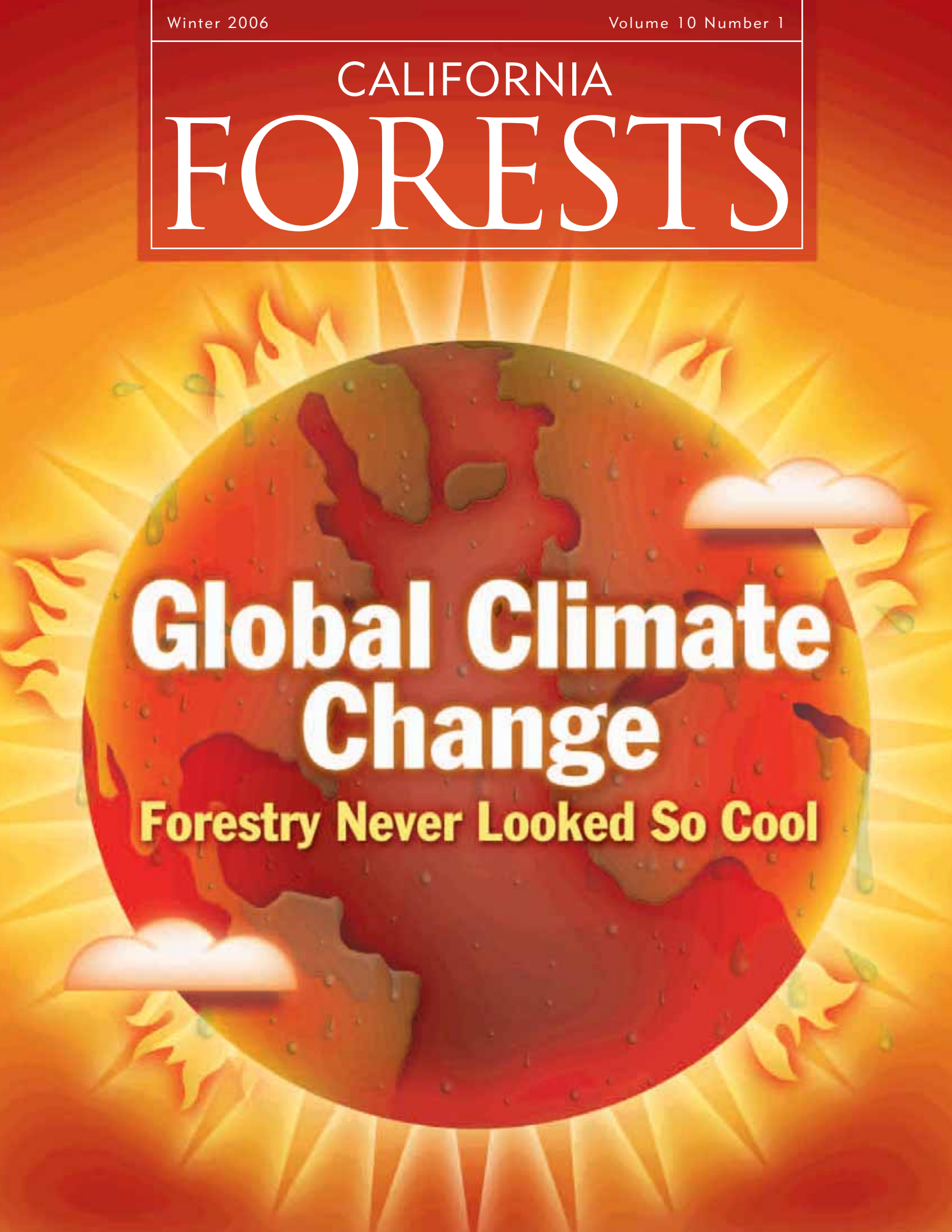
Winter 2006 Volume 10 Number 1

CALIFORNIA FORESTS



Global Climate Change

Forestry Never Looked So Cool

You think only wood comes from California Grown forests?

California forestry is about so much more than trees. California's forestry professionals work hard to protect water every day.

Is it effective? It must be. After all, millions of Californians gladly pay a premium for refreshing water bottled at its forested source.

Cool, refreshing water from California's well-managed forests. Enjoy it today.

The Forest Foundation

Sharing Knowledge about Forests

www.calforestfoundation.org 1-866-241-TREE(8733)

Contents

08 Forest Management: Part of the Climate Change Solution
By Patrick Moore, Ph.D.
Managing forests and using wood are among the best ways to address climate change and remove vast amounts of carbon from the air.

10 How Forests Can Combat Climate Change
By John A. Helms, Ph.D.
Young, well-managed forests sequester carbon more quickly and efficiently than old ones, and present an opportunity to buy time to develop ways to reduce carbon pollution.

12 The Unseen Connection: Building Materials and Climate Change
By Bruce Lippke, Ph.D.
Wood's value as a building material is often misunderstood. Incomplete information can lead to wrong conclusions and "green" building standards that may inadvertently contribute to global warming.

14 Beyond Reducing Emissions
By Kenneth Green, Ph.D.
Most climate change discussions focus on reducing greenhouse gas emissions. Far less attention is paid to options that pull greenhouse gases out of the air, though they hold significant potential.

16 Address Air Pollution at its Roots
Excerpted from an interview with Gabriele Pfister, Ph.D.
In summer 2004, wildfires in Alaska and Canada spewed as much carbon monoxide into the air as all the cars and factories in the continental United States. Managing forests can have doubly positive effects on atmospheric carbon.

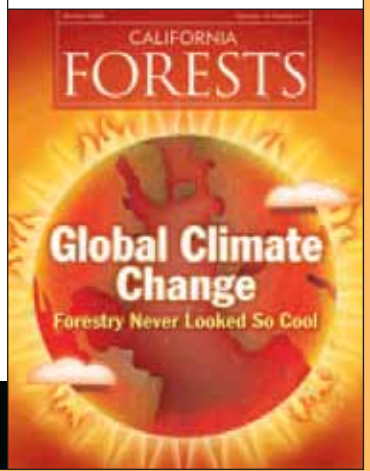
18 Global Warming, Ice Ages and Forests
By Thomas M. Bonnicksen, Ph.D.
Earth is warming, but continental glaciers will return. Forests have responded to climate changes throughout history, and that perspective can help guide forest management decisions.

20 Clean Energy Offers too Much Potential to Ignore
By John Kadyszewski
With proper financial incentives to offset high costs, burning biomass could remove carbon dioxide from the air and prevent it from being released into the atmosphere.

21 Bringing Carbon Buyers and Sellers to Market
By David Sunding, Ph.D.
Trading carbon credits is a straightforward idea that could provide an economic incentive to lower atmospheric carbon levels, if a number of obstacles can be overcome.

www.calforests.org

Cover:
Illustration by Tom McKeith



More timber is growing in California's national forests than is harvested nationwide.

Sierra Forest Products
PO Box 10060 Terra Bella, CA 93270
Ph 559/535-4893 Fax 559/535-4515

CALIFORNIA
FORESTS
CRITICAL THINKING ABOUT
FOREST RESOURCES

Official Publication of the California Forestry Association

1215 K Street, Suite 1830
Sacramento, CA 95814
(916) 444-6592 fax: (916) 444-0170
web site: www.foresthealth.org
e-mail: cfa@foresthealth.org

Publisher
David A. Bischel

Managing Editor
Bob Mion
California Forest Products Commission

Production Manager
Sophia Runne

Advertising
Lori Vance

Membership/Subscriptions
Lori Vance

Design & Layout
CMB Design Partners

California Forestry Association

Officers
Charlie Brown, Chairman
Lloyd Bradshaw, Vice Chairman
David Bischel, President
Dee Sanders, Treasurer
Phil Battaglia, Secretary

In partnership with:

California Forest
Products Commission

For more information on forestry issues call 877-REPLANT or visit **www.calforests.org**

All rights reserved. Duplication of material within this magazine without express written permission by the California Forestry Association is prohibited by law. *© 1997 California Forestry Association.* Neither the California Forestry Association, the California Forest Products Commission, the editorial staff of this magazine nor the editor of this magazine assume any responsibility for any expression of opinion or statement of fact made by any contributors of articles or other materials to this magazine or made by any advertisers in this magazine. All materials, expressions of opinion or statements of fact by the California Forestry Association, the California Forest Products Commission or the editorial staff or editor of this magazine are provided with the understanding that they do not constitute legal advice or other authoritative advice and should not be relied upon or acted upon by the reader. Readers should base their reliance or actions solely on their independent analysis or on independent professional advice.

California Forests magazine is a service to California Forestry Association members.

Additional copies are available by calling (916) 444-6592 or email to cfa@foresthealth.org.

Forestry's Carbon Balancing Act

David A. Bischel
President, CFA

Nature is full of cycles. There are life cycles, energy cycles, and now taking center stage, a carbon cycle.

