Economic Incentives for Oak Woodland Preservation and Conservation[1]

Rosi Dagit,[2] Cy Carlberg,[3] Christy Cuba,[4] and Thomas Scott[5]

Abstract

Numerous ordinances and laws recognize the value of oak trees and woodlands, and dictate serious and expensive consequences for removing or harming them. Unfortunately, the methods used to calculate these values are equally numerous and often inconsistent. More important, these ordinances typically lack economic incentives to avoid impacts to oak woodland values because they fail to clearly identify the economic consequences of oak woodland loss; specifically: non-use values (recreation, aesthetics, and so forth), use values (increased real estate value, Council of Tree and Landscape Appraisers' individual tree valuation) and ecosystem services (carbon sequestration, temperature moderation, air pollution mitigation, stormwater runoff mitigation, and so forth). In this paper, we review the economic methods for valuing oak woodlands that were used to develop fair, equitable and consistent oak woodland values and economic incentives to encourage conservation in Los Angeles County. Economic methods that calculated the true cost of replacing oak values (including ecosystem services and non-use) were found to be more rational and consistent than existing models of simple ratios of replacement by nursery stock. The consensus based decision to move forward with this broader evaluation of oak values represents a major change in Los Angeles County policy, taking 2 years to evolve.

Key words: ecosystem services, economic valuation, non-use values, use values

Introduction

Oak woodlands in Los Angeles County are considered "valuable" for a variety of different reasons. In order to make informed planning decisions, both the costs and benefits of a proposed land use action need to be examined. These valuations should be analyzed in the context of both short and long-term (50 years) impacts, as well as within the context of location. Los Angeles County has over 58 680 ha (145 000 ac) of oak woodlands (Gaman and Firman 2006, Los Angeles County Oak Woodlands Habitat Conservation Strategic Alliance 2011) including 17 species distributed from the coast into the mountains. Although much of these oak woodlands resources are found on publically owned lands, it is estimated that between 12 140 to 17 806 ha (30 000 to 44 000 ac) are privately owned and potentially jeopardized by future development or other impacts such as removal for fuel modification. In terms of biological function, oak woodlands provide habitat for over 300 vertebrate species, thousands of insects, and innumerable associated plants. These trees also provide numerous ecosystem service values to the common good through their aesthetic contributions, abundant recreational opportunities, controlling soil erosion, providing water table management and groundwater recharge, providing carbon sequestration,

---

[1] An abbreviated version of this paper was presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, November 3-6, 2014, Visalia, California.

[2] RCD of the Santa Monica Mountains, 540 S. Topanga Canyon Blvd., Topanga, CA. (rdagit@rcdsmm.org).

[3] Carlberg Associates, Santa Monica, CA.

[4] Carlberg Associates, Sierra Madre, CA.

[5] Natural Resources Wildlife Specialist, Department of Environmental Science, Policy and Management, UC Berkeley, and Department of Earth Sciences, UC Riverside.

filtering air and water pollutants and moderating temperature extremes. Thus, removal of oak woodlands generates a substantial impact to the aesthetic, sustainable and biological diversity of the southern California area and specifically Los Angeles County.

When oak woodlands are removed and replaced by development, it is not simply the trees that are missing, but all the associated functions and habitat are lost as well. The ecosystem services provided by the trees are often replaced with stormwater, carbon, air and temperature management infrastructure which requires long-term investment in maintenance and monitoring. The community assumes the costs to accomplish the services previously provided in perpetuity by the trees.

Oak woodlands are also a repository of genetic variability and biodiversity that can sustain numerous species in times of environmental change. However, it takes 100 years to replace a 100 year-old oak that is removed. In the meantime, the young replacement trees planted as mitigation can only provide a fraction of the benefits lost with the removal of a mature oak, and given the uncertainty of actually recruiting replacement trees into maturity, it takes a very long time, and perhaps never, for any replacement plantings to regain the level of ecosystem services lost with removal of the original woodland trees. Further, replacement trees do not have the provenance of the original trees, which were perfectly suited and adapted to their site.

