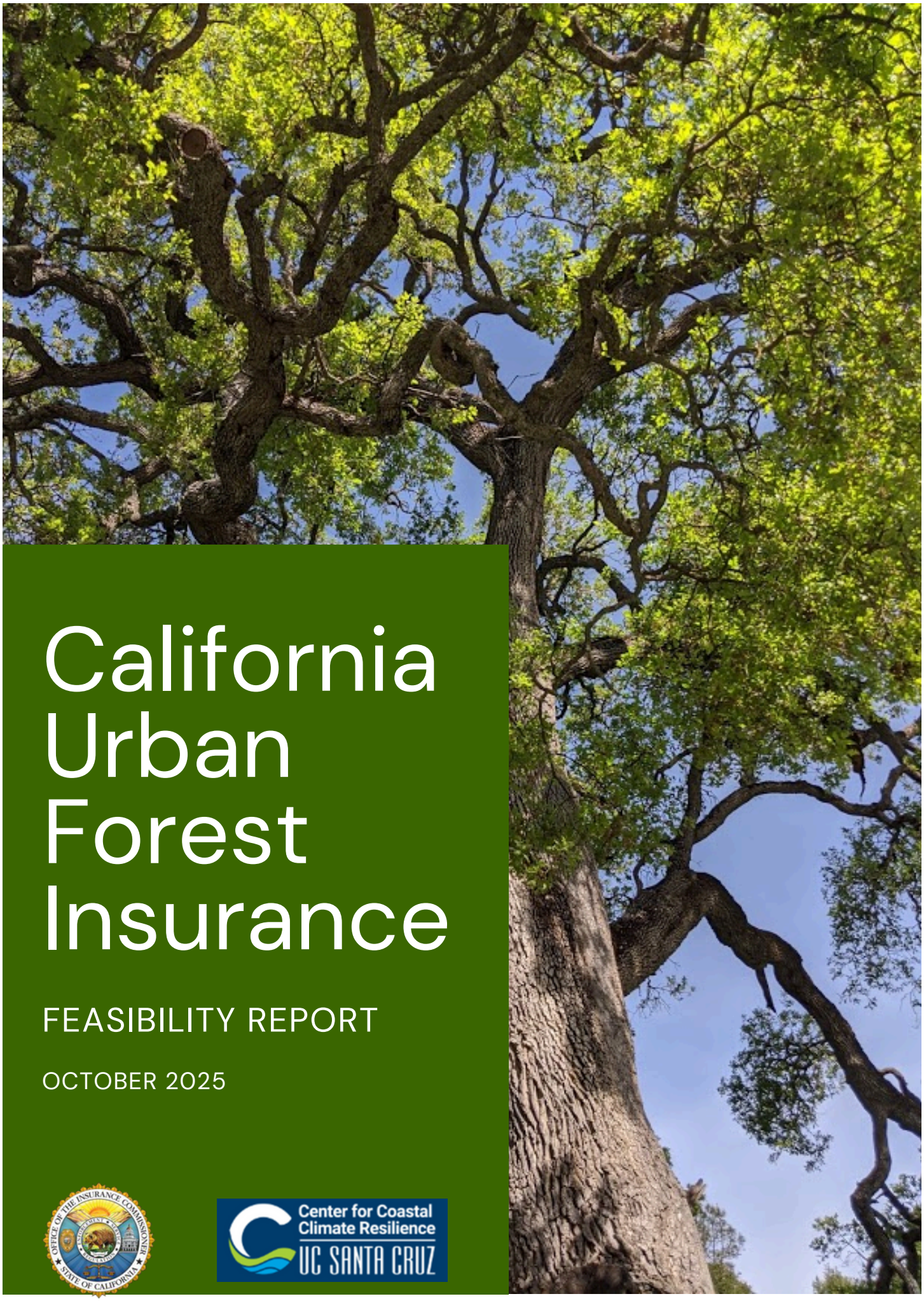


California Urban Forest Insurance

FEASIBILITY REPORT

OCTOBER 2025

Center for Coastal Climate Resilience
UC SANTA CRUZ

Executive Summary

The California Department of Insurance (CDI) recognizes the essential role that healthy ecosystems play in building resilience to climate change and preventing biodiversity loss. As climate change and other human drivers continue to weaken and damage ecosystems, communities are losing benefits from nature and facing heightened risks. Innovations in insurance are being explored as a means to invest in healthy ecosystems and reduce risks to communities.