Carbon naturally cycles through earth's atmosphere, oceans, soils and vegetation. We are currently experiencing relatively high concentrations of atmospheric carbon. Though neither the causes nor effects on our climate are fully understood, many people draw correlations between carbon emissions and global warming.

Climate change is a hot topic in social circles, the media and at universities. Carbon policies are being debated at global, national and state levels.

Governor Schwarzenegger has assembled a climate action team to implement global warming emission reduction programs. He has also taken a leadership position on environmental issues. Supporting sustainable forestry in California is a logical way to help obtain his climate change objectives and uphold California's environmental values.

Nobody knows exactly what affect human activities have on climate cycles. But what is certain is that sustainable forestry removes carbon from the air efficiently and effectively. Carbon storage, or sequestration, is a natural by-product of sustainable forestry cycles. Sustainable forestry also ensures that forestland stays forested.

Trees in well-managed forests excel at removing carbon from the atmosphere. They store it in leaves, roots and wood fiber. Trees sequester carbon most efficiently during their peak growing years. Once they mature, their sequestration rate slows, though carbon stays trapped in their wood. Harvesting trees once their optimum growth rates are achieved maximizes their carbon sequestration potential, and turning those trees into products (like lumber for homes) sequesters that carbon for decades if not centuries. Replanting the forest completes the forestry cycle and continues the carbon sequestration cycle.

Unfortunately, sustainable forestry in California faces significant challenges. While California foresters perform to the highest environmental standards in the world, duplicative regulatory processes have inflated the cost of doing business to the point where private landowners are pressured to sell out and see their land converted to non-forest uses. A recent study from Cal Poly University, San Luis Obispo found that forestry-planning costs have increased 1,200 percent in the last 30 years. Another Cal Poly study found that over-regulation has the unintended consequence of encouraging forestland conversion.

Last May, forestry company representatives, environmental groups, academics and government officials met at a conference sponsored by UC Berkeley and the Pacific Forest Trust to address the threat of forest loss and fragmentation. Forest loss in California has implications far beyond our borders – we already import nearly 80 percent of our wood, and losing forests means losing an important tool for addressing atmospheric carbon…and that those forests won't be here for future generations. Retaining our working forests is an environmental objective we should all rally behind.

We should not shy away from using wood – it is a remarkable renewable resource with environmental advantages over nearly all other building materials. We should embrace the value of sustainable forestry as it pertains to global carbon cycles.

Governor Schwarzenegger has positioned California to be a leader in addressing climate change. Policymakers throughout the state should recognize forestry and working forests as critical to our state's economic and environmental wellbeing, and take steps to ensure a future for sustainable forestry in California.

Contributors

Thomas M. Bonnicksen, Ph.D.
is a forest historian, professor emeritus of forest science at Texas A&M University, co-founder of the International Society for Ecological Restoration, and visiting scholar to the California-based Forest Foundation. He has testified before the California Legislature and U.S. Congressional Committees.
(Story on Page 18)

Kenneth Green, Ph.D.
is the executive director of the Environmental Literacy Council. He received his doctorate in environmental science and engineering from UCLA.
(Story on Page 14)

John A. Helms, Ph.D.
is professor emeritus of forestry at the University of California, Berkeley, and current president of the Society of American Foresters.
(Story on Page 10)

John Kadyszewski
is the coordinator for Winrock International's Ecosystem Services Group. He launched Winrock's work on biomass energy in 1989 and is now responsible for implementing pilot projects for the West Coast Carbon Sequestration Partnership (WESTCARB) funded by the U.S. Department of Energy.
(Story on Page 20)

Bruce Lippke, Ph.D.
is a professor at the University of Washington's College of Forest Resources and president of the Consortium for Research on Renewable Industrial Materials (CORRIM), a non-profit collaborative of 15 research institutions. CORRIM research has been funded by the USDA Forest Service R&D and Forest Products Lab, U.S. Dept. of Energy, consortium members and private companies.
(Story on Page 12)

Patrick Moore, Ph.D.
is a co-founder of Greenpeace, holds a doctorate degree in ecology, founded and chaired the BC Carbon Project in 1990, and is now chairman and chief scientist of Greenspirit Strategies Ltd. in Vancouver, Canada.
(Story on Page 8)

Gabriele Pfister, Ph.D.
is a postdoctoral scientist with the Atmospheric Chemistry Division of the National Center for Atmospheric Research (NCAR) in Boulder, CO. NCAR is operated by the University Corporation for Atmospheric Research under the sponsorship of the National Science Foundation.
(Interview on Page 16)

David Sunding, Ph.D.
is a professor of environmental and resource economics in the College of Natural Resources at the University of California, Berkeley, and served as a senior economist at the White House Council of Economic Advisors during the Clinton administration. His research focuses on environmental regulation, land use, and water resources.
(Story on Page 21)

From our forest to your home...

SUSTAINABLE FORESTRY INITIATIVE

And we have the vertical integration to prove it.

It means more control for you. We own our forests, manufacture the products and operate our own transportation systems. Call or visit our website to see how we can meet your needs.

SIERRA PACIFIC INDUSTRIES
Growing Forests For Our Future

SIERRA PACIFIC Windows
A Division of SIERRA PACIFIC INDUSTRIES

PO Box 496028 • Redding • California • 96049 • usa • 530-378-8000 • fax • 530-378-8242 • www.spi-ind.com
lumber • specialty products • distribution • millwork • poles • windows • transportation • fiber products

The Success of a Company is Measured by Its Growth

Fruit Growers Original Hilt Mill Site Circa 1900

Same Location in 2005 After Three Harvests

FGS

FRUIT GROWERS SUPPLY COMPANY

Forest Management: Part of the Climate Change Solution

Trees are the most powerful concentrators of carbon on Earth

This is a win-win situation for both the economy and the environment. One of the best ways to address climate change is to use more wood, not less.

Wooden furniture made in the Elizabethan era still holds the carbon fixed hundreds of years ago.

By Patrick Moore, Ph.D.

As the world looks for ways to keep carbon dioxide (CO2) – the greenhouse gas produced by burning fossil fuels – out of our atmosphere, science tells us managed forests will play a key role.

Trees are the most powerful concentrators of carbon on Earth. Through photosynthesis, they absorb CO2 from the atmosphere and store it in their wood, which is nearly 50 percent carbon by weight.

You might be surprised to learn young forests outperform old growth in carbon absorption. Although old trees contain large amounts of carbon, their rate of absorption has slowed to a near halt. A young tree, although it contains little fixed carbon, pulls CO2 from the atmosphere at a much faster rate.

While it is true that cutting down an old tree results in a net release of carbon, new trees growing in their place can more than make up the difference. And wooden furniture made in the Elizabethan era still holds the carbon fixed hundreds of years ago.

Taking carbon out of the air

The relationship between trees and greenhouse gases is simple enough on the surface. Trees grow by taking carbon dioxide from the atmosphere and, through photosynthesis, converting it into sugars. The sugars are then used as energy and material to build the cellulose and lignin that are the main constituents of wood.

When a tree rots or burns the carbon contained in the wood is released back to the atmosphere.

Active forest management, such as thinning, removing dead trees, and clearing debris from the forest floor is very effective in reducing the number and intensity of forest fires. And the wood that is removed can be put to good use for lumber, paper and energy.

Accounting provides a useful metaphor to discuss forests and carbon sequestration. Old-growth forests often have a large "balance" of carbon that has built up over time in wood and soil. They are not adding much new carbon because they are decaying at about the same rate as they are growing. In financial terms, this is like a company that has a lot of assets but is operating on a break-even basis. Young forests have a smaller balance of carbon compared to old forests but they are accumulating carbon at a rapid rate. In that sense they are like an emerging company that has few assets but is very profitable and growing rapidly.

The impact of forests on the global carbon cycle can be boiled down to these key points:

- On the negative side, the most important factor influencing the carbon cycle is deforestation, which results in a permanent loss of forest cover and a large release of CO2 into the atmosphere. Deforestation – which occurs primarily in tropical countries where forests are permanently cleared and converted to

agriculture and urban settlement – is responsible for about 20 percent of global CO2 emissions.[1]

- On the positive side, planting fast-growing trees is the best way to absorb CO2 from the atmosphere. Many countries with temperate forests have seen an increase in carbon stored in trees in recent years. This includes New Zealand, the United States, Sweden and Canada. Plus, using wood sustainably reduces the need for non-renewable fossil fuels and materials such as steel and concrete – the very causes of CO2 emissions in the first place.

The good news is that forests in the United States are net carbon sinks, since annual growth exceeds annual harvest. We are currently experiencing an increase in forested land as forests are being re-established on land previously used for agriculture. Catastrophic wildfires are uncommon in managed forests, whereas millions of acres of unmanaged forests burn every year due to excessive build-up of dead trees and woody debris.

