Effects of Disc (Frisbee) Golf on Tree Health

for

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by

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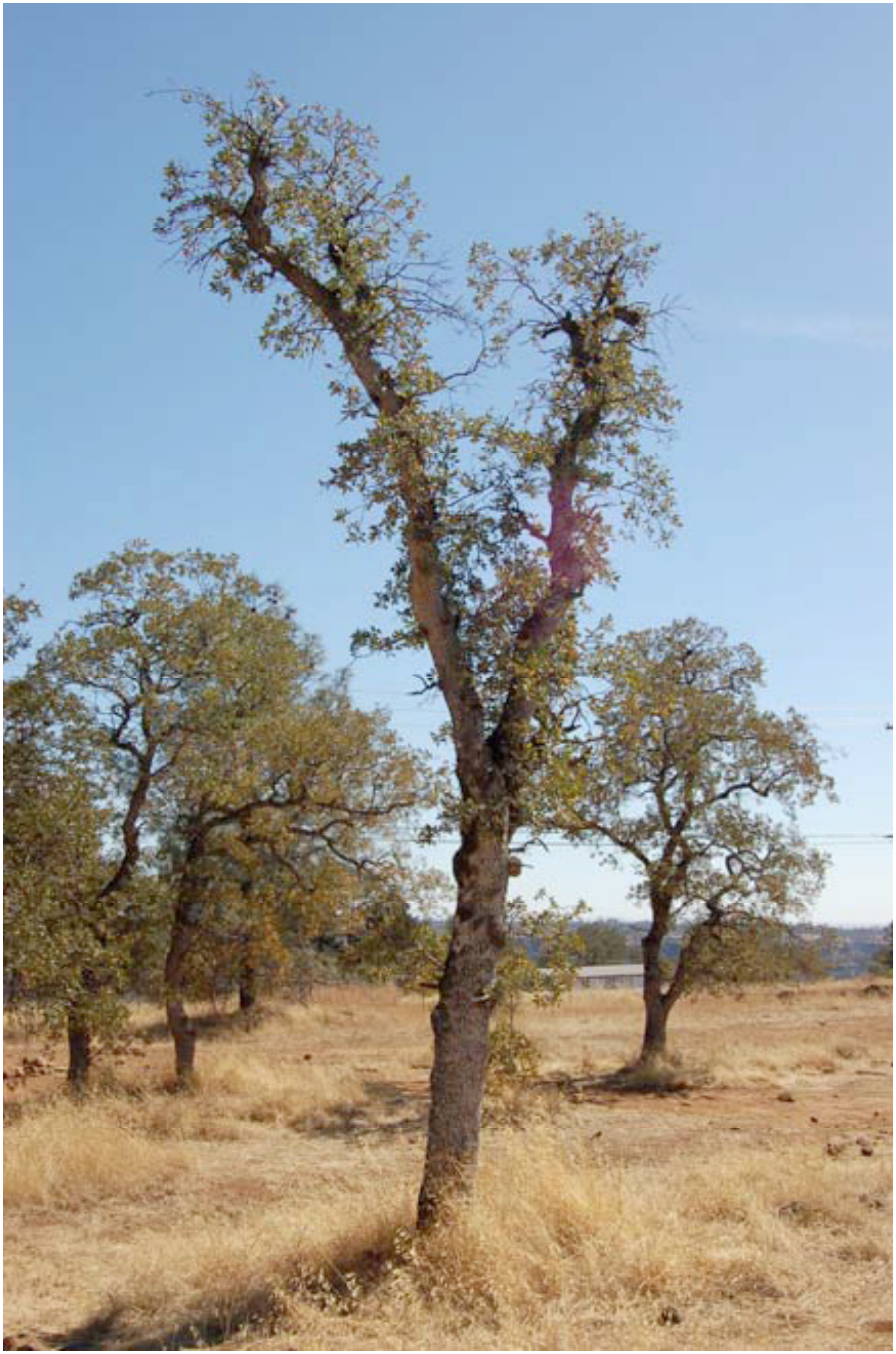

BACKGROUND

Hippy golf?

