FOREST HEALTH ISSUES: AN ENTOMOLOGIST'S PERSPECTIVE

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FOREST INDUSTRY LECTURE NO.29

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From 1960 to 1991 he was with the Department of Entomological Sciences at the University of California at Berkeley and served as Chairman of the Department from 1985-1990. From 1983 to 1985 he also served as Associate Graduate Dean for the Berkeley Campus of the University of California. Dave is presently Professor of Entomology and, since 1991, Chair of the Department of Conservation and Resource Studies at the University of California, Berkeley.

His major research interests are the biology of bark beetles, insect host selection behaviour, insect phenomenons and the use of behaviour modifying chemicals in forest pest management and, forest entomology generally.

He has written over 100 research papers, and has written 19 invited chapters on Forest Entomology. In addition, he was the co-editor of books on the "Control of Insect Behavior by Natural Products" and "Integrated Peat Management in Pine-Bark Beetle Ecosystems". His major research contributions have been in elucidating the chemical communication systems employed by bark beetles in attacking forest trees.

His work has been recognized regionally: Founders Award, 1992; Western Forest Insect Work Conference; nationally: Founders Memorial Award Lecturer for Annual 1988 Meeting of the Entomological Society of America and internationally in Canada: Elected Fellow of the Entomological Society of Canada in Sweden: Silver Medal of the Swedish Council for Forestry and Agricultural Research.

He is frequently invited to lecture at national and international meetings and serves as a consultant to the USDA Forest Service, the National Science Foundation in the United States of America, and advises the Swedish Council for Planning and Coordination of Research.

THE FOREST INDUSTRY LECTURERS

The forest industry in western Canada cooperates with Alberta Environmental Protection to provide funds to enrich the Forestry program at the Department of Forest Science at the University of Alberta through sponsorship of noteworthy speakers.

The Forest Industry Lecture Series was started during the 1976-77 term as a seminar course. The late Desmond I. Crossley and Maxwell T. MacLaggan presented the first series of lecturers. The contribution of these two noted Canadian foresters is greatly appreciated.

Subsequent speakers in the series have visited for periods of up to a week, with all visits highlighted by a major public address. It has indeed been a pleasure to host such individuals as C. Ross Silversides, W. Gerald Burch, Gustaf Siren, K. F. S. King, F. L. C. Reed. Gene Namkoong, Roger Simmons, Kenneth A. Armson, John J. (Jack) Munro, Peder Braathe, K. N. Johnson, V. J. Nordin, J. Paivanen, Conor Boyd, Peter Rennie, John A. Marlow, Gordon W. Gullion, Hugo Von Sydow, Mary Jo Lavin, Harold R. Walt, Adam H. Zimmerman, T. M. (Mike) Apsey. Bjorn Hagglund, Jerry F. Franklin, John Zasada, Clark S. Binkley, J. P. (Hamish) Kimmins and Don G. Roberts.

This paper contains David L. Wood's major public address given on November 18, 1992.

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I N T R O D U C T I O N

From the alarming rate of forest clearing in Brazil .... to the ecosystem damage caused by emissions from fossil fuel combustion in the United States .... to New Zealand's export of forest products in East Asia, it has become increasingly apparent that issues of forest protection and management are defined by events and possibilities beyond national borders. GLOBAL FORESTS: Issues for Six Billion People is the first text that meets these international issues head on. It does so, not in an attempt to solve the many problems, but instead enlarge the context in which forests are studied. Now, more than ever, is the time to address the issues and concerns surrounding forestry in a global context." (From an advertisement - McGraw-Hill's Series in Forest Resources). The authors are Jan G. Laarman, North Carolina State University and Robert A. Sedjo, Director, Forest Economics and Policy Program; Resources for the Future.

I thought I would begin this lecture by acknowledging the alarming rate of increase in the human population as was stated in the title of this book that is primarily concerned with forest resources. Paul and Ann Ehrlich in their essay in **The Amicus Journal,** Winter 1990 (pp. 22-29) entitled, "The Population Explosion, Why Isn't Everyone As Scared As We Are?" describe the challenge facing the human species. They observe that "in the early 1930's, when we were born, the world population was just 2 billion; now it is more than two and a half times as large and still growing rapidly." Parenthetically, this opening sentence in their essay caught my attention because I was born in 1931. The population of the progenitor of **Home sapiens** which "....first appeared some 4 million years ago in the form of australopithecines .... ("Lucy" - like creatures), was estimated to be not more than 125,000 at any given time .... Since there are now well past 5 billion people, the vast majority of the population explosion has taken place in less than a tenth of one percent o f the history of **Homo sapiens ....** Demographers think that growth will not end before the population has reached 10 billion or more" .... over the next 100 years. What this means to me is that this phenomenal population explosion will occur in the lifetime of my two children and three grandchildren. Dr. Nafis Sadik, Executive Director, United Nations Population Fund, states "The choices of the next 10 YEARS .... will decide whether world population trebles or merely doubles before it finally stops growing. They will decide whether the pace of damage to the environment speeds up or slows down."

