

E4. OAK ASSESSMENT



MASTER MANAGEMENT PLAN UPDATE AND ASSOCIATED PARK IMPROVEMENT PROJECTS
DRAFT ENVIRONMENTAL IMPACT REPORT



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
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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 (figure 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).

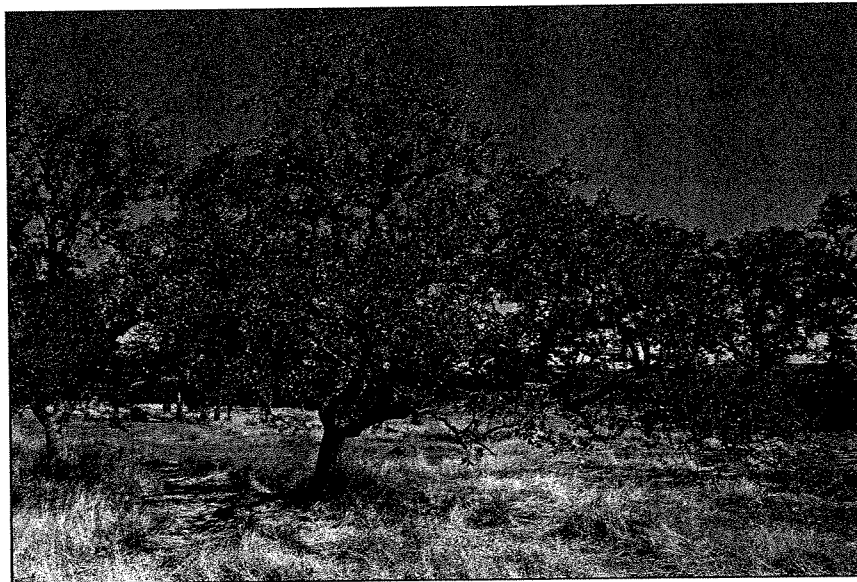


Figure 2. Tree in fair/good health on short course.

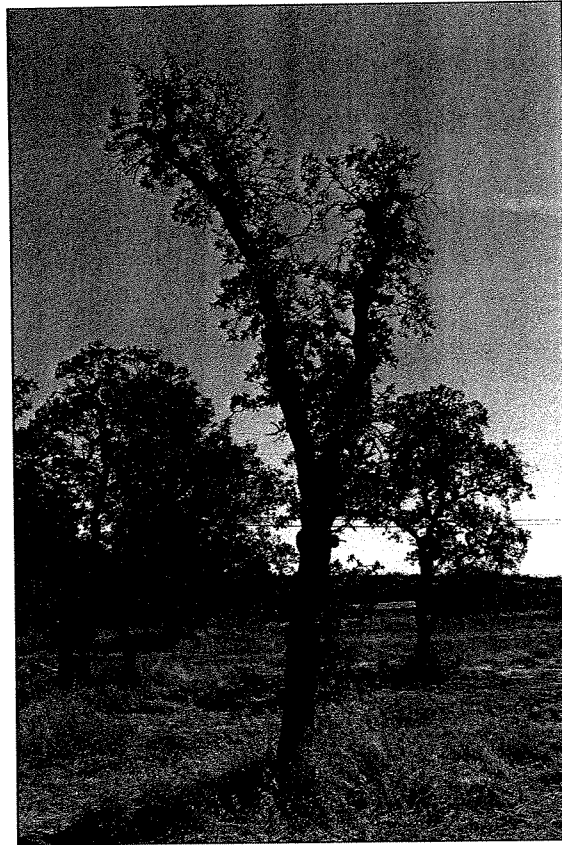


Figure 3. Tree in poor condition on short course; note poor growth rate and epicormic sprouts (low vigor twigs on main trunk).

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 Woodtli, 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).