In particular, the climate risks posed by extreme heat are of increasing concern to California residents and CDI, and urban forests are a powerful nature-based solution to this threat. While targets have been set by the state for increasing tree canopy cover, a combination of tools will be needed to achieve these goals. Parametric insurance of urban forests is being explored as one of those tools.

An expert workshop was convened by CDI and the University of California, Santa Cruz Center for Coastal Climate Resilience in April, 2025 to explore key feasibility questions for insuring urban forests.

Participants included state and local urban foresters, nonprofit and community-based organizations supporting healthy urban forests, and researchers and health care professionals studying the benefits of urban green spaces.

Participants and current literature established a potential role for urban forest insurance, since urban forests are important natural assets facing catastrophic risks that could be transferred. Major drivers of catastrophic urban forest loss in California include storms, extreme heat, drought and pests. Each of these risks was explored to see if they met feasibility criteria across the state for the type of parametric insurance that has been developed for other natural assets (coral reefs).

Storms were identified as a feasible risk for insurance state-wide because there is a parameter, sustained wind speed, that can act as a trigger that meets common feasibility criteria for insurance. Pests may also be a good candidate for urban forest insurance in some cities as there is an existing system for identifying and classifying pest risk, and the presence or degree of infestation of the pest is possible to measure as a trigger. All other major catastrophic risks would be more difficult to insure at this time because they failed to meet at least one of the feasibility criteria with current data and models. General mortality (from any cause) parameters lack the regular reporting frequency needed to monitor trees across the state. Drought and extreme heat risks are currently difficult to model and price, given that they cause tree death over many years and in conjunction with other drivers. Storms were explored further during this workshop as the risk most likely to be feasible to insure state wide today. Pests and other risks warrant further exploration for cities with sufficient data and risk to examine.

Studies suggest that it is possible and cost effective to repair damages from storms, with potential returns of up to 5:1. These returns are likely underestimates, as all studies have focused on a small subset of known urban forest benefits.

A diverse set of stakeholders have expressed interest in sustaining urban forests, and could be clients for insurance against catastrophic storm losses. Stakeholders include multiple California state agencies, local governments, non-profit organizations, and private companies in the tree care industry, real estate, and service industries (hotels and restaurants).

The findings of the workshop and literature suggest that insuring urban forests against storm losses is feasible state-wide, and that insuring against pest or other damages may be feasible for some cities or regions. Such insurance warrants further exploration.