Beginning in 2001, the state of California began to recognize that county and city oak tree protection ordinances were not achieving the goal of protecting and preserving oak resources throughout the state. For example, Los Angeles County was one of the first counties to enact an Oak Tree Ordinance (1982). This ordinance specifically states, “As one of the most picturesque trees in Los Angeles County, oak trees supply beauty and charm to the natural and manmade landscape. Oak trees add distinct and unique aesthetic character to the areas of Los Angeles County in which they are indigenous. The Oak Tree Permit is established to recognize oak trees as significant and valuable historical, aesthetic and ecological resources.” A number of other values have been defined for natural ecosystems since the Oak Tree Ordinance was written in 1982, including the amenity value of living next to a oak woodland preserve, or the value of ecosystem services like carbon sequestration, slope stability, and flood control. Assessment of implementation of that ordinance over forty years suggests that while individual oak trees may have been preserved, oak woodland resources throughout the county were declining and continue to be threatened by development. The Oak Woodlands Conservation Act (AB 242 2001) set up a process for voluntary conservation and identified oak woodlands as a significant resource throughout the state. This law also requires counties to develop an Oak Woodlands Conservation Management Plan (OWCMP) in order to be eligible for state funds to assist in acquiring oak woodlands for the public trust. Only 21 of the 54 counties statewide had developed plans as of 2010 (California Wildlife Conservation Board 2010).

This initial law was augmented by the passage of SB 1334 (Public Resources Code Section 21083.4) in 2004 (California Public Resources Code 2004), which expanded preservation efforts by requiring that a county, “in determining whether the 1973 California environmental quality act (CEQA) requires an environmental impact report, negative declaration, or mitigated negative declaration, to determine whether a project in its jurisdiction may result in a conversion of oak woodlands that will have a significant effect on the environment, and would require the county, if it determines there may be a significant effect to oak woodlands, to require one or more of specified mitigation alternatives to mitigate the significant effect of the conversion of

oak woodlands." Counties and cities now were required to develop criteria for impact thresholds and develop tools to encourage conservation.

In July 2009, the California Forest Protocol (CFP) was adopted by the California Air Resources Control Board (CARB) and incorporated into the CEQA Initial Study Checklist by the Natural Resources Agency. This was in response to the requirements of the Global Warming Solutions Act (2006), which required that the state reduce greenhouse gas (GHG) emissions to the 1990 level by 2020. CEQA now requires the analysis and mitigation of potential effects of GHG emissions related to conversion of oak woodlands. Future CEQA documents must include analysis of how biological carbon emissions will change if oak woodlands are converted to other uses. All of these laws acknowledge that oak woodlands have intrinsic values that provide quantifiable benefits.

Finally, many environmental laws grant standing to anyone seeking involvement in an environmental review or management of a resource. Because of SB 1334, anyone can be considered a stakeholder in the oak values of Los Angeles County, and demand that damage to their oak woodland values be calculated and mitigated under CEQA. The Endangered Species Act (ESA 1973) gives anyone the right to challenge or sue to protect habitat for federally listed endangered species, which can include oak woodlands. Hence individuals and groups that are neither landowners nor regulatory agencies can become stakeholders when oak woodland values are calculated. This creates an exceptionally broad pool of individual potential stakeholders, including community, state, federal, and international residents, and they seek an equally broad array of outcomes from existence values to firewood harvest.

Los Angeles County oak woodlands economic valuation framework

From 2008 to 2011, a group of concerned arborists, foresters, planners, biologists, and other stakeholders formed the Los Angeles County Oak Woodlands Habitat Conservation Strategic Alliance (Alliance) with the goal of developing an oak conservation plan for Los Angeles County. Starting with the goal of articulating a vision for the future of oak woodlands in the County in 50 years, the Alliance quickly realized that one of the biggest challenges was to clearly, fairly and consistently identify how much it costs the community in perpetuity to replace the various ecosystem services provided by oak woodlands should they be removed. Providing a tool for landowners and decision makers to assess the economic value of oak woodlands became a specific goal of the planning process.

The hope was that by requiring a cost-benefit analysis in the early stages of the planning process, the advantages of conserving and preserving oak woodlands, either through more sensitive development design or outright by fee dedication or easements, would encourage voluntary conservation efforts. Economic valuation would also provide a more realistic framework upon which to base mitigation requirements and address the various requirements of state laws. In order to evaluate these issues and make a determination that balances the preservation of the environment with development, land use changes within designated oak woodlands of Los Angeles County will now be required to:

- Characterize the baseline contribution provided by the existing oak woodlands.

