expected precipitation. Early spring seeding and dormant seeding also can be effective in many areas.

During the first year or two of establishment, native grasses typically allocate around 70% of fixed carbohydrates to root development. This explains why it may take up to three years to notice significant foliar development in native grass stands. The phrase "sleep, creep, and leap" is often used to describe the first three years of native grass development. Therefore, it is important to convey to the golfing clientele what to expect when establishing grasslands with native species.

Native grasses also can be established vegetatively. Many nurseries today stock native plants, including grasses. Some golf courses have established on-site nurseries today of native grasses where plant material can be expanded and relocated to desired areas on the golf course.

Vegetative establishment is an effective way to speed stand establishment, and may be especially desirable on steep slopes that are prone to erosion.

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Weed Control

Controlling weeds during establishment is an important facet of a planting program and can involve mowing, hand rouging, spot or wick application of selective herbicides, and open field burning. Mowing establishing grassland areas reduces weed pressure by inhibiting photosynthesis of broadleaf species. Mow twice per year during the first few years of establishment. Pulling weeds manually is one of the most effective methods of weed control, but obviously is labor intensive. Spot applications of a selective herbicide also are possible, as is wick application early in the year when broadleaf weeds have grown above the canopy of the grasses.

However, weed control should be carefully considered. Many plants deemed weeds are in fact valuable herbs and forbes within the community. For instance, milkweed might be considered undesirable by some for aesthetic reasons, but this plant is critical for the reproduction cycle of monarch butterflies. The best approach is to have all plants in the stand identified and their relative significance and abundance evaluated by someone familiar with local ecology. Species identification can determine where and when weed control efforts are warranted.

Open field burning is a very effective means of reducing weed pressure since it destroys weed seed. Burning also reduces disease and insect pests and improves vigor of desirable grasses.3 Burning grasslands is one of the oldest agricultural practices, and its benefits were well known by native peoples of this continent who employed burning of grasslands for millennia. If allowed, burning should commence on an annual basis after the third year of establishment. Burning before this time could cause injury to juvenile grass plants. Burn in early spring, and it may be helpful to swath the area ahead of time to lay senesced tissue down for fuel. Be sure to obtain all necessary permits before proceeding to burn natural areas.

Among the most popular native grasses used on the golf course are big and little bluestem, switch grass, Indian grass, blue grama, side-oats grama, buffalo grass, reed canary grass, wheat grasses, and sheep fescue. These grasses vary in their climatic adaptation, so check references to determine appropriate native grasses for your particular site.

Wildflowers often are a popular component of grass stands and are sometimes established alone. Much of the same advice applies for establishment: minimize tillage and fertility, prepare the site in advance, and seed when germination is favored. Wildflowers usually do not perform well in shaded or trafficked areas, or under very poor soil conditions. Look for sunny, well-drained, outof-the-way sites for wildflowers. As with grasses, choose a mix of wildflowers that is adapted to your region, and choose a desired blend of annual and perennial flowers. Wildflower areas may require annual or biennial seeding to prevent one perennial species from dominating the stand. Weed control requires pre-plant herbicide applications and hand pulling of weeds. Spot applications of herbicides can be made, but no selective herbicides are available for broadleaf weed control in wildflower stands.

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Wildlife

Wildlife habitat can be significantly enhanced with the establishment of grasslands. Birds and mammals utilize prairie plant communities for nesting, foraging, and cover. Stands that are too thick actually reduce habitat quality by impeding overland travel; therefore, maintain open, bunch-type stands of grasses and flowers. Creating cells, or zoned patches, of habitat with shrubs or trees enhances the wildlife value of the area by mimicking natural plant succession. Isolated patches of shrubs provide thermal and protective cover for wildlife, thereby reducing isolation and vulnerability to predators.

A stand of native plants also helps preserve populations of native insect pollinators. Many ecologists have considered the loss of native pollinators a significant threat to many native plant species. The relationship between plant and insect can be very specific, and golf courses offer an opportunity to preserve native plant species within the ecosystem.

