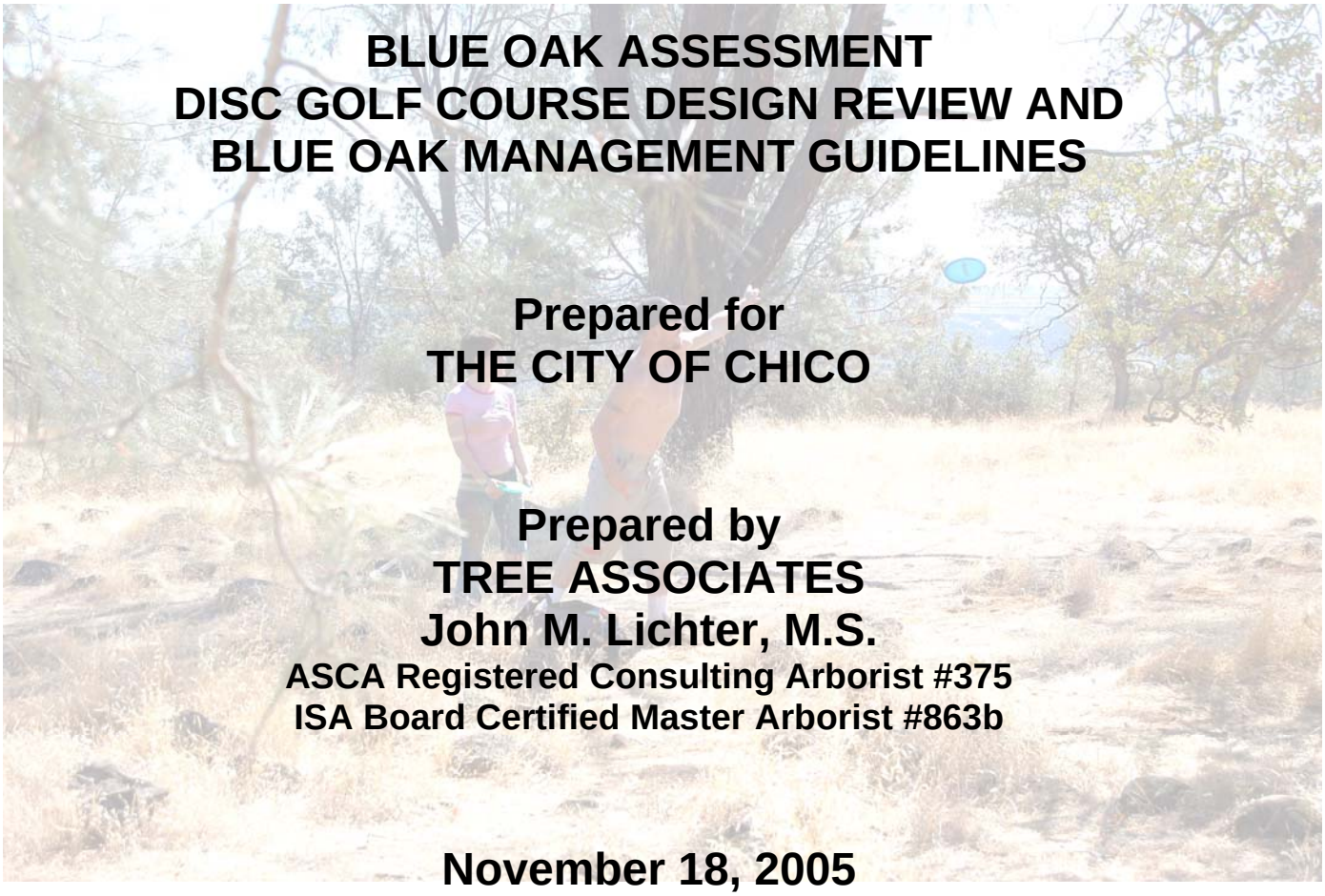
TREE ASSOCIATES

PROFESSIONAL CONSULTING ARBORISTS



BLUE OAK ASSESSMENT
DISC GOLF COURSE DESIGN REVIEW AND
BLUE OAK MANAGEMENT GUIDELINES

Prepared for
THE CITY OF CHICO

Prepared by
TREE ASSOCIATES
John M. Lichter, M.S.
ASCA Registered Consulting Arborist #375
ISA Board Certified Master Arborist #863b

November 18, 2005

Table of Contents

Background/History/Assignment

The City of Chico has hired EDAW, Inc. to develop a Master Management Plan for Bidwell Park. Within Upper Bidwell Park, disc golf has been played for at least ten years. Currently, two courses exist; a short and a long course, with 18 and 21 holes, respectively. The short course receives significantly greater use than the long course and is located adjacent to Highway 32.