- Analyze how a proposed land use action would change this, either by enhancing the oak woodland ecosystem function or impairing it.
- Examine the proposed land use change within the context of the existing and identified restoration potential of local and regional oak woodlands (mapped zones).
- Calculate the relative costs/benefits to the county.

After reviewing the relevant economic ecosystem service literature, the Alliance initiated a series of workshops inviting numerous economists to contribute their suggestions for how best to establish a protocol for quantifying the economic benefits of oak woodlands. Based on this input, the Alliance developed a valuation equation which is fully described in the Los Angeles County OWCMP (Los Angeles County Oak Woodlands Habitat Conservation Strategic Alliance 2011). The OWCMP articulated the following goals:

- Develop incentives to encourage voluntary oak woodland conservation and balance the regulatory elements of the existing Los Angeles County Oak Tree Ordinance.
- Devise a clear, fair way of assessing and putting value to services provided by oak woodlands.
- Clarify the CEQA process related to oak woodlands and carbon sequestration.
- Facilitate uniform evaluation of land development impacts on oak woodlands.

Voluntary economic incentives to conserve oak woodlands

As part of the effort to encourage voluntary conservation of oak woodlands, the OWCMP documents a variety of economic benefits that can only be realized through preservation. These include:

1. Fee dedication or conservation easements

Both fee dedication (title of the parcel deeded to a public entity such as National Park Service) or conservation easements (legal agreement between landowner and either a land trust or government entity that limits uses of the land to protect its oak resources) are tools that have been used to provide tax deductions as well as opportunities for estate planning that allow landowners to achieve a variety of stewardship goals. Outright purchase (fee simple) acquisition of valuable oak woodland resources is the most direct way to ensure long term protection, however funds for such purchases are always limited. Both county and local land trusts are able to accept dedication of conservation easements that allow the landowner to retain title for the land, but the county or land trust would obtain any development rights. By not exercising those rights, development of that land is prevented. Dedication of a conservation easement “runs with the land,” meaning that the development restrictions will continue in perpetuity, even if the land is sold.

The landowner is thus able to control the future of his land by extinguishing some or all development rights. Many landowners are motivated by personal, ethical or aesthetic reasons and want to ensure the long-term sustainability of their property.

Conservation easements provide a landowner an opportunity to protect a family-owned oak woodland permanently, while still using existing structures or other uses.

2. Avoided permitting, CEQA, mitigation costs

Sensitive development design can often work with and around the oak woodland resources on a parcel rather than removing or degrading that resource. Developments that require any kind of discretionary review undergo a series of evaluations, starting with an Initial Study process, and depending on the level of impacts, may require higher levels of environmental evaluation in accordance with CEQA requirements. Further, permits from regulatory agencies such as California Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the Regional Water Quality Control Board may also be required. The costs of preparing the necessary environmental studies and documents required to meet these permit application requirements can be substantial, and it can take many years for a project to move from design to implementation, with the potential for lawsuits along the way. Additionally, each of these regulatory entities requires some form of mitigation if impacts are identified as significant. The cost of implementing these mitigations, as well as the cost of identifying, quantifying and mitigating any carbon sequestration impacts can be very expensive and complex to complete.

Mitigation requirements can vary from replacement planting with maintenance of the trees for 10 years, to donating funds to the County Oak Mitigation Fund allowing purchase of twice the amount of oak woodland habitat that is being lost, or to match the Council of Tree and Landscape Appraisers' (CTLA) value for the trees, whichever is more. A typical individual mature, healthy coast live oak located within an oak woodlands can be valued as much as $100,000. The SB 1334 allows developers to pay into a mitigation fund as part or all of mitigation measures for impacts to oak woodland. In theory, these fees represent the cost of acquiring oak woodland acreage equivalent to the woodland lost, allowing some flexibility where mitigation occurs. This may or may not result in adequate compensation for loss of the oak woodlands in a specific location where there are few opportunities to protect comparable acres of oak woodland.

By contrast, if a development is designed to avoid impacts to sensitive biological resources such as oak woodlands, these costs can be reduced and potentially completely avoided. Such projects would theoretically move through the county planning evaluation and approval process much faster and the resulting overall project cost and timeline reduced.