How wood stacks up

Every wood substitute, including steel, plastic and cement, requires far more energy to produce than lumber. More energy usually translates into more greenhouse gases in the form of fossil fuel consumption or cement production.

Some activists would have us believe using wood is bad for forests. Yet we are the largest per-capita consumers of wood in the world, and North American forests cover approximately the same area of land as they did 100 years ago. According to the United Nations, our forests have expanded nearly 10 million acres over the past decade. This is precisely because we use a lot of wood, which sends a signal to the marketplace to grow more trees to meet demand. This is a win-win situation for both the economy and the environment. One of the best ways to address climate change is to use more wood, not less. Wood is simply the most abundant, biodegradable and renewable material on the planet.

It is hard to imagine a more all-purpose, environmentally friendly act than that of contributing to the number and variety of trees growing throughout the world. In the age of climate change, Johnny Appleseed takes on a new meaning.

[1] *Intergovernmental Panel on Climate Change, IPCC First Assessment Report Overview, August 1990.*

Young forests have a smaller balance of carbon compared to old forests but they accumulate carbon at a rapid rate. In that sense they are like an emerging company that has few assets but is very profitable and growing rapidly.

How Forests Can Combat Climate Change

Vitality is the key to removing carbon from the air

By John A. Helms, Ph.D.

It is well known that human activities like burning fossil fuels that pump carbon into the atmosphere are likely contributing to global warming. While we must seek ways to reduce carbon pollution there is another approach that, in effect, enables us to buy time – that is to capitalize on the remarkably efficient capacity of trees to remove carbon from the atmosphere.

When the capacity of old forests to remove carbon is measured against young forests, old forests come up short. In young forests, the uptake of carbon dioxide greatly exceeds the loss. The reverse can be true for very old forests.

In particular, it's the young trees and forests that are most efficient in taking up carbon. Not that old forests don't contribute – they do. But when their capacity to remove carbon is measured against young forests, old forests come up short.

First, though, a little Biology 101: Trees take up carbon dioxide from the air and return oxygen in the process of photosynthesis. The carbon is stored in leaves, branches, stems and roots. However, trees also respire some carbon dioxide back to the atmosphere. In young forests, the uptake of carbon dioxide greatly exceeds the loss due to respiration. The reverse can be true for very old forests. This prompts two questions: Can we enhance a forest's capacity to store, or sequester, carbon? And if so, what's the best way to do it?

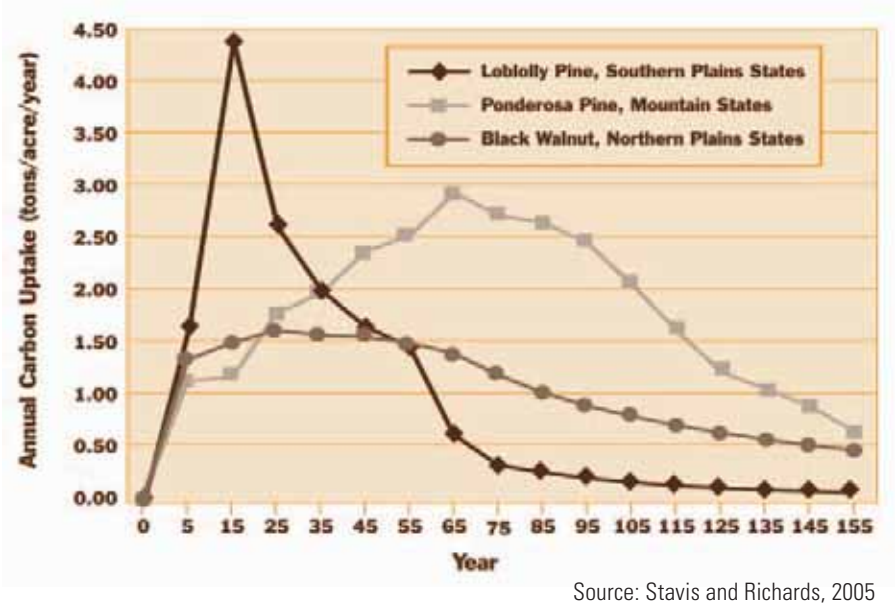
The answer to the first question is fairly straightforward. Increasing carbon storage in forests goes hand-in-hand with other forest management goals, such as providing essential wood products, enhancing watershed health and maintaining biodiversity across the landscape. What's good for forest health is good for carbon sequestration. Active forest management can certainly increase carbon sequestration, especially when the carbon forests capture is put into long-term storage such as in wood products like lumber for building construction.

So how do we enhance carbon sequestration by forests? By improving growing conditions, controlling stand density, increasing tree vigor, examining the implication of rotation lengths and encouraging the development of urban forests. The more rapidly leaves are produced, the quicker leaf area reaches maximum for that given site, and the more carbon is taken out of the atmosphere and stored. The faster a tree grows, the more effective it is at removing carbon from the air. Creating ideal conditions for growing trees also creates ideal opportunities for carbon sequestration.

As forests become older, the rate at which they take up carbon dioxide slows and the rate at which they lose carbon to the atmosphere through respiration and decomposition accelerates. However, older forests with many large trees store more carbon than young forests. In short, there is a trade off in that young forests are better at sequestering carbon, but older forests have higher storage capacity.

Younger Forests, Greater Carbon Sequestration

Carbon sequestration rates for three region/species combination



Source: Stavis and Richards, 2005

» Younger trees sequester carbon at a faster rate than older trees. In California's mixed conifer forests, the annual rate of net carbon uptake would likely increase rapidly in early years, much like the loblolly pine trend line shown, and sustain higher rates longer like the ponderosa pine. Site quality and stand density affect sequestration rates and the total carbon sequestered.

Forest management, focused on the goal

The climate-helping character of young forests should be a boon to society because whether you're interested in wood production or carbon sequestration, the forest-management approaches are similar: you want to increase leaf area, maintain forest health and accelerate growth. That means thinning forests to remove the less vigorous trees, leaving the rapidly growing trees. Replanting the land with fast-growing, young trees quickly restores the forest canopy which continues the process of sequestering carbon.

The same forest-management techniques that maintain healthy forests and sequester carbon offer another climate-change benefit: they reduce the threat of high-intensity wildfires that release tremendous amounts of carbon into the air in a single, catastrophic event.

Active management, active sequestration

To increase the capacity of forests to sequester and store carbon we need to maintain and enhance California's forestland base. We must recognize the negative effects of loss of forests to urban sprawl and development. We should also give careful consideration to encouraging the conversion of marginal agricultural and range lands to forests.

Just how forest management can best be deployed in the effort to increase carbon sequestration is debatable. Although there's currently no market incentive in place to manage forestland to store carbon, California established the Climate Action Registry in 2001 and is refining protocols that may eventually reward forest management activities that increase carbon sequestration. Without financial incentives it is unlikely that forests will reach their full carbon sequestration potential.

But this much is certain: rapidly growing trees sequester carbon more quickly and efficiently than old ones. That fact should stay front and center in policy discussions. If we want to maximize carbon sequestration and storage, we need forest management that results in healthy forests of all ages on the landscape. That means sustainable forestry and plenty of young forests.

What's good for forest health is good for carbon sequestration. Active forest management can certainly increase carbon sequestration.

This much is certain: rapidly growing trees sequester carbon more quickly and efficiently than old ones.

The Unseen Connection:

Building Materials and Climate Change

INCOMPLETE DATA SKEWS THE IMPACT OF ENVIRONMENTALLY FOCUSED BUILDING STANDARDS

You might expect "green" building standards to reduce greenhouse gas emissions or favor removing carbon from the air. But don't count on it.

No green building standard today adequately addresses the carbon stored in wood products or the value in substituting wood for fossil-fuel intensive materials.

By Bruce Lippke, Ph.D.

Before you buy breakfast cereal, you have a pretty good idea of what you're getting. The label on the Wheaties box gives you information about carbohydrates, saturated fats, calories, sodium and so on. You may not always choose the healthiest cereal, but that's up to you.

"Green" building standards should come with the kind of label breakfast foods do.

Environmentalists exploiting fears over global warming have thrust building standards aimed at "environmentally friendly" design and construction into the limelight. So, you might expect those standards to reduce greenhouse gas emissions. You might expect them to favor removing carbon – an element frequently linked to global warming – from the air.

But don't count on it. Instead, the few green building standards that exist today provide incomplete data and often reflect more about a sponsor organization's agenda than a true scientifically based environmental footprint. As a result, states and municipalities that adopt these standards get a skewed perspective of construction's impact and may inadvertently contribute to global warming.

That's where life-cycle inventories and assessment (LCI/LCA) comes in, or should.