Concerns regarding the potential impact of disc golf activity on the blue oaks as well as other sensitive resources (Butte County Checkerbloom, vernal pools, ephemeral drainages, Bidwell's knotweed, native wildflower fields, erodible areas and the Humboldt Wagon Road) on the course prompted the City to retain Mr. Mike Belchik, Professional Disc Golf Course Designer and Environmental Consultant to design a course minimizing impacts to these resources, including the blue oaks.

Tree Associates was contacted to provide expert advice on blue oaks, review the proposed course design and suggest design modifications to minimize potential tree impacts and to provide recommended treatments and best management practices to preserve the blue oaks on the course.

Observations

The disc golf courses are located within a blue oak woodland which includes, in addition to blue oak (Quercus douglasii), foothill pine (Pinus sabiniana) and interior live oak (Quercus wislizenii. The blue oaks on the site were generally growing very slowly as they typically do where soils are shallow due to a lack of resource (particularly water) availability. The soil survey indicated that the soils on site vary from 10 to 26 centimeters in depth (NRCS Web Soil Survey).The following visible results of disc golf use were more pronounced on the short course than the long course, presumably due to increased use:

- Removal of vegetation and organic matter and soil compaction from foot traffic,
- Loss of branch tips and foliage from disc contact and
- Trunk and limb injury from disc contact.

The loss of vegetation, organic matter and soil compaction was most pronounced at the tee and pin areas on both courses (figurer 4). Within the short course, the fairways were heavily trampled throughout, while on the long course, only a few narrow trails were typically found on the fairways.

The loss of branch tips and foliage was widespread across the course, particularly where trees were in the middle of the fairway (figure 5). In several cases, greater than 50% of the foliage and branch tips had been removed by discs. The amount of foliage and branch tip loss was generally greater on the short course than for the long course.

Several trees across the course sustained significant damage to their cambium from disc contact; particularly trees close to tees (figure 5).

Figure 1. Disc golfers playing short course.

Short Course Tree Health Evaluation

In order to determine whether or not the disc golf activity has had an impact on the health of the blue oaks, an evaluation of the health of the trees within the short course was conducted. One hundred and twenty trees on or near fourteen of the eighteen holes were examined (holes picked randomly). Trees within or adjacent to the pin, fairway and tee areas were evaluated.

Data was collected on tree size (trunk diameter), health (a rating of 1 (dead) to 8 (excellent)) and soil disturbance (a rating of 1 (no disturbance under canopy) to 5 (100% of soil disturbed). The following table provides the average health rating for trees for each of the disturbance levels. Note that ratings of 4, 3 and 2 correspond to health ratings of fair/good, fair and poor/fair, respectively.

Table 1. Soil Disturbance Rating and Tree Health

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

Statistical analysis of the data (provided by Dr. Richard Evans, Department of Plant Science, U.C. Davis; utilizing ordinal logistic regression) revealed that soil disturbance levels of 3 (26-50% disturbance) or greater have a significantly negative effect on tree health (see attached for data and statistical analysis).

Figure 2. Tree in fair/good health on short course.

Figure 3. Tree in poor condition on short course; note poor growth rate and epicormic sprouts (low vigor twigs on main trunk).

Number of Trees Impacted by Existing and Proposed Courses

The existing and proposed short and long courses were walked and the number of blue oak trees impacted or potentially impacted from course use was estimated. The total number of trees affected and the total number of affected trees previously unaffected by golf course use is provided below. Data are attached for individual holes.

Table 2. Number of Trees Affected by Disc Golf Course Use

Course	Number of Trees Affected	Number of Affected Trees Previously Unaffected	Number of Holes Evaluated	Average # Trees/ Hole
Existing Short Course	100	0	13	7.7
Proposed Short Course	122	46	18	6.7
Existing Long Course	241	0	18	13.4
Proposed Long Course	277	58	18	15.4

Analysis and Discussion

The Short Course Tree Evaluation provides evidence that disc golf course use is impacting the health of the trees. While the disturbance rating was based on a visual observation of soil disturbance, the study did not distinguish between soil compaction and foliage and branch tip loss impacts. Where soil disturbance was greater, the likelihood of foliage and branch tip loss was generally greater as well. Further study would be required to attempt to determine the relative importance of these factors.