3. Transfer of development rights

Los Angeles County has a program in small lot subdivisions of the Local Coastal Zone where lots that are limited in allowable square footage can be retired in perpetuity, and the square footage transferred to another parcel. In the case of oak woodlands, transfer of development rights for parcels within Priority Conservation Areas would be obtained in exchange for higher density development in already disturbed locations. This action stops housing developments in woodlands, but does not protect oaks against other uses, such as agriculture or firewood harvest. This gap in protection has led to conflicts in other counties, when landowners undertook an approved use in woodlands that other assumed were protected.

4. Avoided carbon sequestration costs

The recently developed Los Angeles County Climate Action Plan (Los Angeles County 2014) has set the stage for the development of cap and trade systems, and it is anticipated that the fees associated with offsetting the loss of oak woodlands could be substantial. It also provides an opportunity for landowners to become reserves for carbon and provide financial incentives for preserving and expanding their oak woodlands. The evolving process for providing credits or penalties could substantially increase the value of oak woodlands and provide opportunities for restoration.

It thus appears that preservation is the most realistic way to mitigate forest carbon biological emissions to less than significant. Avoiding carbon biological emissions now is probably more effective than relying on future emissions avoidance from still to be implemented mitigation measures.

5. Avoided fuel modification costs

Many of the remaining privately-owned oak woodlands in Los Angeles County are located in designated High Fire Severity Zones. Each year County residents in these areas incur significant costs in order to meet fuel modification requirements. The cost of maintaining required fuel modification within or adjacent to an oak woodland is significantly less than similar fuel modification required for native chaparral or watering and care of non-native tree and landscape plants. Clearing vegetation up to 61 m (200 ft) from all structures can be very costly. The presence of oak woodlands significantly reduces clearance costs because:

- The native understory of oak woodlands typically contains less flammable vegetation.
- Oak trees are harder to ignite and not as prone to rapid combustion, which means they require less pruning and thinning.
- Oak stands that are well maintained (deadwood removed, retaining native leaf litter and perennial native shrubs and forbs) prevent slope failure, reduce erosion and can slow down a wildfire.

In addition to the above existing incentives, the OWCMP identified several other potential incentives to encourage voluntary oak woodland conservation. Both include rewarding landowners who voluntarily either expand existing oak woodlands on their property or plant oaks as part of their landscape.

6. Existing oak woodland expansion credits

This proposed incentive would allow a property owner who has lived on the property for five or more years to document the expansion of their oak woodland. This would provide an opportunity for limited expansion of their developed footprint to encroach into their oak woodland. Using the annual aerial photographs taken by Los Angeles County, an increase of more than 10 percent canopy cover from an identified baseline time would be the threshold for using this option. The goal would be to encourage property owners to allow their oak woodlands to naturally expand, knowing that they could potentially build an addition, such as a garage or pool in the future without penalty. The property owner would need to maintain the remaining oak woodland expansion in perpetuity through either a conservation easement or deed restriction of some kind.

Because any impacts to an oak woodland caused by a discretionary project affecting trees over 12.7 cm (5 inches) in diameter would also be subject to CEQA Section 21083.4 (Conversion of Oak Woodlands) as well as carbon sequestration standards, expansion would need to be sufficient to exceed the level of mitigation measures that would ordinarily have been required (a 2:1 ratio), in order to qualify as "other mitigation measures." This provision would need to be incorporated into the County Code. To date, this tool is in the development stage and County planners are developing a procedure and process that will hopefully become available in the near future.

7. Exemption for oaks planted or volunteers nurtured by property owners

In order to avoid any possible impediments to future use of their property, property owners routinely cut down volunteer oaks before they reach a diameter of 20.3 cm (8 inches), which is the threshold for protection in Los Angeles County. Local landfills are reluctant to plant oaks, even though many of these sites border publicly owned oak woodlands, because they fear the penalties and mitigation that might be required if they needed to remove the trees at some point in the future. The OWCMP recommends that the County develop a procedure that would allow landowners to map and document the location of oaks they plant by submitting a plan to the appropriate County agency that would be attached to the permanent record for that parcel. Then if at some future time they wished to remove the tree, they could do so without a permit or penalty. Again, Regional Planning is considering this recommendation for implementation. This would be similar to the City of Los Angeles' Tree Protection Ordinance which currently allows for the removal of protected species that can be proven to have been planted (rather than naturally occurring).