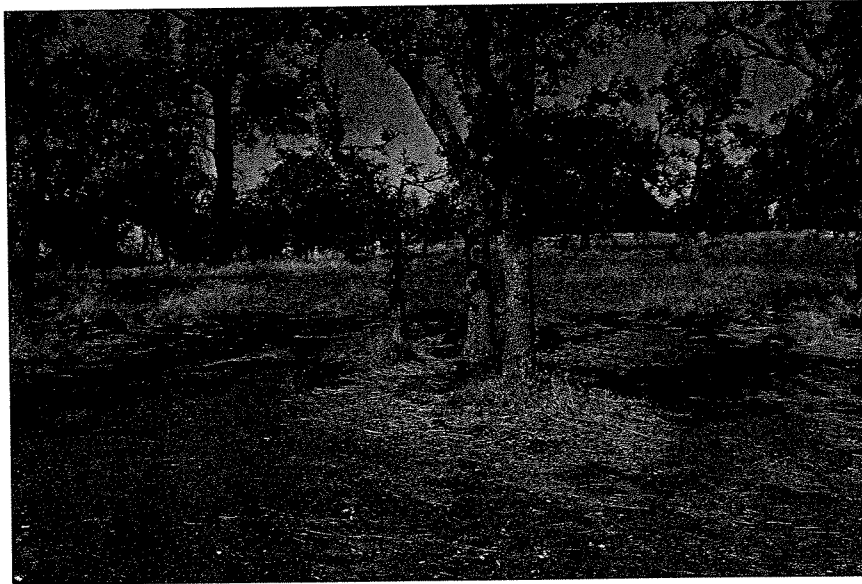


Figure 4. Soil disturbance under oaks on short course.

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.

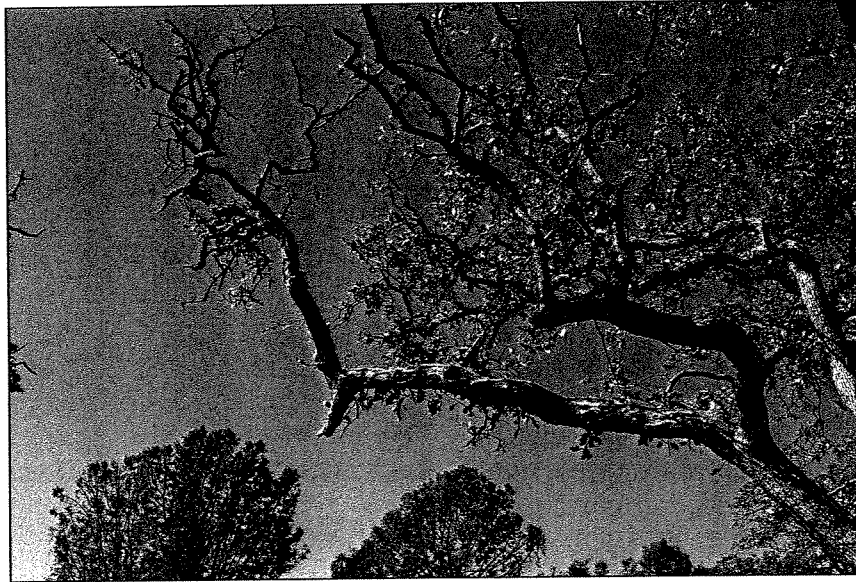


Figure 5. Loss of foliage and growing points and limb damage from disc impact on short course.

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

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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.

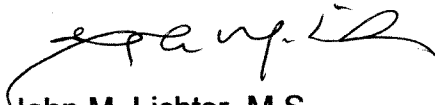
1 Definitions from author or Matheny and Clark, Evaluation of Hazard Trees in Urban Areas, 2nd Edition c 1994, ISA.

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.



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2. It is assumed that any property is not in violation of any applicable codes, ordinances, statutes or other governmental regulations.
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10. Loss or alteration of any part of this report invalidates the entire report.



**City of Chico
Bidwell Park Disc Golf Course**

**Tree Health
and Soil Disturbance
Evaluation**

**To Accompany
Tree Associates Report
Dated 11/18/2005**

Hole	Tree #	Trunk Dia.	%	Disturbance Rating	Health Rating
14	1	15	2	3	4
14	2	24	1	2	2
14	3	11	0	1	5
14	4	7	0	1	4
14	5	15	0	1	4
14	6	13	3	4	3
14	7	10	4	5	2
14	8	6	2	3	3
5	9	10	1	2	4
5	10	9	2	3	2
5	11	9	1	2	4
5	12	9	1	2	4
5	13	9	4	5	2
5	14	10	2	3	3
5	15	9	4	5	2
5	16	9	4	5	2
5	17	11	2	3	4
5	18	13	1	2	6
5	19	8	4	5	3
5	20	10	4	5	3
5	21	10	4	5	4
5	22	11	2	3	4
5	23	10	3	4	4
5	24	9	3	4	4
5	25	8	2	3	4
8	26	10	2	3	5
8	27	8	2	3	3
8	28	9	3	4	3
8	29	20	3	4	5
8	30	11	2	3	3
8	31	10	1	2	3
8	32	9	1	2	3
8	33	9	2	3	3
8	34	17	1	2	4
8	35	9	2	3	3
8	36	17	2	3	3
8	37	11	4	5	3
8	38	6	4	5	2
8	39	7	4	5	4
8	40	9	3	4	3
8	41	10	2	3	3
8	42	10	1	2	3
8	43	7	2	3	3
8	44	9	3	4	3
8	45	9	3	4	3