Another important consideration with regard to wildlife habitat is the presence of eco-tones, which are the transition areas between habitat types. For instance, edges of forests and riparian areas could be considered eco-tones. The most desirable approach when considering eco-tones is to avoid stark transitions like straight lines. Transition areas should approximate the natural landscape and include irregular borders and a diverse vegetative composition. Eco-tones are important components of the ecosystem as they represent areas of community interaction and varied wildlife habitat components. When naturalizing the golf course with native grasses and wildflowers, be sure to start with a small area to evaluate establishment methods and the adaptability of the chosen plants. Also, be sure that the selected areas are appropriately located so as not to adversely affect the speed of play. Excessively thick stands of secondary rough often are located too close to in-play features and can be overly penal. The caliber of play at the golf course should be evaluated to determine where forced carries and other natural areas come into play. The number of available teeing areas per hole also could impact where natural areas are appropriate. From an aesthetic standpoint, determine what types of natural areas are suitable to your site. Not all sites are suited to prairie or meadow-type natural areas, and they may look out of place when forced into the wrong location.

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Riparian Areas

Riparian areas on the golf course include the shorelines of lakes and ponds, stream corridors, and wetlands. Natural vegetation in these areas serves the dual purpose of improving aesthetics and providing a functional component of ecosystem enhancement. Buffer strips along lakes, ponds, and streams reduce soil erosion, filter runoff, provide a barrier between nutrient-rich grass clippings and the water feature, create wildlife habitat, utilize nutrients that have entered the water feature, and help prevent thermal pollution of our waterways. Establishing buffers also saves valuable labor hours by reducing or eliminating time-consuming string trimming and walk mowing. Vegetative buffers also may deter geese from occupying critical play areas such as

greens, tees, and fairways. Geese often are reluctant to venture through thick vegetation when exiting a water source for fear of predators on the terrestrial side.

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Lakes, Ponds, And Streams

Vegetated shorelines and stream banks can be established simply by allowing existing vegetation to grow unmaintained, or native riparian plant species can be established by seed or transplanting. Emergent vegetation such as juncus and iris can be transplanted and provide a wonderful aesthetic enhancement, especially where water levels fluctuate. Cattail seed can be collected by hand and spread along shorelines to establish this extremely productive plant. Cattails utilize many nutrients which otherwise might be available for algal growth. These are a few examples of various techniques used to reclaim shoreline vegetation.

Maintaining vegetation along streams, especially trees in out-of-play areas, provides thermal protection and helps maintain adequate supplies of dissolved oxygen for floral and faunal aquatic species by reducing biological oxygen demand. Vegetated stream banks and shorelines also anchor soils and reduce erosion. Another important consideration for streams is to leave a certain amount of downed wood and rocks in the stream channel to create spillways and eddies for oxygenation and wildlife habitat. This is a lesson the U.S. Forest Service learned after decades of logging and stream clearing when salmon habitat declined severely. Dredging and clearing stream channels eliminates wildlife habitat, reduces natural water purification, and promotes

accelerated erosion.

Water quality in streams, ponds, and lakes should be monitored regularly to document change and establish baseline values for evaluation of maintenance practices. A testing laboratory can perform water quality testing, and stream health can be gauged by sampling macroinvertebrate aquatic species.

Vegetated shorelines and stream banks should be at least 10 to 15 feet deep from the edge, and should be clearly marked for hazard delineation on the maintained edge. Protection of our waterways should be given a high priority by golf courses, as protection of water resources is at the forefront of environmental concern in this country. Also, maintenance hours spent string trimming and hand mowing shorelines and stream banks can be put to better use on other areas of the golf course more critical to play.

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Wetlands

Wetland areas should be clearly delineated, and players and employees should be kept out. Use caution with fertilizer, pesticides, clippings, and irrigation near wetlands. In some cases, it may be appropriate to designate wetlands as environmentally sensitive areas by an appropriate authority. Wetland areas are among the most productive and dynamic ecosystems on the face of the earth, and they are host to numerous foraging and nesting wildlife species. Wetlands should

be monitored yearly for water level fluctuations, water quality, and species changes. Water should be tested and numerous photographs should be taken at regular intervals throughout the year. Documentation of wetland parameters enables the establishment of a database, which can be used to evaluate management practices and correlate to climate variations.