Cost-benefit analysis procedure

Economists examine environmental values from several different perspectives. A few believe that environmental amenities can and should be valued in exactly the same way as any other goods (Baerenklau 2009). However, others such as Salzman (2005) suggests that it is the role of government to pay for achieving ecosystem service protection, because these services cannot be bought or sold and thus function outside of the traditional market system. Others feel that markets reflect individual, rather than community property values in the context of human use only, are volatile and reflect current ideas of value, but don't reflect enduring or intrinsic values. Typically, the benefits provided by functional oak woodlands have not been incorporated into the cost-benefit equation because they are difficult to assess.

As a result of extensive research and discussion, the Alliance explored a variety of strategies for quantifying the economic values of oak woodlands. Models employed by U.S. Fish and Wildlife Service, National Park Service, the Environmental Protection Agency, the Nature Conservancy and other land trusts were all reviewed. It became clear that oak woodland values are never absolute; they are governed by the situation wherein they occur and the motivations of the persons involved. In the past, these values have been calculated to: (A) estimate compensation for damage; (B) appraise land value in real estate transactions; or (C) estimate non-market values and cost/benefit of management options.

In the first case, oak woodlands are assigned a dollar value to calculate the cost of settlements in tort cases, CEQA mitigation, or *post facto* penalties/fines when oak trees or woodlands are damaged. In the second case, oak woodlands have a market value in real estate transactions, either as an amenity, because they enhance the land-owner's quality of life; or as a resource attached to the land (firewood, edible mushrooms). In the third case, values present in oak woodlands become independent of the land where they occur, and are used to estimate the relative costs and benefits of management actions or relative value of ecosystem services (wildlife habitat, carbon sequestration, watershed protection).

One of the most direct means of establishing the value of oak woodlands is to calculate the cost of recreating these values after they are lost. Pincetl (2009) suggests that only by examining the costs of restoring impaired or damaged oak woodland, can we determine how much a functional oak woodland is worth. In theory, replacement or restoration costs bypass the need for estimation of abstract or non-market values, by assuming that all these values are restored once the mitigation is carried out. Regulatory agencies and landowners could then forego the complicated process of identifying stakeholders and calculating the values for each instance where an oak tree or oak woodland is damaged. The disadvantage is that the replacement value becomes a general solution to the specific values that are lost when an oak woodland is damaged. There are five models of replacement value: (1) acquisition of oak woodlands that are equivalent to the oak woodlands converted to other land-uses; (2) complete restoration (or creation) of oak woodlands; (3) partial restoration of oak woodland values; (4) planting of oak saplings to replace oak trees removed from the landscape, and; (5) transplanting oak trees that would be lost in a project.

The OWCMP distilled all this information and identified three categories of values: use, non-use and ecosystem services. These were integrated using all of the above considerations into an equation that provides flexibility for users to incorporate whatever tools are most appropriate and applicable to any given situation. Thus the OWCMP quantifies the total oak woodland value as the sum of the use value plus the non-use value plus the ecosystem services values.

Use values

The most fundamental use value is the market value of the land upon which the oak woodland resides. Properties with functional oak woodlands offer higher real estate benefits (amenity values) than comparable lands without oaks (Diamond and others 1987, Standiford 1999, Standiford and Scott 2001). Extractive uses such as timber harvesting, firewood production and other uses such as hunting, fishing, providing mast for wildlife, beehives and other harvesting activities also provide a market driven value for a particular oak woodland. Therefore, the market values are more easily compared between the baseline condition of a parcel and any proposed development activity.

Another commonly used tool for valuing individual oak and other landscape trees is the Guide for Plant Appraisal (Guide; Council of Tree and Landscape Appraisers 2000). With a long history of use in calculating the value of tree damage in tort cases, the Guide provides an accepted tool for calculating the value of a tree based on its species, condition, and location. These factors are evaluated either using a Replacement Cost Method, which is applied to smaller trees that could realistically be purchased at a nursery; the Trunk Formula Method, which is used to estimate the value of trees considered too large to be readily available; or the Cost of Cure Method, which is used to identify cost to replace/repair a property to near its natural

condition, and takes into account the cost of maintenance and time needed for re-establishment of the damaged landscape. Each factor can be depreciated by the appraiser if the species is not locally native, is in poor condition, or located where it does not contribute substantially to the overall woodland landscape (Council of Tree and Landscape Appraisers 2000).