Soil Compaction, Prevention and Amelioration
Soil compaction rearranges soil particles, increasing soil strength and reducing the amount of large pore space in the soil. These changes can restrict root growth directly, and lead to growth restriction and/or disease from their negative impact on soil water infiltration, drainage and aeration.

Because remediating compacted soils is difficult and not always effective, preventing soil compaction on as yet undisturbed treed portions of the proposed course is of prime importance. Preventing the re-compaction of ameliorated soil is also of obvious benefit.

A previous study (Lichter and Lindsey, 1994) found that six inches of woodchip mulch significantly reduced, but did not offset compaction from a front end loader. While I am unaware of studies which have looked at surface treatments to reduce compaction specifically from foot traffic, I would expect that this treatment would significantly reduce soil compaction as long as the depth of mulch was maintained. Another benefit of mulch application would be to increase the level of organic matter in the soil in areas where, due to foot traffic and the lack of vegetative growth, it likely has been decreasing.

Breaking up the soil (i.e. tilling or subsoiling) when it is fairly dry is an effective means of ameliorating compacted soils (Harris, R., N. Matheny and J. Clark, 2004). However, “tree root sensitive” treatments for breaking up soils in the root zone of trees are limited. Soil removal and replacement (with sandy loam, organic matter or combinations of soil and organic matter) in radially-oriented trenches has been shown to increase tree growth (Day and Bassuk, 1994; Watson, Kelsey, and Woodltli, 1996; and Smiley, 1997). The soil can also be broken up effectively with minimal damage to tree root systems utilizing a pneumatic excavator. Recently, soil compaction amelioration treatments utilizing a pneumatic excavator to break up the soil while incorporating organic matter have been recommended by Smiley (personal communication).

Figure 4. Soil disturbance under oaks on short course.

Foliage and Branch Tip Loss
While most trees can withstand periodic defoliation, severe decline or death may occur following more than two seasons of complete defoliation (Johnson, W.T. and H.Lyon, 1988). The tolerance of trees to defoliation is related to the amount of foliage lost, the time of year of defoliation, tree condition and horticultural site suitability. Often, secondary insects, diseases or drought will kill a tree which has been stressed by defoliation (Dunbar and Stevens 1975, Davidson et al. 1996, in Randall, M., 2004). While defoliation on the course in any given year is not complete on any tree, the regular and growing season long defoliation from disc golf use could be contributing to the stress of affected oaks on the course along with soil compaction and likely periodic drought stress due to the shallow soil present on site.

Aside from designing the course to avoid trees within the potential flight path of the trees, I know of no means of reducing the loss of foliage or branch tips from flying discs. The design modifications listed in the attached table provide a means to reduce the number of trees within the flight path of discs.

Trunk and Limb Damage
On a course wide basis, the damage to trunk and limbs is of lesser importance than the factors discussed above, as fewer trees are impacted and, for many of these trees, the impact is limited to a particular branch and/or one side of the trunk. However, this damage can have a significant impact on tree health, particularly for small trees and when foliage and branch tip damage occurs in addition, which is common.

For such affected trees, wrapping the trunk or limbs with protective material or shielding the impacted (or potentially impacted) trunk or limbs will limit impacts. Trunk or limb wrapping should be done in such a way as to avoid girdling (restricting diameter growth) the tree. Shielding should be done in such a way as to avoid root injury.

Figure 5. Loss of foliage and growing points and limb damage from disc impact on short course.

Potential Disc Golf Course Design Layout Modifications

Mr. Mike Belchik designed new short and long courses with the goals of reducing impacts to several sensitive environmental resources. By looking at Table 2, it can be seen that the proposed courses will affect additional trees which were not previously affected. Because treatments to prevent and ameliorate soil compaction are not always effective and the impacts of flying discs are unavoidable in order to maintain a disc golf course within a blue oak woodland, minimizing the number of affected trees which were previously undisturbed would be of primary importance to reduce overall impacts. In addition, a design avoiding impacts to previously impacted trees would potentially allow for recovery of these trees, following remediative treatment.