Disc golf is also known as Frisbee Golf, Frolf and Hippy-golf among other monikers. Since its humble beginnings as an adaptation of the ancient game of “ball golf” invented in Scotland, disc golf has grown from one permanent course in Pasadena in 1975 to more than 5,000 courses worldwide today (DG CourseReview 2013). Disc golf grew out of an era of emerging lifestyle sports in the early 1970's, such as surfing, that changed the way much of the public chooses to recreate. Although serious competitions for professional disc golfers are on the rise, it is largely an unstructured, accessible (cheap) sport that is easy to learn but difficult to master, which gets a lot of people addicted. For the most part courses are laid out in public parks or recreation areas in loop, zig-zag, figure-8 or out-and-back routing patterns (Figure 1). The target is called a “basket” or “pole-hole” (Figure 2), instead of a hole in the ground as in “ball golf”. Hole lengths generally range from 150 to 450 feet long. On average 1-acre per hole is desirable. A good 18-hole course would require about 20 acres of land. Tee areas, where players are allowed to run up and launch their drives into the fairway are made of either poured concrete, permeable rubber mats, bare dirt or turf. Disc golfers follow their drives and throw again where it lies, often trampling areas off trail or dense in vegetation to recover errant throws.

Speak for the trees

Trees are very desirable landscape features on disc golf courses. Trees provide disc golfers with shade on hot days, block strong winds from wreaking havoc on approach shots, create engaging, canopy tunnel shots where they grow together, and serve as landmarks along the course to help gauge distances and angles. Trees located near tee-off areas are often bombarded by stray drives at upwards of 60 miles per hour, damaging protective bark and causing genus like pine to 'bleed'. These trees often instill ire from frustrated golfers who blame them just for “being there” and “causing” their bogey. Is disc golf really such the happy, low-impact “green” sport that the industry portrays it as? The largest financial rewards in disc golf come from the sales of the small, hard-plastic, aerodynamic “frisbees”

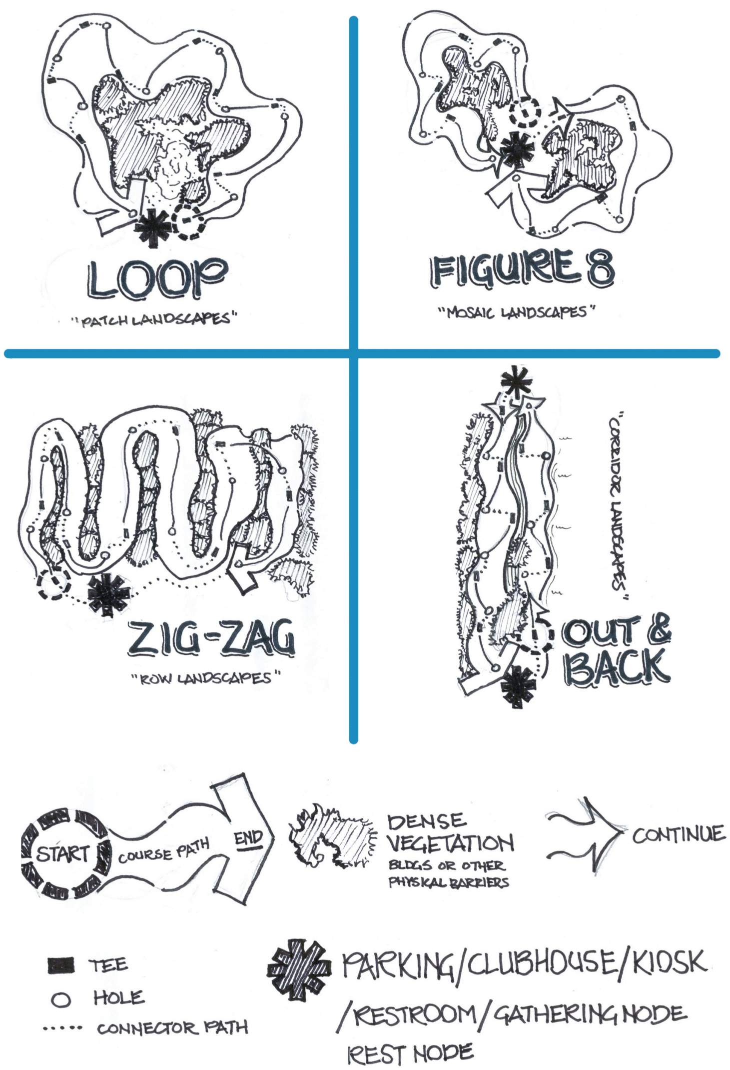

Figure 1. Disc golf course routing patterns (Plansky 2013)