However, we recognize that oak woodlands are different from developed landscapes and that the Guide may not be adequate to develop realistic restoration or replacement costs for an oak woodland. The advantage of the CTLA system is that the damaged party is paid at the time of damage, and is not left with a promissory mitigation, which may or may not materialize. A recurring disadvantage with this method is that it is possible to generate a value for the trees that is greater than the real estate value of the land the trees occupy. Another problem is that this method fails to incorporate any ecosystem service values, and instead focuses primarily on the anthropogenic values.

Ecologists include the spatial distribution of oaks when discussing the functional value of an oak woodland (Standiford and Scott 2001). This value resembles the monopolistic value of land, in that the aggregate resources in an oak woodland at one location can never be replicated anywhere else. From a pragmatic perspective, parcels containing oak woodlands in Los Angeles County are as similar or dissimilar as we choose to view them. Nevertheless, the complex climate, geology, soils, and biogeography of the County tend to enhance the unique features of individual oak woodlands.

The value of these woodlands is linked to their scarcity, which in turn is affected by the rate and extent of oak woodland conversions. Location can become critical even when oak woodlands are still abundant: if a linear woodland is permanently severed, then the movement of wildlife along that woodland cannot be restored at a different location. In this sense, the spatial structure and context of a particular oak woodland are integral parts of its value.

Ultimately, the OWCMP recommends that for every 1 acre of oak woodland impacted, at least 2 acres of oak woodland of the same or better quality be placed into the public trust. By using market values associated with the cost of purchasing the two to one replacement ratio, the USE value can be most simply calculated.

Non-use values

Economists define non-use values as those that do not derive from in-situ consumption of the resources (Kopp and Smith 1993). These benefits are described as *non-market values*, and include those elements of oak woodlands that have no commodity, consumptive or dollar equivalency. Examples would be passive uses such as recreation, open space, watershed protection, or landowner amenity values. Recreational opportunities provided by oak woodlands (hiking, bird watching, and others) result in dollar benefits to local businesses, increase real estate value of adjoining properties, and are considered valuable by both local and long distance stakeholders. Travel costs to access an oak woodland open space, and willingness-to-pay for protecting oak woodlands are examples of methods used to identify how important these resources are in a contingency valuation setting (Baerenklau 2009).

The quantification of these values is an evolving field with multiple procedures that can be utilized, each having a best fit for specific circumstances. The OWCMP provides flexibility for use of the most appropriate model for each circumstance, rather than requiring that any particular tool be employed to calculate the non-use

value for the baseline existing condition of a property and compare that to the value post proposed development.

Ecosystem service values

Oak woodlands are critical components of healthy terrestrial and aquatic ecosystems, providing habitat, preventing erosion, moderating water quantity and supporting water infiltration, sequestering carbon, filtering out air and water pollutants, moderating temperatures, and supporting watershed function. These are but a few of the potential ecosystem service values that can be quantified using a variety of tools.

In additon to the quantification of various services provided by oak woodlands, it is important to recognize the role of ecosystem processes and how strongly that influences their value. For example, oak trees survive summer drought because of hydrologic processes that move water through the soils and substrates where oaks occur, and symbiotic processes allow oaks to move water into their roots. However, if the pathway of this process is disrupted, then woodlands are unlikely to remain intact. Recognizing and calculating the cost of replacing this critical landscape scale process should be incorporated into the valuation effort. It is important to note that landscape scale processes like the hydrologic cycle extend far beyond the canopy of oak trees. The relationship between the woodland and its watershed must be considered in defining an oak woodland and hence are important in estimating oak woodland values.

The life history of oaks provides another example of woodland processes that are difficult to detect and quantify in standing trees. Stands of oaks appear remarkably stable; however, individual oak trees eventually succumb to diseases, insect pests, and competition for water, nutrients and light. The process of tree replacement is not necessarily visible in the patterns of trees across a landscape. For instance, coast live oaks have a remarkable ability to expand when conditions are good, and to survive when conditions degrade. In a good year, oaks can rapidly produce thousands of acorns and seedlings, and an established seedling can become trees in a relative short time (5 years). The process however, is dependent on suitable conditions for seedlings to germinate and thrive. The values associated with the individual oak trees can be intact, but the values associated with the ability of the oak woodland to thrive over time can be altered.