**City of Chico
Bidwell Park Disc Golf Course**

**Tree Health
and Soil Disturbance
Evaluation**

**To Accompany
Tree Associates Report
Dated 11/18/2005**

Hole	Tree #	Trunk Dia.	%	Disturbance Rating	Health Rating
8	46	9	3	4	3
8	47	9	3	4	3
8	48	4	4	5	3
8	49	10	0	1	4
8	50	10	0	1	4
8	51	10	0	1	3
8	52	17	0	1	3
10	53	13	1	2	4
10	54	15	1	2	5
10	55	13	1	2	3
10	56	19	2	3	3
10	57	18	3	4	4
10	58	17	4	5	1
12	59	17	1	2	6
12	60	10	0	1	6
12	61	12	0	1	6
12	62	8	2	3	2
12	63	18	1	2	4
12	64	18	2	3	4
12	65	9	3	4	2
12	66	13	2	3	5
12	67	14	2	3	4
12	68	18	2	3	4
12	69	20	0	1	4
18	70	12	0	1	5
18	71	9	0	1	3
18	72	12	2	3	4
18	73	11	0	1	4
18	74	16	3	4	4
18	75	16	1	2	5
18	76	10	3	4	4
18	77	15	1	2	5
18	78	15	3	4	4
18	79	8	3	4	4
18	80	11	3	4	3
6	81	9	1	2	3
6	82	10	0	1	4
6	83	10	1	2	4
6	84	10	2	3	3
6	85	13	1	2	3
17	86	17	1	2	6
17	87	11	0	1	5
17	88	9	0	1	4
17	89	12	1	2	4
17	90	13	1	2	3

**City of Chico
Bidwell Park Disc Golf Course**

**Tree Health
and Soil Disturbance
Evaluation**

**To Accompany
Tree Associates Report
Dated 11/18/2005**

Hole	Tree #	Trunk Dia.	%	Disturbance Rating	Health Rating
2	91	12	1	2	4
2	92	11	1	2	4
2	93	13	1	2	1
2	94	11	2	3	2
2	95	12	2	3	4
2	96	9	1	2	4
2	97	16	3	4	4
2	98	10	3	4	5
2	99	24	2	3	4
15	100	11	1	2	4
15	101	12	0	1	4
15	102	12	0	1	4
16	103	10	0	1	4
16	104	24	3	4	2
16	105	10	0	1	3
16	106	10	1	2	1
13	107	13	2	3	4
13	108	20	2	3	1
13	109	20	4	5	4
13	110	14	2	3	3
13	111	22	2	3	3
4	112	9	2	3	5
4	113	13	3	4	5
4	114	9	3	4	4
4	115	10	2	3	4
4	116	14	1	2	4
4	117	16	3	4	2
4	118	8	2	3	4
4	119	16	2	3	3
4	120	14	3	4	3

Ordinal logistic regression

Model: Health is a function of trunk diameter and soil disturbance

Response Information

Variable	Value	Count
Health R	1	4
	2	12
	3	38
	4	49
	5	12
	6	5
	Total	120

Logistic Regression Table

Predictor	Coef	StDev	Z	P	Odds Ratio	95% CI	
						Lower	Upper
Const(1)	-4.3391	0.8373	-5.18	0.000			
Const(2)	-2.7428	0.7054	-3.89	0.000			
Const(3)	-0.8426	0.6625	-1.27	0.203			
Const(4)	1.3533	0.6661	2.03	0.042			
Const(5)	2.7353	0.7578	3.61	0.000			
Trunk Di	-0.03782	0.04355	-0.87	0.385	0.96	0.88	1.05
Disturba							
2	0.6035	0.5489	1.10	0.272	1.83	0.62	5.36
3	1.3956	0.5416	2.58	0.010	4.04	1.40	11.67
4	1.2332	0.5760	2.14	0.032	3.43	1.11	10.61
5	2.6971	0.7014	3.85	0.000	14.84	3.75	58.67

Log-likelihood = -162.497

Test that all slopes are zero: G = 19.690, DF = 5, P-Value = 0.001

Interpretation: The log-likelihood statistic indicates that there is a significant effect of one of the factors on tree health. Since the Trunk diameter term has a P value of 0.385, one cannot conclude that diameter has a significant effect. However, the disturbance terms are significant. The ones listed under Disturbance indicate the probability that the stated level of disturbance affects health significantly relative to the next lower level of disturbance. Disturbance levels above 2 have an increasingly significant effect on health. The positive coefficient indicates that health decreases as disturbance increases.