Coursewide Design Features

Mr. Belchik has suggested the use of concrete tees, trunk protection and defining paths along the fairway and between holes (Belchik 8/28/05 report and personal communication). The presence of concrete tees will limit the need for golfers to search for higher ground during the winter months which should limit the area which is compacted around the tees. Concrete tees should be established sufficiently distant from the tree canopies considering the nature of traffic around them (estimated to be a circular area with up to a 20' radius. The area around the tees should be covered with woodchip mulch to be maintained at 6" thick (tree trimming "waste" is acceptable) in order to avoid compaction in this area.

Defining pathways down the fairway as well as between holes should also limit the spread of traffic and the area compacted. The pathways can be covered with mulch and delineated with rocks or tree limbs or other objects as desired as long as they are installed above grade and without the operation of equipment within an area equal to twice the distance from the trunks to the edge of the branches of the trees (hereafter considered the" tree protection zone").

Restoration of Oaks

Since there does not appear to be much natural regeneration of oaks in recent years within the courses and since it appears that golf course use has affected the condition of the oaks, in addition to the above measures to preserve oaks, establishing oaks on the property may be desired. The major limiting factors to oak regeneration on this site are expected to include: drought stress due to shallow soil, browsing and competition with weeds.

Newly planted blue oaks may be given the best chance for success by planting the trees or acorns in tree tubes and covering the vicinity of the planted oak with landscape fabric covered by 6" of woodchip mulch. Planting trees on the north or east side of existing trees may also improve seedling growth as these areas will not be as droughty as other planting sites. Temporary irrigation could have a major impact on seedling survival and growth rate.

Recommendations

- Modify proposed course designs as suggested within the attached table where possible.
- Install and maintain at least 6" of coarse woodchip mulch within the protection zone (twice the drip line area) of all blue oaks which are currently undisturbed and within the tee, fairway or pin of the proposed course.
- For trees with existing soil disturbance, during the winter, when soils are moist (and not wet), utilize a pneumatic excavator to pulverize the soil within the tree's root zone, then apply woodchip mulch as recommended above.
- Install concrete tees on course.
- Install paths as discussed in the report above.
- Install trunk/limb protection as discussed above.

References

Day, S. and N. Bassuk. 1994. A Review of the Effects of Soil Compaction and Amelioration Treatments on Landscape Trees. *J. Arboriculture* 20:9-17.

Harris, R.W., J.Clark and N. Matheny. Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines, 4th Edition. Prentice Hall ©2004. 578 p.

Johnson, W.T. and H. Lyon. Insects that Feed on Trees and Shrubs. Cornell University Press ©1988. 556 p.

Lichter, J.M. and P.A. Lindsey. Soil Compaction and Site Construction: Assessment and Case Studies. In The Landscape Below Ground: Proceedings of an International Workshop on Tree Root Development in Urban Soils. G. Watson and D. Neely, editors. 222 p.

Randall, M.S. Area-Wide Analysis of Hardwood Defoliator Effects on Tree Conditions in the Allegheny Plateau. *Northern Journal of Applied Forestry*. March, 2004.

Smiley, T. Strategies for Reducing Soil Compaction. *Tree Care Industry*. 8(4):24-26, 28, 30-32.

Watson, G.W., P. Kelsey and K. Woodtli. 1996. Replacing Soil in the Root Zone of Mature Trees for Better Root Growth. J*. Arboriculture*. 22:167-173.

Glossary

Bow
- the gradual curve of a branch or stem.

Callus
- growth resulting from and found at the margin of wounds.

Canker
– a localized area of dead tissue on a stem or branch, caused by fungal or bacterial organisms.

Central Leader
– the main stem of the tree.

Chlorotic
- yellow.

Codominant
– equal in size and relative importance.

Crown
– parts of the tree above the trunk.

Decay
– process of degradation of woody tissues by fungi and bacteria.

Dieback
- death of shoots and branches, generally from tip to base.

Dropcrotch
- the process of shortening trunks or limbs by pruning back to dominant lateral limbs.

End Weight
– the concentration of foliage at the distal ends of branches.

Epicormic
– shoots which result from adventitious or latent buds; often indicates poor vigor.