The California Air Resources Board (2008) and the California Forest Protocol (SB 812 2002) have designated the conversion of oak woodlands to non-forest use as a biological emission of carbon dioxide that is subject to CEQA analysis and mitigation. The air quality criteria established requires the measurement of oak woodland biological emission by documenting the live tree biomass (including roots), standing dead tree biomass, and wood lying on the ground. With this information in hand, the protocol requires that the potential carbon sequestration over the next 100 years be calculated for all trees over 7.6 cm (3 inches) or greater diameter at breast height, as well as to determine how much sequestered carbon would be released if the live trees, standing dead trees and woody debris were burned. Comparison of the existing condition to the proposed condition following the land use change would then be used to identify the level of significance for this impact.

Additionally, there are several methodologies that are used to document the amount of water run-off reduction, air pollution filtration, temperature moderation (energy use) and erosion control benefits provided by a tree or group of trees. Most are designed for use primarily within the urban forest context, rather than natural

landscapes, however, given the proximity of most oak woodlands in Los Angeles County to the urban edge, these may be applicable.

Existing models that may have applicability for oak woodland service estimation include:

a. Urban Forest Effects (UFORE) is a computer model designed to characterize forest structure (species composition, number of trees, size, density, health, leaf area, biomass, diversity) and use these variables to evaluate primarily air quality parameters like removal of particulate matter, carbon sequestration and storage, temperature effects resulting in energy use benefits and pollen impacts (Nowak and Crane 2000).
b. STRATUM is the street tree management and analysis tool used by many local cities. Using commonly collected inventory data on tree species, size, health and location, the computer model calculates the dollar value of aesthetics, energy conservation, air quality improvement, carbon dioxide reduction, stormwater control and property value increases. The applicability of this model to oak woodland land use conversion is dependent on the location of the proposed development in relation to a more urbanized environment (USDA Forest Service 2009).
c. InVEST (Integrated Valuation for Ecosystem Services and Trade-offs.2) is another computer program designed to "help land managers and government workers assess this wide array of services" (ESA Press Release).

Summary

Ultimately, the Alliance concluded that developing a consistent process for quantifying the existing baseline value of an oak woodland and then comparing that to the value following the proposed development is critical to making informed planning decisions. In order to achieve a goal of no net loss of oak woodlands, the more traditional mitigation measures such as on-site tree preservation and replacement plantings need to be replaced by a more comprehensive and effective mitigation strategy that will not only replace the lost acreage by protecting twice as much acreage of an equivalent stand of comparable size, but also recognizing that replacement plantings will take 30 to 100 years to be effective at sequestering carbon as well as replacing other lost ecosystem services. The costs of such mitigation could be significant.

While the value of oak woodlands is linked directly to the land price (and subsequent management costs) and endowments to manage replacement woodlands, the non-use and ecosystem service values contribute to the overall value of the resource. The structure of woodland acquisitions and the mitigation fee are not fixed; however, the Wildlife Conservation Board has set guidelines to insure consistency in mitigation across counties. In turn, these guidelines can be translated into the price of mitigation and hence the value of oak woodlands. The foremost guideline is that mitigation payments will be used to acquire oak woodlands that are at minimum equivalent to the oak woodlands lost (same species, physical characteristics and site conditions). Ideally the woodlands that are appropriate for mitigation would be identified *a priori*, through an inventory conducted by the County. This suggests that the amount of compensation should be calculated as the

assessed value of the land that contains the replacement oak woodland or the assessed value of an easement over the replacement woodland. If no replacement woodland can be found, then the value would be based on either the appraised value of the land where the impact to oaks occurs, or the median assessed value of comparable oak woodlands in the vicinity.

Acknowledgments

The Alliance would like to thank Dr. Ken Baerenklau, Dr. Bowman Cutter, Dr. Stephani Pincetl, and Dr. David Sunding for their assistance in understanding the economic valuation strategies.

References

Baerenklau, K. 2009. **Valuing environmental services for land use planning: contingency values of oak woodlands.** Presented to the Oak Woodland Strategic Alliance, March 2009. Eaton Canyon Nature Center, Pasadena, CA.