Seeing the bigger picture

LCI essentially measures all inputs and outputs for every stage of processing a building material from origin through construction, producing a comprehensive set of data. LCA aggregates the data into key environmental risk indices like global warming potential and water pollution.

By comparing building assemblies using different products and manufacturing processes, LCA makes clear the trade-offs between one building material and another. It measures the environmental effects of each material from forest management or extraction to product manufacturing, transportation, building use and final disposal or recycling.

Lacking sufficient information, some green building standards promote the use of non-renewable resources over renewable resources even when they consume much more fossil-fuel energy. An LCA shows that using steel and concrete results in more greenhouse gas emissions, more energy consumption, and greater water quality degradation than using wood.

Measuring wood's performance

Recent work by the Consortium for Research on Renewable Industrial Materials (CORRIM) compared steel, concrete and wood in residential home construction. In Minneapolis, a wood frame house was compared to a steel frame house. In Atlanta, wood was compared to concrete. The study found that using steel in the above-grade wall generates 33 percent more greenhouse gas emissions than wood, and concrete 80 percent more.

In fact, wood outperformed steel in terms of greenhouse gases, energy use, air and water

emissions. The wood wall outperformed concrete in all measures except water pollution, which showed no difference.

A closer look at greenhouse gases reveals wood's unique advantages in addressing global climate change. Trees remove carbon from the air (first positive impact) and store it in long-lived wood products (second positive impact). Futhermore, wood is used to generate clean energy in biomass or cogeneration facilities (third positive impact). Already, the majority of energy used in wood processing is generated from wood residuals like bark.

Using wood products reduces the need to burn fossil fuels for concrete and steel products, which reduces the amount of carbon released into the atmosphere (fourth positive impact). Forests can also be regenerated, so while much of the carbon from a harvested forest remains sequestered in wood products, growing new trees takes more carbon out of the air (fifth positive impact).

In contrast, using steel or concrete depletes a non-replaceable resource and emits greenhouse gases.

Yet, there is an apparent anti-wood bias in some green building standards.

Shortsighted analysis, long-term detriment

No green building standard today employs LCA, nor do they adequately address the carbon stored in wood products or the value in substituting wood for fossil-fuel intensive materials. Adopting LCA, now up for consideration, would require a dramatic overhaul of current rating systems.

Sustainable forest management leverages a renewable resource and reduces greenhouse gas emissions. CORRIM's research further shows that forest management can be adapted to maximize carbon sequestration. For example, intensive forest management that can grow more wood on shorter rotations rather than longer intervals between harvesting can sequester more total carbon over time. Frequently trapping carbon in wood products can capitalize on young trees' rapid growth to sequester carbon and more quickly create opportunities to replace the use of fossil fuel-intensive building materials like concrete or steel.

Ignoring the carbon stored in wood products and the impact of non-wood substitution can result in misleading building guidelines, flawed policies and unintended environmental consequences.

The core problem with green building standards today is insufficient or skewed data. They miss the mark on greenhouse gas emissions. LCA can address this problem.

It's like the cereal box label: you need to know what you're getting before you choose. When energy consumption labels were put on refrigerators, units with low efficiency were driven out of the market quickly. LCA offers the chance to make an informed decision when designing building components and selecting building designs.

The complete CORRIM study is available online at: www.CORRIM.com

Understanding the Value of Wood

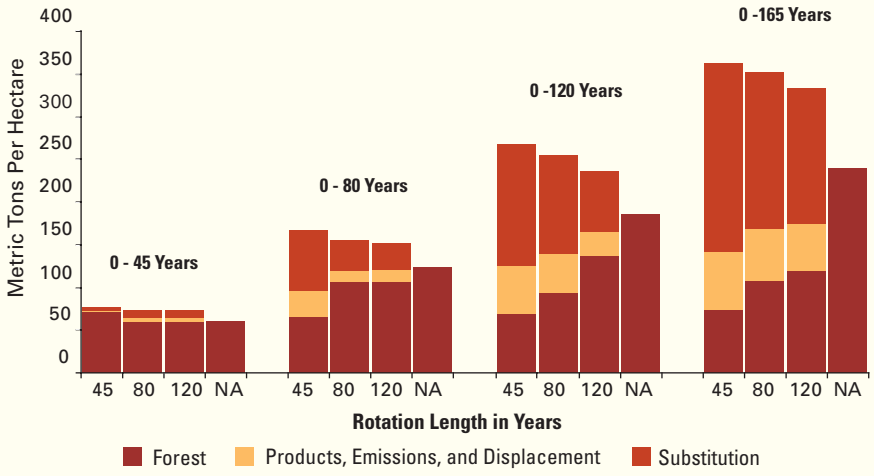
Environmental performance indices for above-grade wall designs.

Minneapolis house	Wood frame	Steel frame	Difference	Steel vs. wood (% change)
Embodied energy (GJ)	250	296	46	18%
Global warming potential (CO_2 kg)	13,009	17,262	4,253	33%
Air emission index (index scale)	3,820	4,222	402	11%
Water emission index (index scale)	3	29	26	867%
Solid waste (total kg)	3,496	3,181	-315	-9%

Atlanta house	Wood frame	Concrete frame	Difference	Concrete vs. wood (% change)
Embodied energy (GJ)	168	231	63	38%
Global warming potential (CO_2 kg)	8,345	14,982	6,637	80%
Air emission index (index scale)	2,313	3,373	1,060	46%
Water emission index (index scale)	2	2	0	0%
Solid waste (total kg)	2,325	6,152	3,827	164%

Shorter Rotations, More Carbon Sequestered

Average annual carbon in forest, product, and concrete substitution pools for different rotations and specified intervals.



Shorter harvest intervals can increase the total amount of carbon sequestered by increasing the carbon stored in wood product pools and displacing carbon emissions by substituting wood products for other building materials sooner.

Source: CORRIM, 2004

Beyond Reducing Emissions

Forests can play a larger role in addressing climate change

The immediate storing of carbon in wood products and young forests, the reduced risk of wildfire on managed land, and clean energy production potential all highlight the value of forest management in addressing global climate change.

By Kenneth Green, Ph.D.

When it comes to global climate change, we know the basic dynamic – the climate is an ever-changing system that has recently entered a warming period, and human activities such as greenhouse gas emissions and land use changes are likely contributors to that warming. But beyond that, we know very little about the probable extent of change, or which human activities have the strongest impact on the climate.

>> About 70 percent of the carbon in every log brought to a sawmill is sequestered in wood products.

That ignorance should spur a broad range of explorations to determine the full spectrum of our policy options.

Unfortunately, rather than asking hard questions and looking even-handedly at a range of both interceptive and adaptive options, the overwhelming focus of climate change discussion has focused on the idea of reducing greenhouse gas emissions. Far less attention is paid to options that pull greenhouse gases out of the air (called sequestration), or finding ways to adapt to climate changes at the local level. We need to go beyond the current tunnel-vision approach that examines one element of the climate change equation (greenhouse gas emissions) without considering the factors that affect it. To that end, let's look outside of the "reduce emissions" box and talk about the "pull the carbon out of the air" approach.

Numerous research studies have shown that forestry holds excellent potential for removing carbon from the air. When trees grow, they absorb carbon dioxide (CO_2) from the atmosphere and separate the carbon atom from the oxygen atoms through photosynthesis. The tree returns the oxygen to the atmosphere but uses the carbon to build its own structure in the form of wood fiber, roots and leaves. Healthy, rapidly growing forests function as efficient air cleaners and carbon holders, constantly adding wood fiber and releasing oxygen.

Wood also continues to store, or sequester, carbon long after trees have been harvested. The carbon stays trapped in the wood, locked in the lumber, furniture or paper product the tree becomes. In California, about 70 percent of the carbon in every log brought to a sawmill is sequestered in wood products.

This simple fact has been too frequently overlooked in climate change discussions. According to researchers, failure to account for the long-term storage of carbon in wood-based products has caused overestimates of worldwide CO_2 emissions by 10 percent.

Action beats preservation

To fully understand the forest's role in carbon sequestration, we must consider the potential energy-saving and product-storing impact of actively managing forests rather than simply "preserving" them as they are. All forests sequester carbon, but not equally.

Compared to simply preserving a mature forest as it is, the use of advanced forest management techniques – including forest thinning, "stand" improvement, fire protection, competition control and pest management – can enhance the removal of carbon dioxide by improving forest growth. Over the long haul, such practices can sequester more carbon in forests, displace more non-renewable fossil fuel energy, and store greater amounts of carbon in products than simple forest preservation alone can.

According to the USDA Forest Service, managed forests in the United States remove approximately 310 million metric tons of carbon, or 17 percent of U.S. greenhouse gas emissions, per year. This is equivalent to removing the carbon dioxide emissions from 235 million automobiles on the road per year.