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Forests

Trees can be both an environmental asset and liability on golf courses. The key is to know where forest habitat is appropriate and where it is not. From an environmental standpoint, it generally is believed that a diverse mix of both tree species and ages is the best for wildlife and plants. A stand consisting of a well-developed structure provides the greatest amount of habitat niches for the most diverse amount of wildlife. Thus, canopy, secondary growth, and understory all are important functional components of the forest community. It has been well documented that snags and dead or decaying trees provide excellent roosting habitat for many raptors and nesting habitat for cavity-nesting bird species such as the spotted owl. Equally important, but often overlooked, is downed wood on the forest floor. Downed wood provides habitat for many terrestrial species, serves as nurse logs for new trees, is important for nutrient cycling, and helps hold moisture in humus and soil layers. Leaving downed wood in forest areas is just as important as leaving snags.

In many climates across the United States, however, there are areas of the golf course where

natural forest areas are not appropriate. Where summer humidity and disease pressure are problems, a well-structured forest in close proximity to turfgrass can create severe problems, especially for greens and tees. This is the case where trees can actually create an environmental liability. Shading and restricted air circulation limits growth and recovery of turfgrasses, and enhance disease pressure. To keep grass alive, increased pesticide use often is necessary, which increases employee and golfer exposure, volatile losses to the atmosphere, and the threat of groundwater or surface water pollution. Although proper management and application can minimize these risks, modification of the growing environment can reduce the amount of needed chemical inputs. Shade and poor air circulation are among the biggest problems for turf management in the United States, reflecting people's poor understanding of the effects of trees on turfgrass. Forested areas can provide tremendous environmental enhancement, but they need to be properly located and also properly balanced with the rest of the management program.

Rarely do tree plantings approximate the natural condition. Trees planted on golf courses should be selected for a number of management and playability factors, and species that are part of native, local forest communities should be selected. Never plant trees to the immediate southeast of greens and tees, as they eventually restrict morning sunlight penetration. Morning sun is thought to be the most important of the day. Also, avoid introduced species. The Norway maple is an example of an introduced tree species commonly used on golf courses. It severely restricts grass growth and has become a problem in natural forest communities. Norway maples develop leaves much earlier in the season than most native trees, and they hold their leaves much later into the fall. The result is that many forest species and turfgrass are effectively shaded out of establishment. This weed can be considered one of the greatest threats to native plant
communities in many parts of the country.

Using forested natural areas as corridors between larger natural areas is a progressive means of enhancing wildlife habitat and managing within the larger ecosystem. Linking fragments of habitat preserves genetic diversity among populations and provides thermal and protective cover for diurnal and seasonal movement of wildlife. Golf courses often serve as links between surrounding habitats and natural features. This point should always be given consideration during new development.

Forested natural areas can be an excellent benefit to wildlife and the environment, but be sure they are properly located far enough away from critical play areas. Allowing forest plants to develop through natural succession is perhaps the best way to manage these areas. Leave snags and downed wood, and allow the forest to manage itself. Walking paths with signs identifying different species and components are a wonderful way to share the benefits of natural areas with golfers.

The implementation of plans for natural areas on the golf course can be a rewarding experience for humans and nature. Every golf course has something different to offer, and collectively golf courses can play a tremendous role in landscape conservation across this country. The game of golf is here to stay, as is continued population growth and development. The focus now should be retrofitting the nearly 15,000 golf courses nationwide to maximize their environmental contribution, and laying the groundwork for sustainable golf course development and management in the future. Golf has long shared a close connection with our environment, and

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the game now has an increasingly important role in conservation. It is time to step up and contribute at your course. After all, it isn't called 'the greatest game for nothing.

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