California Global Warming Solutions Act. 2006. **Assembly Bill No. 32.** http://www.arb.ca.gov/cc/ab32/ab32.htm. (07 February 2015).

California Oak Woodland Conservation Act. 2001. **Assembly Bill No. 242.** http://www.leginfo.ca.gov/pub/01-02/bill/asm/ab_0201-0250/ab_242_bill_20011009_chaptered.pdf. (07February 2015).

California Senate Bill 1334. http://www.leginfo.ca.gov/pub/03-04/bill/sen/sb_1301-1350/sb_1334_bill_20040924_chaptered.html. (07 February 2015).

California Air Resources Board. 2008. **Climate Change and Forestry in California.** www.arb.ca.gov/cc/forestry/forestry.html. (07 February 2015).

California Environmental Quality Act. 1973. CEQA: The California Environmental Quality Act. http://ceres.ca.gov/ceqa/. (20 February 2015).

California Public Resources Code. 2004. item 21083.1 Sacramento, CA

California Wildlife Conservation Board. 2010. **Oak Woodlands Conservation Program.** Prepared for the California State Legislature, Sacramento, CA.

Council of Tree and Landscape Appraisers. 2000. **Guide for Plant Appraisal, 9th edition.** Champaign, IL: International Society for Arboriculture.

Diamond, N.K.; Standiford, R.B.; Passof, P.C.; LeBlanc, J. 1987. **Oak trees have varied effect on land values.** California Agriculture 41(9,10): 4–6.

Ecological Society of America. February 2, 2009. **Ecologists report quantifiable measures of nature's services to humans.** Press Release. Ecological Society of America. http://www.esa.org/esa/category/pao-2/press-release/page/13/.

Endangered Species Act [ESA].1973. **Endangered Species Act.** 16 U.S.C. 1531-1536, 1538-1540. http://www.fws.gov/laws/lawsdigest/esact.html. (07 February 2015).

Gaman, T.; Firman, J. 2006. Oaks 2040: **The status and future of oaks in California.** Oakland, CA: California Oak Foundation.

Kopp, R.J.; Smith, V.K. 1993. **Valuing natural assets: the economics of natural resource damage assessment**. Washington, DC: Resources for the Future.

Los Angeles County. 2014. **Climate action plan**. http://planning.lacounty.gov/CCAP.

Los Angeles County. 1982. **Oak Tree Ordinance.** http://ucanr.edu/sites/oak_range/files/60602.pdf. (07 February 2015).

Los Angeles County Oak Woodlands Habitat Conservation Strategic Alliance [LACOWCMP]. 2011. **Los Angeles County Oak Woodland Conservation**

Management Plan. Prepared for Los Angeles County. http://planning.lacounty.gov/oakwoodlands. (20 February 2015).

Nowak, D.J.; Crane, D.E. 2000. **The Urban Forest Effects (UFORE) Model: quantifying urban forest structure and functions.** In: Hanson, M.; Burk, T., eds. Integrated tools for natural resources inventories in the 21st century. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service. North Central Research Station: 714–720.

Pincetl, S. 2009. **The yet uncertain science of valuing nature's services.** Presented to the Oak Woodland Strategic Alliance, April 2009. Eaton Canyon Nature Center, Pasadena, CA.

Salzman, J. 2005. **Creating markets for ecosystem services: notes from the field.** New York University Law Review 80: 870–961.

Scow, J. 2009. **CTLA appraisal summary: a brief overview of the 9th edition of the guide for plant appraisal.** Presented to the Oak Woodland Strategic Alliance, April 2009. Eaton Canyon Nature Center, Pasadena, CA.

Standiford, R.B. 1999. **Sustaining oak woodlands in California's urbanizing environment.** The Journal of the International Oak Society 9: 126–141.

Standiford, R.B.; Scott, T.A. 2001. **Value of oak woodlands and open space on private property values in Southern California.** Special issue - Investigación agraria: sistemas y recorsos forestales - towards the new forestlands commercial and environmental benefits accounting: theories and applications (P. Campos Palacin, ed.): 137–152.

USDA Forest Service. 2009. **I-Tree: tools for assessing and managing community forests.** www.itreetools.org. (20 February 2015).