**City of Chico
Bidwell Park Frisbee Golf Course**

Existing and Potential Tree Impacts

**To Accompany
Tree Associates Report
Dated: 11/18/2005**

Course/ Hole	Number of trees affected	Number of affected trees previously undisturbed
se1	no data	
se2	9	
se3	no data	
se4	9	
se5	17	
se6	4	
se7	no data	
se8	23	
se9	no data	
se10	6	
se11	no data	
se12	8	
se13	5	
se14	5	
se15	1	
se16	2	
se17	3	
se18	8	
Total	100	
sp1	10	10
sp2	14	1
sp3	2	0
sp4	4	0
sp5	13	3
sp6	16	0
sp7	3	0
sp8	6	0
sp9	2	0
sp10	0	0
sp11	1	1
sp12	2	2
sp13	4	0
sp14	0	0
sp15	16	8
sp16	14	6
sp17	8	8
sp18	7	7
Total	122	46

se = existing short course
sp = proposed short course
le = existing long course
lp = proposed long course

affected trees include trees
hit or potentially hit by
a significant # of discs
or those receiving foot
traffic

**City of Chico
Bidwell Park Frisbee Golf Course**

Existing and Potential Tree Impacts

**To Accompany
Tree Associates Report
Dated: 11/18/2005**

Course/ Hole	Number of trees affected	Number of affected trees previously undisturbed
le1	8	
le2	8	
le3	4	
le4	13	
le5	5	
le6	29	
le7	10	
le8	10	
le9	4	
le10	11	
le11	14	
le12	21	
le13	22	
le14	13	
le15	13	
le16	20	
le17	16	
le18	20	
Total	241	
lp1	11	4
lp2	10	0
lp3winter	6	5
lp 3summer	10	0
lp4winter	5	3
lp4summer	4	1
lp5	12	2
lp6	7	2
lp7	3	3
lp8	9	6
lp9	21	0
lp10	12	0
lp11	12	0
lp12	16	12
lp13winter	18	3
lp13summer	31	0
lp14	15	0
lp15	25	0
lp16	24	0
lp17	14	5
lp18	12	12
Total	277	58

se = existing short course
sp = proposed short course
le = existing long course
lp = proposed long course

affected trees include trees
hit or potentially hit by
a significant # of discs
or those receiving foot
traffic

Course/Hole	Comments, Potential Design Modifications to Proposed Courses
Short/1	Remove hole to avoid impacts to 10 previously unaffected trees or move pin to east and use previously existing tee nearby would avoid impacts to 3-4 oaks.
Short/2	Move tee to east at existing tee (avoids impact to one previously unaffected tree); move pin to the east outside of the canopy of trees (may reduce interest of hole).
Short/3	
Short/4	Keep pin and tee impact areas outside canopies.
Short/5	Move tee outside canopy of trees; move pin west.
Short/6	
Short/7	Move tee northeast to avoid one tree.
Short/8	Move bench from under oak to under a pine - need to prune pine.
Short/9	
Short/10	
Short/11	Keep tee impact area outside canopy of tree.
Short/12	Keep pin impact area out of canopy of trees.
Short/13	Move pin north near two large pines to avoid impacts to three trees.
Short/14	
Short/15	Move pin closer to smaller pine than oak; use previous tee for pin which is near sp8 or to the east of this point.
Short/16	Make sure tee and pin impact area is away from tree canopies; hole may need to curve toward east near end.
Short/17	Move tee toward west away from trees; move pin to the north outside of canopy of trees.
Short/18	Move pin northwest to avoid 5 oaks previously undisturbed.
Long/1	Keep tee impact area outside canopy of large blue oak.
Long/2	Move tee outside canopy of tree to west of tree avoids compacting additional root zone of tree near tee and avoids impact to previously unaffected oaks.
Long/3winter	
Long/3summer	
Long/4winter	Keep tee impact area outside canopy of oak.
Long/4summer	Keep pin impact area out of canopy of trees.
Long/5	Move tee away from large live oak so discs will not be hitting tree.
Long/6	Shorten hole or move pin toward cliff and away from trees.
Long/7	
Long/8	Move pin away from grove of oak trees; curve hole toward south (may reduce interest of hole); or use existing pin to the west of proposed pin.
Long/9	
Long/10	
Long/11	Move pin to the east outside of trees; avoids impacts to 4 trees.
Long/12	Hole impacts many previously undisturbed trees. Consider removing hole or move pin to the west and outside canopy of trees.
Long/13winter	New tee; outside canopy of trees, adds other trees prev. unaffected (3 trees). Consider using this tee only and establish tee impact area outside of tree canopies.
Long/13summer	Existing hole tee and pin
Long/14	Move tee toward east away from trees
Long/15	
Long/16	
Long/17	Turn hole sharply to south once outside trees near tee to avoid 5 trees previously undisturbed; end near tee of #18.
Long/18	Move tee to the east of pin of #17; locate pin outside canopy of oaks near digger pine snag.