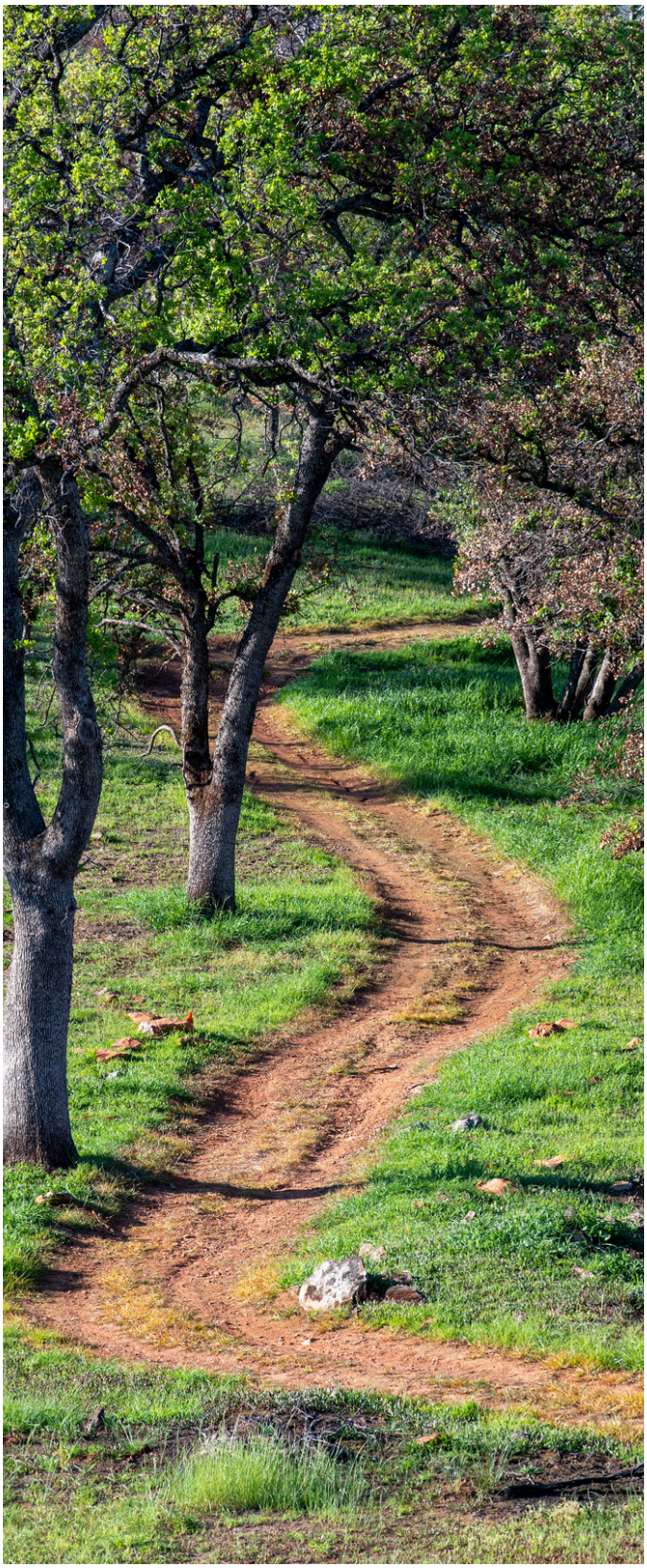
Background

Context

CDI recognizes the essential role that healthy ecosystems play in building resilience to climate change and preventing biodiversity loss. Nature provides critical ecosystem services—from carbon sequestration to climate regulation—and the degradation of these services results in significant societal and economic costs. As climate change and other human drivers continue to weaken and damage ecosystems, communities are losing benefits from nature and facing heightened risks.

Innovations in insurance are being explored as means to invest in healthy ecosystems and reduce the risks communities face. While the world's first insured ecosystem—the coral reef in Quintana Roo, Mexico—was protected in 2018, and similar reef insurance models have since been implemented globally, no other ecosystem type has yet been insured. In California, CDI has expressed growing interest in addressing the climate risks posed by extreme heat. Despite being an increasingly costly and deadly natural hazard1, extreme heat remains largely uninsured in the state.

Urban forests are a powerful nature-based solution to this threat. California's urban tree canopy has been shown to significantly reduce ambient air temperatures reducing air conditioning costs and health impacts from extreme heat. Beyond cooling, urban forests offer a wide range of benefits including carbon sequestration, wildlife habitat, soil stabilization, stormwater management, and improved physical and mental health. These tree networks function as "green infrastructure," offering increasing returns over time—unlike traditional gray infrastructure, which typically depreciates.



Background

Expert Workshop

The California Department of Insurance (CDI), in collaboration with the University of California, Santa Cruz Center for Coastal Climate Resilience, co-hosted a workshop to explore the feasibility and necessity of insuring urban forests. Participants included a diverse group of stakeholders: state and local urban foresters, nonprofit and community-based organizations advocating for healthy urban forests, academic researchers studying the dynamics of urban forests and the benefits of urban green spaces, and health care professionals examining the public health impacts of trees and greenspaces.