Figure 2. Pole-hole (Disc Golf Association n.d)

which are molded into high-tech designs for long distance (drivers), mid-range and for putting close to the basket. Inevitably discs get worn out and lost over time, and there is always a "hot" new design coming out that the avid disc golfer must test-out. The proliferation of courses (which are mostly free of charge), essentially fuels the sales of more discs. The petrol used to make golf discs is really just a "drop in the bucket", but what about the the sport's effect on trees on heavily used, popular courses? Based on a cursory investigation, there is little, if any scientific research on projectile impacts on living trees and its effects on long term tree health. On the other hand, research in the fields of arboriculture and forestry have a lot to offer about the impacts of soil compaction. As a baseline, this paper will briefly discuss two case studies where arborists were hired to investigate the impacts of disc golf activities on the health of trees along course routing paths. To support the findings of these arborists and to explore what further measures course stewards might take to mitigate damages, journal articles on tree health and soil compaction will be reviewed. Finally, a brief set of guidelines will be offered to help course designers, park maintenance managers and average disc golfers to appreciate the effects of the sport's environmental impacts while empowering them to make decisions which mitigate those impacts, ensuring both happy trees and happy disc golfers underneath and beside them, well into the future.

BIDWELL PARK

Overview

The City of Chico, CA hired the design and planning firm EDAW (now AECOM) to develop a Master Management Plan for Bidwell Park (2005). The municipal park covers 3,670 acres on both sides of Big Chico Creek Canyon, and stretches into the Sierra Nevada foothills, with many recreational amenities and hiking trails split into Lower and Upper sections. It is governed by the Bidwell Park and Playground Commission. Much of the park is sensitive and has special rules for use.

Since 1995 disc golf has been played in the upper section on two courses; a short course (18-holes) and a long course 21-holes, of which the short course receives greater use, located next to Highway 32. John M. Lichter M.S, was hired as a consulting arborist to assess community concerns about impacts of disc golf activity on Blue Oaks (*Quercus douglasii)*, and suggest design modifications to minimize potential tree impacts and recommend best management practices (BMPs).

Site observations

The blue oak woodlands of the course extents also contain foothill pine (Pinus sabiniana) and interior live oak (Quercus wislizenii). Before the disc golf activity began, the blue oaks had been observed to be generally growing very slowly, which is typical on such a site where water availability

Figure 3: Bidwell Park Disc Golf Course (Lichter 2005)

is very low, and soils are consequently very shallow (10 to 26 cm). On the short course the following conditions were observed; removal of vegetation and soil compaction from foot traffic, loss of branch tips and foliage from disc contact and trunk/limb injury from disc impact. Not surprisingly, the tee and pin (basket) areas had the most compaction, especially on the lower course, and the fairways were heavily trampled throughout. The long course, which receives less use, had only a few narrow trails on the fairways. On the short course as much as 50% foliage and branch tip loss was observed. Several trees near tee areas exhibited damage to their cambium.

Method & Results

One hundred twenty trees on the short course were examined (picked randomly). Data was collected on tree size (trunk diameter), health (rating of 1=dead, 8=excellent) and soil disturbance (1=no disturbance, 5=100% soil disturbed). Averages health ratings for trees within each soil disturbance rating are shown below:

Table 1. Soil Disturbance Rating and Tree Health (Lichter 2005)

Soil Disturbance Rating	Average Health Rating
1	4.2
2	3.8
3	3.4
4	3.5
5	2.7

Soil disturbance levels of 3 (26-50%) or greater have been shown to have significant negative effect on tree health (Evans n.d.). Disturbance levels were based on visual observation.

Analysis and Discussion

Where **soil disturbance** was greater, the likelihood of foliage and branch tip loss was generally greater as well. Soil compaction rearranges soil particles, which increases soil strength but reduces the amount of large pore space, which can restrict root growth and overall tree growth, and predispose a tree to disease. Soil water infiltration, drainage and aeration are all effected. Lichter and Lindsey (1994) found that 6 inches of woodchip mulch significantly reduced but did not offset compaction of a front end loader, but no studies were found by Lichter (2005) that looked at treatments to reduce compaction from foot traffic. Breaking up soil (tilling, subsoiling) when it is fairly dry is also an effective way to ameliorate compacted soils (Harris, Matheny and Clark 2004). Soil replacement in radially-oriented trenches has been shown to increase tree growth (Day and Bassuk 1994, Watson, Kelsey and Woodltli 1996 and Smiley 1997). This is best executed by utilizing a pneumatic excavator, which minimizes damage to tree root systems.