More aggressive forest management could subtract even greater amounts of carbon. Managed forests provide beneficial growing conditions and efficient carbon sequestration. Furthermore, tree harvesting essentially transfers the carbon from one "pool" – the forest pool – to another – the product pool – where it can stay for hundreds of years. Post-harvest replanting starts the cycle over again. Through sustainable forestry, a single land mass can provide a continual, effective source of carbon sequestration.

The immediate storing of carbon in wood products and young forests, the reduced risk of wildfire on managed land, and clean energy production potential, all highlight the potential value of forest management in addressing global climate change.

Multiple options, maximum value

There are many different approaches that we might take to the question of manmade climate change – it's not a one-dimensional issue. We could choose to reduce greenhouse gas emissions, or pull carbon dioxide out of the air through sequestration processes, or focus on adapting to the change that we already think is waiting in the climate pipeline, or we could look at "all of the above."

Policies aimed at affecting global climate change will inevitably involve trade-offs – ecosystems and economic systems are inexorably linked. Looking at only one part of the picture (greenhouse gas emissions) while giving short shrift to options like forestry-based sequestration is likely to lead society to make policy decisions that are ultimately less effective, and wasteful of the resources that we need to continue building prosperity around the world. ■

The opinions expressed here are solely those of the author.

» Wood products provide long-term carbon sequestration.

Carbon stays trapped in the wood, locked in the lumber, furniture or paper product the tree becomes.

All forests sequester carbon, but not equally. Compared to simply preserving a mature forest, forest management can enhance the removal of carbon dioxide.

Address Air Pollution at its Roots

Managed forestland can help clear the air

Photo courtesy of Alaska Division of Forestry

California Forests *interviewed Gabriele Pfister, Ph.D. Following is a text of her remarks.*

Scientists know that when forests burn, air quality suffers. The summer of 2004 provided a unique opportunity to see just how badly.

When a forest isn't burning, it's helping to clean the air.

Not managing forests, leaving them to grow overcrowded, invites short and long-term air quality degradation.

That year, particularly intense wildfires blazed through Alaska and Canada, driven by unusually warm and dry weather. For more than two months, wildfires burned more than 11 million acres and spewed as much carbon monoxide into the air as all the cars and factories in the continental United States combined in those same months.

The same wildfires increased ground-level ozone by up to an estimated 25 percent in parts of the northern United States and 10 percent as far away as Europe during intense burning.

Poor air quality aggravates asthma and leads to other ailments. Carbon monoxide can cause nervous system and brain damage. Ozone irritates the eyes, nose and respiratory systems and may increase the risk of heart attack.

If we really want cleaner air, we must understand where pollutants come from and how they interact with our atmosphere, then address air quality threats at the source.

Capitalizing on a scientific opportunity

The International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) study conducted during the time of the Alaskan and Canadian wildfires captured uniquely comprehensive measurements of the effect of catastrophic wildfires on air quality. Using satellite, air- and land-based monitoring technology, this campaign traced wildfire plumes throughout North America and all the way to Western Europe. Those efforts are helping researchers to distinguish wildfire pollutants from other pollutants and study the impact these fires had on atmospheric composition.

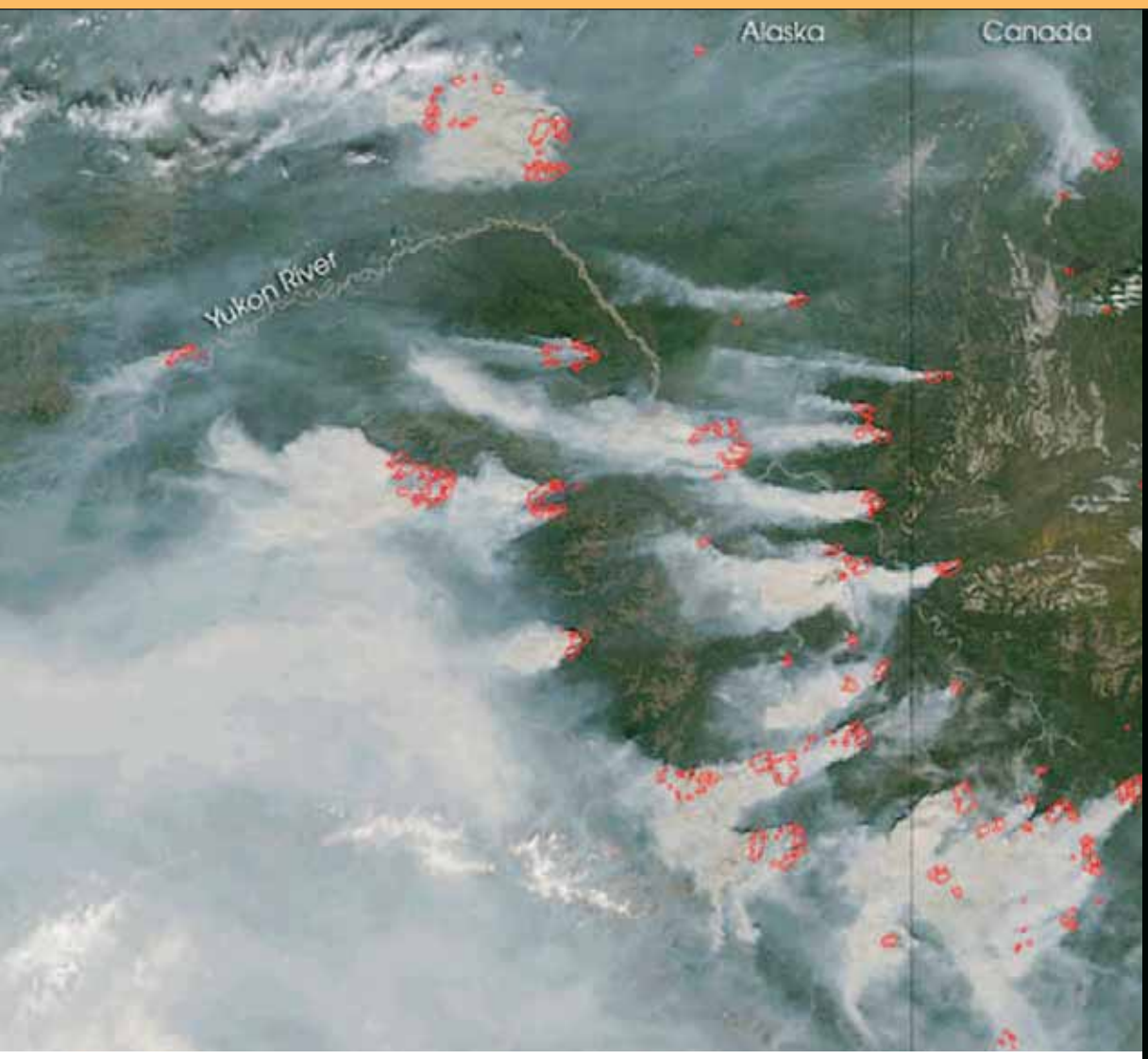
Human activities like burning fossil fuels account for major contributions to the elevated pollutant levels in the atmosphere, and reducing fossil-fuel emissions is a necessary step toward better air.

Wildfire smoke releases similar pollutants as automobile tailpipes, and millions of acres of forestland burn every year in North America. With wildfires, reducing pollution at the source is feasible and can have doubly positive effects on atmospheric carbon concentrations. When a forest isn't burning, it's helping to clean the air.

Forest vegetation removes carbon dioxide from the air through photosynthesis. Trees store the carbon as wood fiber and release oxygen to the air. Trees also capture trace elements of other gases that if left in the atmosphere can contribute to poor air quality.

Whereas a healthy forest stores carbon, wildfires release carbon. When the forest burns, all of the carbon that was trapped in the wood is released in one massive outburst. Chemical reactions in the smoke trigger ozone production, and ash can fill the sky for hundreds, even thousands of miles.

Eventually, the carbon released in wildfires will be offset by the up-take during forest re-growth. But in the near term, the massive release of



<< This satellite image shows smoke from wildfires in eastern Alaska and western Yukon Territory, Canada, on June 29, 2004. Actively burning fires are outlined in red.

Source: The MODIS Rapid Response Team, NASA-Goddard Space Flight Center

carbon in a fire can throw natural systems out of balance – an effect made worse because many unmanaged forests in the West have become overcrowded. Human fire suppression efforts have put out natural fires that would have thinned the forest for a century. That extra forest fuel contains extra carbon.

Hands-on approach can help air quality

Managing a forest can reduce fuel loads and the frequency of catastrophic fires. It simultaneously prevents the mass-release of carbon and accelerates the absorption of carbon from the air by growing trees and producing wood products that store carbon long-term.