Given the significant ecological, social, and economic values of urban forests—and the long-term investment they represent—this workshop examined whether urban forests should be treated as insurable assets. Guided by The Nature Conservancy's Guide to Insuring Natural Assets, participants explored the following key questions:

Guiding Questions

- Do urban forests provide a **valuable service** in California?
- Can the value of the urban forest be **quantified**?
- What are the main **risks** urban forests face?
- Are the main risks driving catastrophic loss **insurable**?
- Who would be the **buyers** and beneficiaries of an insurance product?
- What **partnerships** could support the development of such a model?

Based on current literature and workshop discussions, this report explores the feasibility of insuring urban forests in California. Participants indicated interest in urban forest insurance and identified resources that support adequate quantification of the benefits at risk, as well as an insurable catastrophic risk (storms), setting the stage for further exploration of insurance design and implementation.

California Urban Forests Provide Valuable Services

Key Finding

It is well established that urban forests provide multiple valuable services in the United States, including in California.

A subset of these services has been quantified and monetized, providing sufficient basis to argue for insurance and to conduct cost-effectiveness analyses.

Insurance is a contract to transfer risk to an insurer to recover losses or damage. In order for insurance to be a relevant risk transfer mechanism, there must be some thing or service of sufficient value to warrant paying insurance premiums to cover potential losses.

Urban forests provide a wide range of benefits, including but not limited to cooling air temperatures, carbon sequestration, stormwater reduction, energy conservation (from cooling air), aesthetic value, increased property value, flood risk reduction, extended life of surface streets, improved soil, water and air quality, and wildlife habitat.[2-4]

A state-wide comprehensive analysis on two services (energy cost savings, carbon sequestration) estimated that 173.2 million urban trees are a $181 billion asset that is producing in excess of $8 billion in services per year[5]. For comparison, this asset value exceeds the state's reported capital asset value for state highway infrastructure, buildings and other depreciable property in 2023 ($143.4 billion)[6].

Multiple studies have also established that links between urban trees and public health are robust and economically significant, including benefits to mental health, maternal health, and cardiovascular health[7]. For example, a study of 5 million Northern California residents showed that those living in the greenest areas (based on satellite observations of greenness (Normalized Difference Vegetation Index; NDVI)) paid $374 less per year in adjusted health care costs than those living in the least green areas (based on data from 2003 – 2015).[8]

An economic analysis conducted by CAL FIRE, in collaboration with California ReLeaf, concluded that the planting, care and maintenance of urban and community forests in California contributed $12.9 billion to the state economy in 2021 (through direct, indirect and induced effects) through an industry that employed over 78,560 people that year[9].

Additional findings of the analysis include:

- Urban trees provide significant enhancements to property value;
- Health care patients with more access to tree canopy saved $250 in health costs per year;
- Attractively landscaped properties generate significantly more sales tax;
- Overall, urban forests generate more than $20 billion in benefits annually.

The California Air Resources Board (CARB) has used iTree tools designed by the U.S. Forest Service to estimate project-level greenhouse gas emissions reductions and other benefits of urban forestry projects funded by the California Climate Investments (CCI). As of November 2024, CCI funding through CAL FIRE's Urban and Community Forestry Program has resulted in approximately 480,186 MTCO2e of estimated greenhouse gas emissions reductions[10].

State-supported urban greening projects that planted 84,000 trees across 35 counties (between 2016-2020) reduced cooling costs by an estimated $3.3 million per year, reduced stormwater management costs by $3.2 million per year, reduced crime-related costs by $5.2 million and increased property values by $4.1 million on an annualized basis[11].

Additionally, through California's 2022 Scoping Plan Update modeling, CARB found urban forests were one of the only ecosystems analyzed in California that are projected to either maintain or enhance their current level of carbon stocks (and associated climate mitigation benefits) into the future[12].