Foliage and branch tip loss was observed in fairways due to repeated impacts and glances of discs. While most trees can withstand occasional defoliation, more than two seasons of complete defoliation can cause severe decline or death (Johnson and Lyon 1988). The tolerance level of defoliation is related to the amount lost, time of year of loss, tree condition and site suitability. Insects, diseases or drought can kill a tree that has been predisposed by defoliation (Dunbar and Stevens 1975). Lichter (2005) observed that while defoliation on the course in any given year is not complete on any one tree, the heavy use of disc golfers combined with soil compaction and periodic drought stress due to shallow soils, could be contributing to the stress of affected oaks on the course extents (fairways).

Lichter (2005) noted that **trunk and limb damage** was of lesser importance than other factors because less trees were impacted and the impact was limited to a particular branch and/or one side of the trunk. However, this type of damage can have more significant impact on small caliper trees also experiencing defoliation from discs – predisposed. Lichter (2005) suggests trunk or limb wrapping with protective material in such a way to avoid girdling (restriction of diameter growth), or root injury.

GOLDEN GATE PARK

Overview

After an initial trial period of 18 months the disc golf course installed at Golden Gate Park in San Francisco was evaluated by an arobrist (James R. Clark PhD., HortScience, Inc.) for its impact on tree health at the behest of the San Francisco Recreation & Parks Department in 2005. The course was established in an unmanaged area of the park adjacent to a meadow among a mix of mature and semi-mature trees and scattered shrubs.

Site Observations

Course designers tried to limit traffic by delineating paths. Traffic along the paths has removed pre-existing groundcover, leaving bare ground. The dominant trees on the site are typical of Golden Gate Park: Blue Gum (*Eucalyptus globulus),* Monterey Pine (*Pinus radiata*) and Monterey Cypress (*Cupressus macrocarpa*). Also observed on site were Coast Live Oak (Quercus agrifolia), Plum (*Prunus sp.*), and Brisbane Box (*Lophostemon confertus*). Damage to these species from the play of disc golf was observed to occur in three ways:

(1) Indentations confined to the outer bark

(2) gouges through the outer and inner bark, exposing the cambium, resulting in sap flow on the pines

(3) Mechanical injury to twigs and leaves, essentially 'shearing 'by the passing disc

Figure 4. Blue Gum knicks (Clark 2005)

Figure 5. Monterey Pine gouges (Clark 2005)

Analysis & Discussion

Clark (2005) asserts that the extent of damage is associated more with the age of the tree than the species. In general, the mature trees, regardless of species, had nicks in the bark, whereas the young trees were "gouged", creating deeper wounds that could kill twigs and stems, because of the thinner bark on the younger trees and branching closer to the ground (disc flight patterns). For the young Monterey Pines, these gouges to the bark may increase the susceptibility of the tree to Red Turpentine Beetle (*Dendroctonus valens*), which is present in Golden Gate Park. Clark (2005) says this beetle is attracted by the volatile chemicals that are emitted when pines are wounded and expects they will eventually die due to this feeding action. The other species did not appear to have insect or disease pests associated with wounds from golf discs.

Another concern is the pruning of trees by the Disc Golf Club to open up 'fairways' for more desirable flight patterns. As a protective measure screens and barriers have been erected around some trees (Figure 7), and appear effective. Shifting from being an unused area of the park to hosting regular

Figure 6. gouges in myoporum trunk (Clark 2005)

Figure 7. Protective Poles around Pine (Clark 2005)

foot traffic, surmises Clark (2005), is bound to create a more open, less densely vegetated space absent of young trees and shrubs, comprised of mature trees with high canopies but without an intermediate layer of small trees, due to a 'dose response', ie: repeated impacts of discs. The high canopies of the mature trees are generally clear of disc impacts and their thicker bark restricts damage to the surface.

SUPPLEMENTARY LITERATURE REVIEW

Despite not having scientific research at our disposal beyond these limited case studies at present that has directly addressed the impact of health of trees from projectiles hitting and shearing stems, branches or foliage, or the effects of recreational activities specifically on tree health via soil compaction, we can learn a lot from other studies from a synergistic, investigative point of view. New disc golf courses are being built in a wide range of developed parks and underutilized landscapes to meet the demands of low cost, accessible recreation. Other courses have been around for decades and have valuable lessons to offer. For each site soil profiles, history, climate, species mix and species age must be considered together. Some universal tenants can inform the designer/ investigator. Rivenshield and Bassuk (2007) found that most trees grow best in well aggregated, well-drained soils with bulk densities less than 1.5mg/m(cubed). Compacted urban soils can be 2.0mg/m(cubed). Macroporosity and bulk-density are useful indicators of soil compaction. Macroporosity is defined by Rivenshield and Bassuk (2007) as "the arrangement of solid particles in a soil and is low when particles are close together". Macropores (larger than .78mm) enable rapid drainage through the soil profile.