Not managing forests, leaving them to grow overcrowded, invites short and long-term air quality degradation. Here's why: Catastrophic wildfires can pour thousands of tons of trace gases and particulate matter into the air. Carbon dioxide and other gases emitted by fires (e.g. methane) or produced from fire emissions (e.g. ozone) are greenhouse gases and contribute to an increase in global temperatures, which, in turn, could lead to more droughts, thus increasing the incident of wildfires in boreal forests.

Actions after a fire can have an impact on air quality. Private forestland managers replant after fires to accelerate the return of a healthy forest. Much charred public forestland goes without reforestation. According to a 2005 survey by The Forest Foundation, only 28 percent of California's severely burned national forestland in 2001 has been replanted, and only 43 percent will ever be replanted. Replanting a burned forest prevents the landscape from turning to brush fields or rangeland, both of which store far less carbon than a thriving forest.

While we look for ways to reduce emissions from our freeways and factories, as we must to conserve a healthy environment, we might also want to consider ways to neutralize the impact of similar emissions from wildfires. Managing forestland so it stores carbon rather than mass-releases it, so trees grow rather than burn, could help us all breath a little easier.

Whereas a healthy forest stores carbon, wildfires release carbon. When the forest burns, all of the carbon that was trapped in the wood is released in one massive outburst.

Global Warming, Ice Ages and Forests

Forests change with the times, and endure

By Thomas M. Bonnicksen, Ph.D.

We live in an Ice Age. You may find this surprising because most people think our climate is stable and warm, and the Ice Age is just something that happened long ago. Think again.

We must keep our forests more open to mimic the way they looked when the climate was hotter and low-level fires more frequent.

Mile high sheets of ice slid southward 17 times during the last 1.65 million years. Each time they melted as the climate warmed, then they returned. Together these warm and cold periods form Ice Ages.

Cold periods lasted about 100,000 years and warm periods lasted up to 20,000 years. The last cold period was the Pleistocene. We live at the end of the most recent warm period; the Holocene, which counterintuitive as it may seem, is still part of an Ice Age.

We know that Earth's surface temperature increased 0.5 – 1 degree F in the last century. We also know that atmospheric carbon dioxide (CO2) has increased 31 percent since 1750, although how much comes from human activity is uncertain. Finally, we know CO2 is a greenhouse gas that can trap heat in the atmosphere. Many people then jump to the conclusion that CO2 emissions from burning fossil fuels are the primary cause of global warming. They may be right, but they also may be wrong. Just because two things happen at the same time doesn't mean one causes the other.

No single influence

We cannot isolate one cause of global warming since many natural forces and human activities, including today's unnaturally large forest fires, influence earth's climate in unpredictable ways. As the Environmental Protection Agency (EPA) points out, "scientists think rising levels of greenhouse gases in the atmosphere are contributing to global warming; but to what extent is difficult to determine."

So many things influence earth's climate that temperatures rise and fall in short irregular cycles even within long cold and warm periods. Earth has experienced cold snaps as it has warmed, spikes in temperature as it has cooled, and extended periods of extreme temperatures. Earth's climate is never stable and neither are forests. The forests we see today seem permanent, but science shows that they have assembled from tree species that moved from place to place in response to climatic changes.

Roughly 12,900 years ago, for instance, earth had been warming for thousands of years when temperatures dropped back to full glacial conditions. This event, known as the Younger Dryas cold period, lasted 1,300 years. Then the warming trend abruptly resumed.

Some 9,000 years ago, during the Holocene Maximum, temperatures rose to 4 degrees F warmer than today. Many meadows went dry in California's Sierra Nevada and lake levels dropped throughout the West. The drought also robbed the Great Basin of much of its moisture and previous Ice Age lakes disappeared.

This Great Drought, which lasted 4,000 years, profoundly influenced people and forests throughout the world. For example, Paleoindian tribes in eastern North America thrived because nut-bearing trees such as oak, hickory, beech,

and chestnut expanded their range while people who lived on the Great Plains suffered. This also was the time when thick forests of Douglas fir, western hemlock, and alder spread over vast areas in the Pacific Northwest.

Middle-age warmth

Global temperatures have dropped and risen many times since the Great Drought. The climate grew significantly warmer during the Medieval Warm Period that extended from AD 900 to 1300. As a result, foxtail pine moved higher into alpine areas of the Sierra Nevada and fires doubled in frequency in Giant Sequoia forests. Forests were open then and frequent, low-intensity fires kept fuel to a minimum.

Temperatures plummeted again in AD 1450, taking the world into the Little Ice Age, which ended about 1850. This cold period forced foxtail pine to lower elevations in the Sierra Nevada while eastern hemlock and white pine did the same in the White Mountains of New England.

Embracing a cycle of harvest and replanting over one of catastrophic fire, flood and mud, which has become prevalent, would be a step in the right direction.

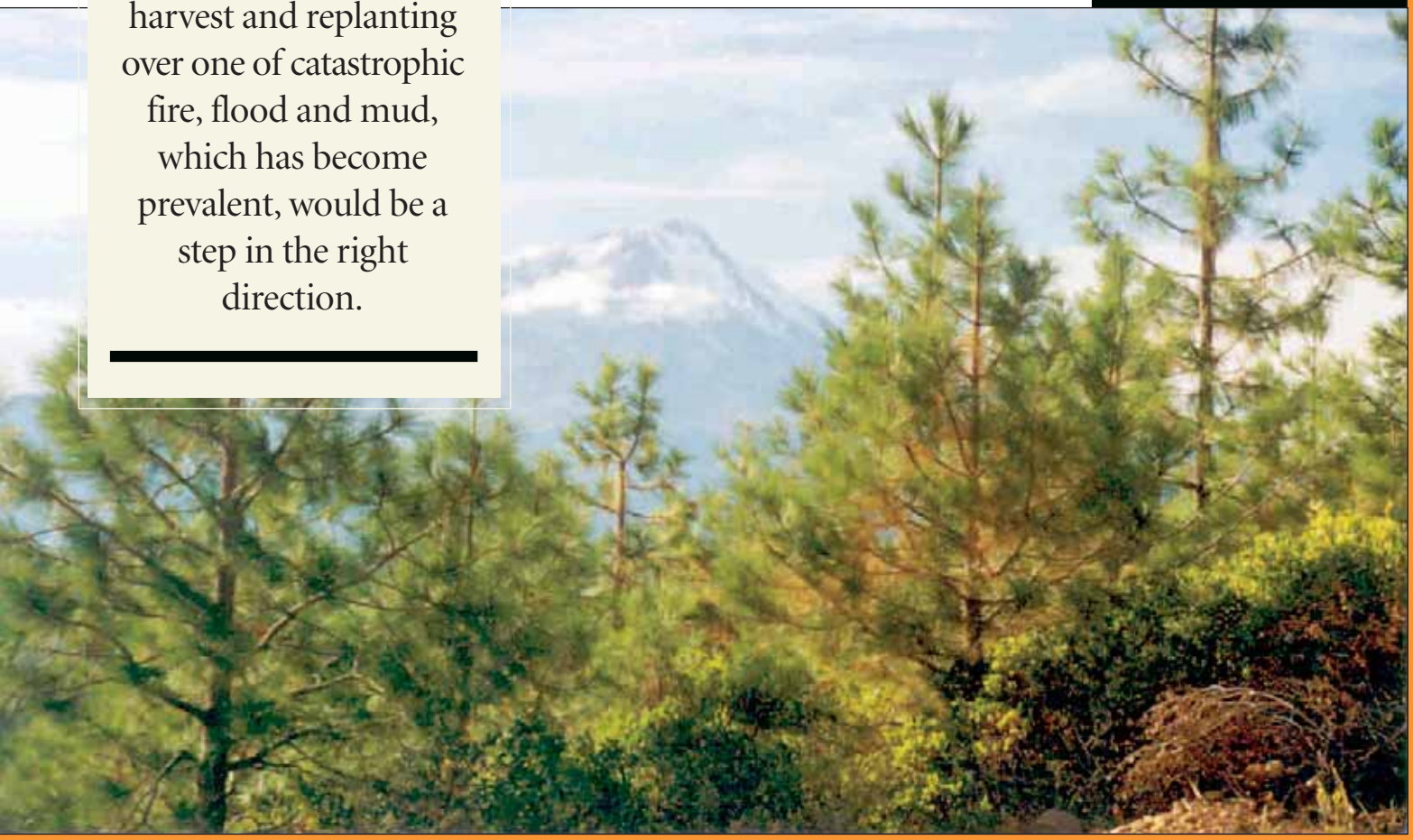
What history teaches

The climate may again be shifting to a temporary warm period. If so, we must learn from history and expect warm climate species, such as ponderosa pine, to expand their range. Likewise, we must keep our forests more open to mimic the way they looked when the climate was hotter and low-level fires more frequent.