Further research on the benefits of California urban forests is underway. For example, the California Natural Resources Agency is working with the UC Berkeley Center for Law, Energy & the Environment to study the economic and workforce impacts of urban forestry, among other nature-based solutions. The project, anticipated to be completed in 2026, will assess the expected benefits of increasing urban forest extent to achieve the state's urban and community greening and forestry targets developed as a part of California's Nature-Based Solutions Climate Targets, pursuant to AB 1757 (C. Garcia, 2022).

An Insurable Risk To Urban Forests

Key Finding

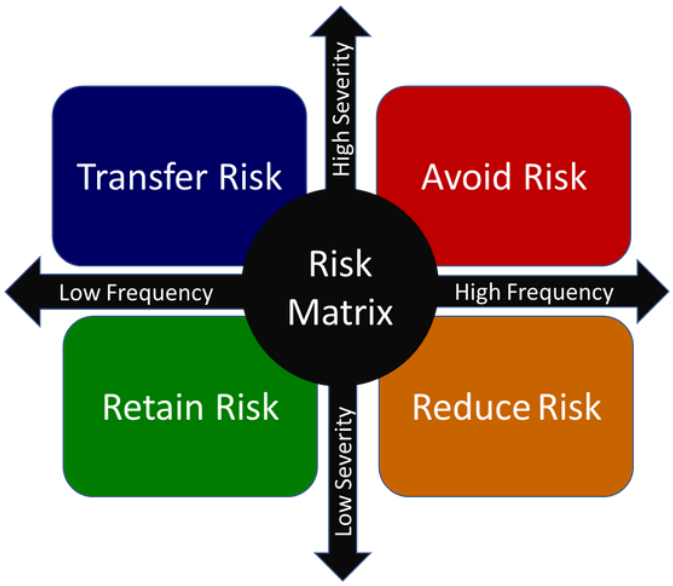
Storms are a leading driver of catastrophic urban tree loss that may meet the criteria needed to be insurable across California.

Pests, drought, and extreme heat stress are other major drivers of catastrophic urban tree loss that may be insurable for individual cities or regions, but have current characteristics that make them challenging to insure state-wide.

Most U.S. cities are losing urban forests over time, with a net loss of 4 million urban trees every year, or ~1.3% of the total tree stock.[13] A multi-faceted strategy will be needed to address the primary risks to urban forests. Insurance is one tool that may help in providing the necessary funding and tools to address some risks. The risk matrix can be used to narrow the set of risks driving these declines to focus on those that may be relevant for insurance.

In considering the urban forest, it can help with determining which risks can be reduced via investment in urban forest maintenance and which ones would benefit from being insured. For high frequency, low severity events, the goal would be to reduce risks through management and maintenance. For low frequency, high severity events (here called catastrophic events), urban forest managers can focus on transferring the risk through a mechanism like insurance.[14]

Drought, extreme heat, storms, wildfire (from wildland urban interface), pests and land use change are leading drivers of major urban forest loss in California. Between 2018 and 2022, California lost 2% of its urban canopy.[15]



Land use change is a risk to forests that is typically not addressed through insurance, but rather can be reduced through policy and management planning. For example, pursuant to AB2251 (2022), CAL FIRE is developing a statewide strategic plan to achieve a 10 percent increase in canopy by 2035, with priority for increasing tree canopy cover in disadvantaged and low-income communities. CAL FIRE is setting targets and actions to increase canopy cover, and must identify resources and strategies to address threats to urban forests, including land use change, as well as climate change, extreme weather, pollution, drought, disease, and pest. The strategic plan will be submitted to the Legislature in June 2026.

The risk of losses from intermittent, high frequency and high severity risks - including drought, extreme heat, storms and pests - can be transferred through insurance. For a catastrophic risk to be insurable, it needs to meet several criteria. The current model for insuring natural assets uses a parametric policy, which requires the identification of a trigger (or parameter). Parametric insurance rapidly pays out a set amount based on observable measures of the catastrophic event, such as wind speed in a certain location during a hurricane. When the designated parameter is reached, a payout is triggered.[16]

The parameter is a characteristic of the event that is correlated to the damages caused to the asset.[17] Insurance products can rely on more than one parameter if the relationships are analytically well-established. The trigger that determines the payout on a parametric policy is typically correlated with the actual loss and can be independently and objectively measured during or immediately after the event.[18] Many triggers for disaster parametric policies are related to measures of the intensity of an event.[19] In addition, parameters are often required to have quantifiable historical data and predictive models that can be used to determine the risk to the asset.