Included bark
– pattern of development at branch junctions where bark is turned inward rather than pushed out.

Primary limb
- limb attached directly to the trunk

Root crown
- area at the base of a tree where the roots and stem merge.

Secondary limb
- limb attached directly to a primary limb.

Sound wood
- undecayed wood.

Suppressed
– trees which have been overtopped and whose crown development is restricted from above.

Target
– people or property potentially affected by tree failure.

Train
- to prune a young tree to establish a strong structure.

Vigor
– overall health.

1 Definitions from author or Matheny and Clark, Evaluation of Hazard Trees in Urban Areas, 2nd Edition c 1994, ISA.

Certification of Performance

I, John M. Lichter, certify:

- That I have personally inspected the tree(s) and/or the property referred to in this report, and have stated my findings accurately. The extent of the evaluation and/or appraisal is stated in the attached report and the Terms and Conditions;
- That I have no current or prospective interest in the vegetation or the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved;
- That the analysis, opinions and conclusions stated herein are my own, and are based on current scientific procedures and facts;
- That my compensation is not contingent upon the reporting of a predetermined conclusion that favors the cause of the client or any other party, nor upon the results of the assessment, the attainment of stipulated results, or the occurrence of any subsequent events;
- That my analysis, opinions, and conclusions were developed and this report has been prepared according to commonly accepted Arboricultural practices;
- That no one provided significant professional assistance to the consultant, except as indicated within the report.

I further certify that I am a member of the American Society of Consulting Arborists, and that I acknowledge, accept and adhere to the ASCA Standards of Professional Practice. I am an International Society of Arboriculture Certified Arborist. I have been involved in the practice of Arboriculture and the care and study of trees since 1985.

John M. Lichter, M.S.
ASCA Registered Consulting Arborist #375
ISA Board Certified Master Arborist #863b

3963 CENTRAL LANE, WINTERS, CA 95694
530.795.1517
www.treeassociates.net

ASSUMPTIONS AND LIMITING CONDITIONS: John M. Lichter dba TREE ASSOCIATES

1. Any legal description provided to the consultant/appraiser is assumed to be correct. Any titles and ownerships to any property are assumed to be good and marketable. No responsibility is assumed for matters legal in character. Any and all property is appraised or evaluated as though free and clear, under responsible ownership and competent management.

2. It is assumed that any property is not in violation of any applicable codes, ordinances, statutes or other governmental regulations.

3. Care has been taken to obtain all information from reliable sources. All data has been verified insofar as possible; however, the consultant/appraiser can neither guarantee nor be responsible for the accuracy of information provided by others.

4. The consultant/appraiser shall not be required to give testimony or to attend court by reason of this report unless subsequent contractual arrangements are made, including payment of an additional fee for such services as described in the fee schedule and contract of engagement.

5. Unless required by law otherwise, possession of this report or a copy thereof does not imply right of publication or use for any purpose by any other than the person to whom it is addressed, without the prior expressed written or verbal consent of the consultant/appraiser.

6. Unless required by law otherwise, neither all nor any part of the contents of this report, nor copy thereof, shall be conveyed by anyone, including the client, to the public through advertising, public relations, news, sales or other media, without the prior expressed written or verbal consent of the consultant/appraiser -- particularly as to value conclusions, identity of the consultant/appraiser, or any reference to any professional society or institute or to any initialled designation conferred upon the consultant/appraiser as stated in his qualifications.

7. This report and any values expressed herein represent the opinion of the consultant/appraiser, and the consultant's/appraiser's fee is in no way contingent upon the reporting of a specified value, a stipulated result, the occurrence of a subsequent event, nor upon any finding to be reported.

8. Sketches, drawings, and photographs in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering or architectural reports or surveys unless expressed otherwise. The reproduction of any information generated by architects, engineers, or other consultants on any sketches, drawings, or photographs is for the express purpose or coordination and ease of reference only. Inclusion of said information on any drawings or other documents does not constitute a representation by John M. Lichter or TREE ASSOCIATES as to the sufficiency or accuracy of said information.

9. Unless expressed otherwise: 1) information contained in this report covers only those items that were examined and reflects the condition of those items at the time of inspection; and 2) the inspection is limited to visual examination of accessible items without dissection, excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the plants or property in question may not arise in the future.

10. Loss or alteration of any part of this report invalidates the entire report.