Donnelly and Shane (1986) studied soil and vegetation response to artificially imposed surface compaction and the effect of bark mulch over a 5-year period, looking at three Quercus (Oak) species and *Acer rubrum* (Red Maple) growing in a forest environment in loamy sand in northwestern Vermont. Compaction resulted in increases in soil bulk density, soil penetration resistance, surface soil moisture, and soil temperature. Infiltration capacity and radial growth of Acer rubrum and Q. velutina decreased. Application of bark mulch prior to compaction tended to reduce compaction effects, but post compaction addition of bark mulch did not result in noticeable amelioration of compaction-induced changes two years after application.

Kozwolski (1999) found that compaction typically alters soil structure and hydrology by increasing soil bulk density, breaking down soil aggregates, decreasing soil porosity, aeration and infiltration capacity. Additionally Kozwolski (1999) found that increasing soil strength, water runoff and soil erosion leads to physiological dysfunctions in plants including reduced water absorption and leaf water deficits in many species. The study also found that soil compaction can induce changes in the amounts and balances of growth hormones in plants, especially abscisic acid and ethylene. Major mineral nutrient absorption is reduced by both surface soil compaction and subsoil compaction. Photosynthesis rates of plants growing in substantially compacted soil is reduced by both stomatal and non-stomatal inhibition, and smaller leaf areas, and respiration of roots shifts toward an anaerobic state. Kozwolski goes on to state that severe soil compaction influences forest regeneration by inhibiting seed germination and growth of seedlings, as well as inducing seedling mortality. Combined, the effects of soil compaction described above lead to a “decreased supply of physiological growth requirements at meristematic sites”. (Kozwolski 1999). Protocols such as (1) the planting of compaction-tolerant species, (2) controlling vehicular and animal traffic, (3) amending soils with coarse materials and/or organic matter, (4) replacing compacted soils with uncompacted soils, (5) loosening soils with aerating equipment, (6) installing drainage systems, and (7) judicious application of fertilizers, show widely variable success in alleviating effects of soil compaction.

Finally, Dinseh and Osawah (1998) actually studied a nature trail in a patchy urban forest remnant in order to understand the effects of trampling by recreational pursuits. They found that trampling affects not only vegetation structure and composition, but also reduces species richness and coverage (invertebrate fauna). The retarded successional development of plant communities was observed by examining understory succession, root configuration and growth patterns of colonizing species. The site consisted of human planted confiers: Cryptomeria japonica and Chamacyparis obtusa (70% combined). Plansky (2013) found that while wildlife prevalence on disc golf courses was highly valued at newer courses, disc golfers interviewed at old courses noted a lack of wildlife. This suggests that designers and managers of new courses should take great care to not only to retain tree health by ameliorating soil compaction but also for the benefit of localized wildlife preservation. Research has shown that taking measures such as mulching trails, paths, and heavily trampled zones before compaction gets serious, can be very effective, but that once it has occurred, it becomes very difficult to address without laborious and costly methods such as radial trenching.

GUIDELINES & PRESCRIPTIONS

Between the case studies and the literature review, the following list was developed as a choice of ingredients to help designers and managers of both established and new courses to devise their own recipe for ameliorating effects of disc golf on trees and the desirable recreational environments they create.

research **species specific traits** in regards to compaction and wounding and age

pervious concrete or recycled rubber tees (20' radius from tree canopies) *prevent erosion/compaction*

trunk protection (wood stakes, attractive screens)

defining paths (especially on connector paths between holes, mulch above-grade, stay on trails!)

Design longer **connector paths** from hole to next-tee

Design layout for **vegetated fairway dividers**, and designate as OB (out-of-bounds) when possible

mulch to 6" around tee areas and greens (organic), 4" on fairway paths (organic or gravel)

tree protection zones (mulch 2X drip zone)

new plantings on north and east sides (in drought areas)

temporary and/or intermittent **irrigation**

replant outside of fairways

provide **impact protection** to young trees planted in fairways (screens or barriers, poles or bollards)

monitoring program using reference photographs

set **out-of-bounds** areas to limit the area impacted

alternate pin positions (close fairways seasonally, rotate fairways: active and fallow)

educate with interpretive signage (encourage golfers/ clubs to be stewards who perform small, incremental tasks such as mulch spreading/gathering and watering during regular rounds)

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