To summarize, for risks that cause catastrophic events to be insurable with a parametric approach, there needs to be:

- a sufficiently long record of data on the risk to understand its probability and impacts;
- an ability to project levels of future risk using reliable models; and
- a trigger (parameter) that is correlated with the actual losses and can be independently, objectively measured and reported during or immediately after the disaster.[20]

These conditions were explored for several risks to California urban forests.

All Cause Mortality

Since there are multiple drivers of catastrophic loss acting on California urban forests, it may be possible to develop insurance as a general coverage for mortality from all causes of catastrophic loss (here called all cause mortality).

Inventories of all cause urban tree mortality in California do exist (UC Agriculture and natural Resources Western Tree Failure Database, California Urban Forest Inventory), but they are not currently updated on a regular basis. Early efforts to use remote sensing mapped tree health, but only on a small scale (University of California, Davis campus)[21]. A recent remote-sensing advance makes data on canopy cover available at a high resolution across the state[22], but there are no apparent plans to repeat this analysis regularly.

Many California cities maintain tree inventories within their jurisdiction, which include relevant information for reporting tree losses or injuries.

Most are updated every five years, which is not frequent enough to act as a trigger for the current and expected future patterns of catastrophic losses. There does not appear to be a viable trigger for all-cause catastrophic mortality to support the development of parametric insurance on all causes across California at this time.

Extreme Heat & Drought

Drought has been shown to lead to substantial urban tree canopy loss, with associated losses in air cooling services,[23] and both drought and heat risks are expected to increase in some California counties.[24] However, tree mortality from drought and extreme heat are currently difficult to model and price, across the state, given that they cause tree death slowly over many years and in conjunction with each other or other factors. These risks currently are unlikely to be insurable and are not being pursued further for insurance at this time.

Pests

Pests dramatically affect California urban forests and reduce the services they provide. For example, the invasive shot hole borer beetle is responsible for the deaths of thousands of trees in Southern California and poses an imminent threat to the integrity of our urban and natural forests.[25] The beetle infects over 100 species of trees including commercially significant species like almond. The pest typically spreads slowly but made a rapid expansion to San Jose, possibly through the movement of timber. More generally, bark beetle outbreaks across the state, in conjunction with drought, have been found to have the potential to lead to heavy and dry fuel loads that could result in more extreme fire behavior and more severe effects.[26]

Early pest detection and rapid response to limit infestation are possible. Existing pest classifications and rankings can help identify particularly problematic species, and early detection efforts can reduce the risk of severe infestation. However, current funding for such activities is often limited to agriculturally significant crops. Local governments could benefit from insurance that addresses the risk posed by pests not only to agriculturally significant trees, but also to trees that provide services such as shade, cooling, carbon sequestration, health benefits, and biodiversity.

A focus on the presence of pests as a trigger, rather than on tree mortality, could facilitate faster and more effective response activities. The California Department of Agriculture monitors and reports pests relevant to agriculture. The feasibility of using this system to report on pest emergence as a trigger for insurance needs further exploration than was possible during this workshop.

Storms

Storms, including atmospheric rivers and high wind events, can lead to major urban tree losses in California.[27–29] For example, a single storm in 2023 led to the loss of over 1000 trees in the city of Sacramento. Sustained wind speed is a parameter of storms that is associated with tree damage and mortality that could meet insurance needs.

Long term data on storm frequencies and intensities exist and the relationship between wind and tree damage is well established. Sustained wind speeds of <30 mph are associated with low tree failure rates; winds of 39-46 mph generally cause small limb failure; winds of 47-63 mph generally cause large limb and whole tree failures; and sustained winds >64 mph lead to massive, large-scale failures of many trees.[30]

Most municipalities are prepared to respond to damages from storms with <50 mph winds. A tiered parametric insurance could be designed with appropriate levels of payout at different intensities of sustained winds. The National Weather Service and National Oceanic and Atmospheric Administration regularly report sustained wind speeds, providing an objective, regularly reported, and publicly available source of data on the parameter. Storms of different magnitudes with different sustained wind speeds can also be modeled to establish potential risks.