A historical perspective can help guide management that makes productive use of forest resources and reduces the incidence of high-intensity wildfire. Rather than ignore climate change and corresponding changes in forests, we ought to use our technology and insight to adjust to a warmer climate. Embracing a cycle of harvest and replanting over one of catastrophic fire, flood and mud, which has become prevalent, would be a step in the right direction.

Earth is warming, but continental glaciers will return. Unfortunately, science can't tell us how warm it will get or when it will grow cold again. But one thing is certain; we must live with the climate we have. Managing forests to conserve resources and prepare for anticipated climate change seems more than prudent – it seems the obvious choice.

A historical perspective can help guide management that makes productive use of forest resources.



» If our climate shifts to a warm period, we should expect warm climate species, such as ponderosa pine, to expand their range.

Clean Energy Offers too Much Potential to Ignore

Can we make biomass credits work?

By John Kadyszewski

America will continue to burn fossil fuels for the foreseeable future even though their emissions increase carbon dioxide concentrations in the air and may contribute to global climate change. But if we focus efforts elsewhere, burning biomass may be able to remove carbon dioxide from the air and prevent carbon dioxide from being released into the atmosphere.

For mechanical thinning to become a source of biomass energy fuel, alternate revenue streams must be established to offset the costs.

Biomass energy is widely used by forest products companies to meet internal energy needs, and a few independent plants supply power to the electric grid. Cost considerations, however, have prevented biomass energy production from becoming widespread. But what if crediting biomass energy for its value in reducing carbon emissions and its value in reducing wildfire risk could turn that around?

Limited use, vast potential

Biomass energy is produced through the controlled burning of organic material. It has a "net zero" carbon impact because it releases the same amount of carbon as the plant removed from the atmosphere when it was growing. The carbon released can be replaced by re-growing organic material. Wood residues from timber harvesting, or waste from wood products manufacturing, can be turned into biomass energy.

So, too, can the excess trees that now crowd many unmanaged lands. Natural fire has been suppressed for so long that many unmanaged forests have grown dense with material that would have been burned off with more frequent, lower intensity fires. In California, according to the USDA Forest Service, some 8 million acres and more than a thousand communities face a serious threat of catastrophic wildfire.

Can forest management provide the biomass necessary to reduce carbon emissions and reduce wildfire risk at the same time?

It won't be easy. Most thinning efforts face significant regulatory and economic challenges. The fuels that must be treated – small trees and brush that can quickly carry a fire into tree crowns – have little or no economic value. Prescribed burns – intentionally set fires aimed at reducing fuel loads – represent the least expensive fuel treatment option, though in many cases, forestlands are too crowded to allow controlled burns. Mechanical thinning can be effective, but is expensive.

Harvesting some larger trees can help offset some costs, but for mechanical thinning to become a source of biomass energy fuel, alternate revenue streams must be established to offset the costs of collection and transportation. More than half of California's biomass energy facilities have closed since 1990, increasing the cost of getting fuels to the plants that remain.

The carbon dioxide reducing benefit of biomass energy may provide the answer. Not only can removing accumulated fuels from the forest floor reduce catastrophic fires and the emissions they produce, but using that fuel to increase the production of biomass energy can reduce the need to burn fossil fuels for energy.

Addressing an immediate need

California faces the challenge of meeting the energy needs of a rapidly growing population.

Continued on Page 22

Burning biomass material can produce clean energy and help reduce carbon emissions.

Bringing Carbon Buyers and Sellers to Market

Obstacles abound, but markets hold potential

By David Sunding, Ph.D.

Ask any inventor: Thinking up a workable idea is one thing. Marketing it in a meaningful way is another. It's the difference between, say, having the blueprints for the internal combustion engine and an assembly line ready to roll out a fleet of Model Ts.

The carbon market is in a similar situation. We know that sustainable forestry can help lower atmospheric carbon levels, a stated goal for those concerned with global climate change. Well-managed forests flush with rapidly growing trees remove (or "sequester") carbon quite efficiently. But we don't know yet whether markets can be established in this country to provide any economic incentive to do so.

Trading carbon credits might work, the idea is straightforward. If a company wants to build a new power plant that would result in X amount of carbon emissions, for example, it could offset those emissions by buying credits from another company with the means of sequestering the same amount of carbon in trees or other sources.

In Europe, carbon trading is already being practiced. Components of the Kyoto Agreement, the first multi-national attempt to limit carbon emissions, established protocols for companies in ratifying nations to openly trade carbon credits. And while the Agreement has proved controversial in the United States and elsewhere, interest in developing domestic carbon markets is gaining momentum.

In fact, some carbon trading efforts are underway, but prices and limitations make it hardly worth the effort.

Getting out of the gate

Why the challenge? Complexity is the main culprit. Markets require established definitions, baselines and enforcement mechanisms – features missing from the relatively new practice of commercial carbon sequestration. Much of the accepted science in the field comes with margins for error as high as 40 percent.

Truth is, carbon sequestration is difficult to measure. The amount of carbon being sequestered is not obvious, nor is the length of time the carbon is being sequestered.

Exactly what level of credit to grant for various activities isn't obvious, either. One school of thought says that credit should be given for actions that decrease net carbon emissions. But what about companies that already sequester carbon efficiently? They would receive no reward for their actions under such guidelines. The same is true for energy producers using comparatively "clean" technologies.

No company that helps reduce net carbon emissions should be ignored. California companies that practice sustainable forestry, for example, sequester tremendous amounts of carbon – and do so very efficiently – by optimizing tree-growing conditions on their lands. Unless these companies are "grandfathered" into any market agreements, they would forgo any benefit for what are extremely positive actions. If you are already sequestering carbon efficiently, your potential to provide a significant difference over "business as usual" is very slim.

These challenges, however, shouldn't prove insurmountable. Markets, once established,

Continued on Page 22

Unless California companies that practice sustainable forestry are "grandfathered" into any market agreements, they would forgo any benefit for what are extremely positive actions.

Markets are certainly preferable to more government regulation and mandates. Command-and-control approaches tend to be comparatively inefficient.

A Tremendous Source of Pride

Timber Products Company was the first hardwood plywood manufacturer in the world to carry the Sustainable Forestry Initiative Program® label. This label on hardwood plywood manufactured in our Grants Pass and Medford, Oregon facilities indicates that we have been independently third-party certified by PriceWaterhouseCoopers to be in conformance with the SFI® Label Use Requirements.

SFI PARTICIPATING MANUFACTURER℠

Our softwood plywood, particleboard, and softwood veneer are also certified to use the SFI® label.

The raw materials for all of these products come from our forestlands in Northern California where we have been a full participant in the SFI® program for many years.

A tradition of sustainable forestry and certified products is a tremendous source of pride at Timber Products Company.

Timber Products Company
THE TREMENDOUS RESOURCE

800-547-9520 www.timberproducts.com

FORESTLAND MANAGEMENT

W. M. BEATY & ASSOCIATES, INC.

845 BUTTE STREET / P.O. BOX 990898 / REDDING, CA 96099-0898 / 530-243-2783

OFFERING SERVICES IN:

- TIMBER SALES
  TIMBER HARVEST PLAN PREPARATION, MARKETING & ADMINISTRATION
- NON-INDUSTRIAL TIMBERLAND MANAGEMENT PLANS
- WILDLIFE SURVEYS, INVENTORIES AND MONITORING
- REFORESTATION
- CRUISING & INVENTORY
- GLOBAL POSITIONING SYSTEMS (GPS)
- GEOGRAPHIC INFORMATION SYSTEMS (GIS)
- AERIAL PHOTOGRAPHY MAPPING

William M. Beaty, RPF 584 • Donald J. Beaty, RPF 1704 • Phillip J. Battaglia, RPF 2089
Lennart Lindstrand, Jr., RPF 624 • Scott P. Carnegie, RPF 2540 • Ivan J. Houser, RPF 2649
Peter D. Johnson, RPF 2384 • David J. Loveless, RPF 2220 • John D. Mills, RPF 2713
Donald E. Pierce, RPF 2336 • Jeffrey A. Pudlicki, RPF 2416 • Benjamin C. Rowe, RPF 2686
Robert G. Rynearson, RPF 1921; PCA 6355 • John R. Van Duyn, RPF 2635
Robert L. Carey, TWS Certified Wildlife Biologist

Clean Energy Offers too Much Potential to Ignore

Continued from Page 20

Importing energy from fossil fuel sources only increases carbon emissions. Under such circumstances, meeting more of that need in-state with biomass energy not only reduces emissions but can produce economic benefits.

The challenge lies in establishing meaningful value for sequestering carbon and lowering carbon dioxide emissions. Some programs aimed at doing that are in place in the United States, but it is a small market, with few transactions and at prices too low to provide any real economic motivation to reduce carbon emissions.

But the concept – deriving value for having a positive impact on airborne carbon – holds promise.