Wind speed is not the only parameter correlated with tree damage and loss during storms. High precipitation and associated soil saturation or flooding can also damage trees. In addition, drought-affected, diseased, or otherwise stressed trees are likely to be more susceptible to storm strength winds, and trees may topple at lower wind speeds when stressed. Development of parametric triggers should take these other stresses into consideration if possible. For example, a lower trigger level could be set overall to account for trees of lower health. If multi-parameter triggers could be developed, metrics like soil saturation (or sustained precipitation; to indicate flooding), number of previous days exceeding a high heat index (to indicate extreme heat stress), or others could be combined with wind speed to more accurately represent likely risk.

Catastrophic loss from storms is currently the most likely risk to California urban forests to be insurable across the state, and will be the focus of the remainder of this report. Additional risks warrant further exploration for some cities and regions.

Cost-Effective Asset Repair

Key Finding

Urban forest damages from storms can be repaired – through planting of new trees or maintenance actions that improve the health and resilience of trees. Replacing or repairing damaged urban forests is cost-effective when multiple benefits are considered.

The intent of insurance policies explored in the workshop is to provide funds to repair damages or compensate beneficiaries for the loss and recovery of ecosystem service flows.[31] For insurance to be viable, it must be feasible and cost-effective to repair the asset after it is damaged.

Trees that are harmed but not killed by storms can be pruned or maintained in other ways, improving survival of the remaining tree. Trees killed by storms can be replaced with new trees, preferably native species. Importantly, the repair or replacement of urban trees and forests after catastrophic loss would need to be designed in a way that replaces the stream of benefits lost during the event and recovery period.

Not all trees or sites are alike, so close consideration is needed to understand which services are lost, at what scale, and to whom; and how maintenance and replanting can be designed to recover those losses. Designing and executing effective recovery plans relies on qualified arborists and sufficient seedling supplies.

For insurance to be feasible, the cost of repairing the natural asset needs to be lower than the economic losses caused by the decline in ecosystem services due to catastrophic events.

Discussions suggested that the appropriate costs to consider in the case of storm impacts on urban forests are the costs of recovering the lost stream of benefits during the storm and the recovery period. These costs include designing a recovery plan sufficient to replace lost benefits, and the costs of replanting and maintaining trees and forests. Other costs, such as downed or hazard tree removal, disposal, and impacts to infrastructure are typically covered by emergency management funds or other forms of insurance.

A state-wide study showed high net returns from urban tree planting investments, including a 5.82:1 return across California.[32] A smaller-scale analysis focused on low tree cover areas of Los Angeles found a 1.5:1 return on the planting of 7.9 million trees.[33]

An analysis of the returns on a municipal tree planting program in Sacramento, CA showed the program to be highly cost effective based on air conditioning savings, and cost-effectiveness rose further for some species of trees when air pollution reduction benefits were included.[34] Longer term (5 yr) survival of trees in this program was around 60%, due mostly to unstable home ownership and poor management practices by home owners, emphasizing the role of maintenance in overall returns from urban forest programs.[35]

Others have argued that the rate of return for planting and maintaining urban trees can exceed the returns typical in many for-profit business sectors.[36]

All of these studies have focused on a small subset of the known benefits that urban forests provide, so returns are likely to be substantially higher than those reported.

Interested Stakeholders

Key Finding

The California state government, local governments, and many non-profit organizations value urban forests and are interested in repairing damages and losses.

There may also be significant recognition of urban forest values by health providers, community financial institutions, the tree care industry, Chambers of Commerce, and others who benefit from the presence of urban forests and the ecosystem services they provide.

For insurance to be viable, there must be stakeholders that recognize the value of urban forests and have an interest in repairing damages. These stakeholders can be owners of the natural assets or people who benefit from the ecosystem services the assets provide.

The State of California owns and manages extensive urban forests in urban state parks, including Griffith Park in Los Angeles, Candlestick Point State Recreation Area in San Francisco, and Crystal Cove State Park in Orange County. The State has set a goal to not only maintain these natural areas, but increase tree canopy cover 10% on all public and private lands by 2035 (AB 2251, 2022).

The California Department of Forestry and Fire Protection's Urban Forestry Program advances the development of sustainable urban and community forests in California, so also has a vested interest in the long-term health of urban forests.

The State Hazard Mitigation Plan, managed by the California Office of Emergency Services, recognizes extreme heat as a hazard to address, and urban forestry is a specifically identified mitigation strategy against this risk. The Federal Emergency Management Agency, historically a major federal funder of action towards the State's Hazard Mitigation Plan, has invested risk reduction and recovery funds in recovering urban forests damaged by a hurricane in New York City.

Other state government agencies that fund tree stewardship and maintenance and may be interested in recovering losses include the California Natural Resources Agency, the Governor's Office

of Land Use and Climate Innovation, the State Water Resources Control Board, the California Department of Food and Agriculture, the Public Utilities Commission, the Wildlife Conservation Board, CalRecycle, the Strategic Growth Council and the California Environmental Protection Agency.

Local governments have primary jurisdiction over the majority of urban forests in California. Some cities have set goals for increasing or maintaining urban canopy cover. For example, Los Angeles county has set a goal to increase canopy cover by 20% of baseline by 2045[37], and the city of Los Angeles has set a goal of planting 90,000 new trees.[38] The City of Palo Alto's 2022 Sustainability and Climate Action Plan includes an aspirational goal of achieving 40% tree cover citywide by 2030.[39] Many cities have dedicated staff and budgets to maintain urban trees and greenspace, and fund these efforts through a range of local, state, and federal sources (e.g. see Davis, California's Urban Forestry Operations and Funding).

In addition to government interest, several non-profit organizations actively invest in urban forests and are committed to their thriving. These include California ReLeaf, TreePeople, San Francisco StreetTrees, Trust for Public Lands, Green Schoolyards America, CivicWell, The Nature Conservancy, California Urban Forest Council, American Forests, and many others. Many school districts, private schools and colleges across the state also invest in greening on their grounds.

Given the established connections between urban forests and health, health care providers such as Kaiser Permanente, Sutter Health, Blue Shield of California, L.A. Care and others, are benefiting from urban forests[40], and may be interested in recovering urban forest losses. Large employers may also be interested in reducing health care costs for their employees via urban forest benefits.

Private companies also benefit from urban forests and may be interested stakeholders. The tree care industry contributed $12.9 billion to the state economy in 2021 (through direct, indirect and induced effects) and employed over 78,560 people that year.[41] The industry has a vested interest in the continued presence and need for maintenance of urban trees and forests. Some restaurants and businesses located near urban green spaces benefit from an attractive setting, making some restaurant associations, business associations or retail districts possible investors. Realtor's associations may also be interested, as home and property values are often higher near urban trees and forests.

Across these many stakeholders, there is likely to be sufficient interest to support urban forest insurance, but additional conversations are needed to explore their ability to invest.

The Design Phase

The next phase in assessing insurability of urban forests is the design phase. Key questions in this phase include:

1

What is the insurance design?

- What amount of funds are needed after an event, and how much risk needs to be transferred?
- What is the specific trigger and associated threshold value (or tiers of values) that would be used?
- What is the area where a trigger should be met?

2

What are the institutional arrangements?

- Would the insurance cover losses on public lands, private lands, or both?
- Who pays for the insurance, who holds the policy, and who receives the payout?
- What is the governance to manage the payout and use of funds after an event?

Following the design phase, additional implementation questions regarding a pilot location, local goals and needs for urban forest management, terms and procurement, and capacities for managing and implementing an insurance policy and fund would need to be explored.

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