Developing a system where credit is given for implementing a forest management regime that reduces the incidence of catastrophic fire should be encouraged as policies to address global climate change are created. Combined with a credit for displacing the use of fossil fuel-based energy, such a system might allow our forest resources to be more widely deployed in efforts to combat global warming.

We have the ability to manage forests to further reduce the amount of carbon in our air. We must find economic incentives to make it happen.

Bringing Carbon Buyers and Sellers to Market

Continued from Page 21

ultimately bring efficient solutions. They are certainly preferable to more government regulation and mandates. Command-and-control approaches tend to be comparatively inefficient, and they likely would make it more costly to reduce net carbon emissions.

California may have sufficient economic clout to be a leader in establishing domestic carbon markets. While high real-estate values and costs of doing business may put California companies at a disadvantage, there are advantages to taking a leadership role and encouraging markets to develop sooner rather than later. Once markets are established, the expertise companies develop becomes marketable, transferable knowledge.

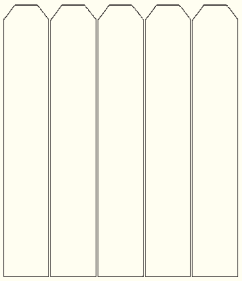
If the cost of sequestering carbon in forests or through other means provides a financial incentive to other methods of reducing net emissions, carbon markets could flourish. It's too soon to tell for sure, but forestry and other land-based sequestration possibilities look promising.

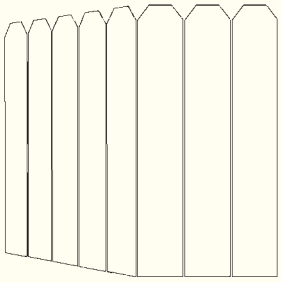
ROGERS MACHINERY COMPANY, INC.

24 Hour Service
Rentals Available

3428 JACOBS AVENUE, EUREKA, CALIFORNIA 95501
707 / 443-6388 FAX 707 / 442-1086
Compressors, Pumps and Blowers
Branches Throughout the Pacific Northwest

INCENSE CEDAR FENCING





Sierra Cedar Products & Tembec Industries, Inc.
877-588-2379

Hancock Forest Management

William L. Marre
General Manager, NW Division
1499 SE Tech Center Place,
Suite #250
Vancouver, WA 98683
(360) 260-4567
(360) 256-5474 Fax
wmarre@hnrg.com
www.hancocktimber.com

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.

Geology for THP's * Slope Stability * Hydrology
Landslide Investigations * Road Engineering
Watershed Inventories * Surveying * Botanical Surveys
707/441-8855
812 W. Wabash, Eureka, CA 95501-2138
480 Hemsted Dr., Redding, CA 96002-0117
SHN Home Page: shn-engr.com

MFG, Inc.
a Tetra Tech Company
consulting scientists and engineers
www.mfgenv.com

ESA Compliance & Permitting • Watershed Analysis • Water Resources • Wildlife • Road Inventories • Fish Passage & Culvert Design • Fisheries • Hydrology • GIS & Data Management • Air Quality • Modeling & Permitting • Botanical Surveys • Noise & Odor Evaluation

Arcata, CA (707) 826-8430
Coeur d'Alene, ID (208) 667-2948
San Francisco, CA (415) 495-7110
Seattle, WA (425) 921-4000

The Northern California Log Scaling and Grading Bureau

Providing fair impartial third party scaling services to the timber industry for over forty years. The Bureau can fill all of your scaling or checkscaling needs throughout California. We also provide log evaluation and quality control work at your logging site.

- **Friendly Reliable Staff**
- **Fair, Dependable Log Scale**
- **Timely Accurate Reports**

Nor Cal Log Scaling is a nonprofit cooperative serving the logging and sawmill community throughout California.

Call us today for Scaling, Checkscaling, or Quality Control Work.

707-822-3614

GEOMATRIX Engineers, Geologists, and Environmental Scientists

Searching for **practical, innovative,** and **cost effective** solutions?

Geomatrix provides **solutions**:

• Slope Stability • Landslide Investigation • Water Resources
• Hydrology • GIS and Data Management • Air Modeling and Permitting
• Storm Water Management • NPDES Permitting
• Waste Discharge Requirements • Water Quality Monitoring

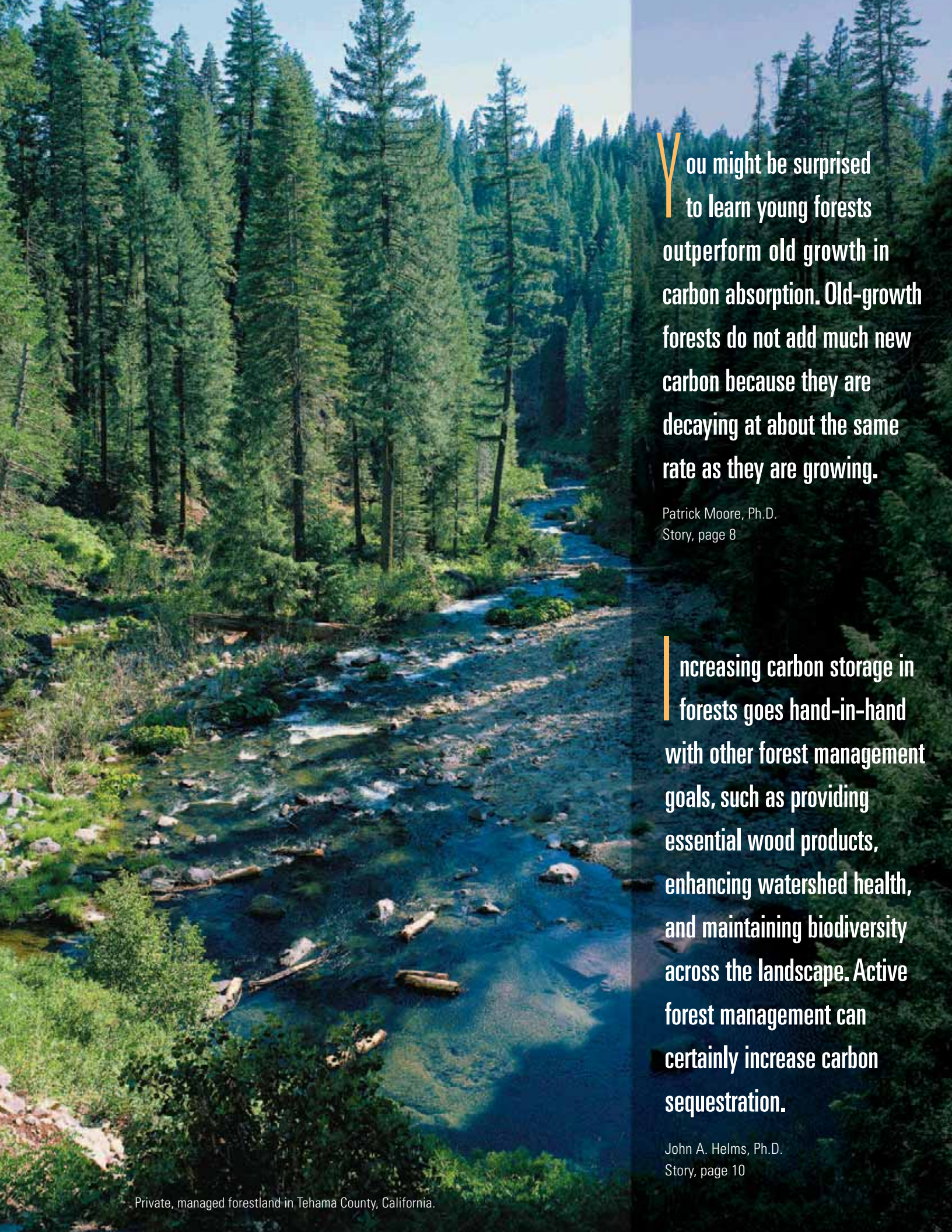
www.geomatrix.com

Geomatrix has offices located throughout North America.

Oakland	(510) 663-4100	Costa Mesa	(949) 642-0245
Folsom	(916) 353-2150	Corona	(909) 273-7400
Eureka	(707) 444-7800	Sacramento	(916) 286-0790

CALIFORNIA FORESTS
CRITICAL THINKING ABOUT FOREST RESOURCES

To place your ad contact:
(916) 444-6592
cfa@foresthealth.org | www.foresthealth.org



You might be surprised to learn young forests outperform old growth in carbon absorption. Old-growth forests do not add much new carbon because they are decaying at about the same rate as they are growing.

Patrick Moore, Ph.D.
Story, page 8

Increasing carbon storage in forests goes hand-in-hand with other forest management goals, such as providing essential wood products, enhancing watershed health, and maintaining biodiversity across the landscape. Active forest management can certainly increase carbon sequestration.

John A. Helms, Ph.D.
Story, page 10

Private, managed forestland in Tehama County, California.