I believe that the foregoing summary of our population growth projection sets the stage for my comments today. Despite any successes in the future in slowing growth of the human population, competition for the use of our natural resources will continue to increase. Thus whether you subscribe to the teachings of Thomas Malthus or Karl Marx for solutions to the population problems, conflict over the increasing need for using our natural resources is an everyday event for resource managers, politicians, and the public. This interface between biology and politics has been termed "biopolitics". Today, I will describe my experiences in two areas where humans are in conflict over resource utilization. As my title indicates, this is an entomologist's perspective; however, I take full responsibility for my analyses and opinions that transcend the usual boundaries of entomological expertise. The two topics are:

I. Importation of Unprocessed Logs and Wood Products into North America.

II. Urbanization of Forest Ecosystems in California.

Before discussing these topics, I wish to define what I mean by Forest Health. In a letter (November, 1990) to the Chairman of the California Forest Pest Council, Hal Walt, your Forest Industry Lecturer in March 1988 and Former Director of the California Department of Forestry and Fire Protection, stated ".....Forest Health is a broad concept that encompasses forest pests and describes forest ecosystem resilience and productivity relative to public values, needs, and expectations. Forest pests are a major component of Forest Health Monitoring. The forest pest survey component will include data collection, analysis and reporting. In addition, detailed area and site-specific pest impact and trend evaluation surveys will be implemented. An important element of monitoring will be a long-term research to improve the understanding of cause and effect relationships relative to forest pests in forest ecosystems .....It is a concept that is perceived in a positive light by `lay people' and `concerned publics'. I strongly encourage you and your Executive Committee to consider changing the name of the Council to the California Forest Health Council."

The USDA, Forest Service 1988 publication Forest Health Through Silviculture and Integrated Pest Management (p. A-1) addresses ".... nine `perceived' issues that represented current opinions and conventional wisdom about factors affecting forest health .... The data do not provide evidence establishing that a nationwide deterioration in the health of the forests was taking place .... Although increased forest pest activity can be an appropriate indicator of forest health problems, the presence of forest pest populations within the forest ecosystem do not automatically indicate forest health deterioration. With few exceptions, the frequency and intensity of forest pest outbreaks reflect normal biological system dynamics. The susceptibility of host may reflect natural and/or cultural events." (Recently published: Healthy Forests for America's Future: A Strategic Plan. USDA Forest Service. April 1993. MP-1513.)

"A forest becomes `unhealthy' when events occur which place stress upon members of the forest population. Using this definition we find that a forest is generally in some state of unhealthiness. Since health of a forest is of concern only to man, and historically to man mostly for economic reasons, then `health' really becomes an economic question. At least that was the way it was. Now forest health must have a much broader meaning. Economics cannot be a sole justification of when to do what, what to do, and how much to do. Other values such as recreation, esthetics, wildlife, and research each have high values." (From a statement prepared by Brian R. Barrette and David Adams, California Department of Forestry and Fire Protection, Presented at the Annual meeting of California Forest Pest Council, Sacramento, CA, November 1991).

I hope that you will see the connections to these statements as I describe the two biopolitical areas mentioned earlier:

I. IMPORTATION OF UNPROCESSED LOGS AND WOOD PRODUCTS INTO NORTH AMERICA.

A report published in September, 1992, by the Society of Wood Science and Technology states that: "In the U.S. wood accounts for 25% of the value of major industrial materials. On a tonnage basis the U.S. each year uses roughly as much wood as all metals, plastics and Portland cement combined. In 1988, the United States stood at the top of the per capita paper and paper board use in the world, i.e., at 317 kilograms/year. In second and third place are Sweden and Canada at 311 and 246 kilograms/year, respectively. In contrast, the Soviet Union and India consume 35 and 2 kilograms/year, respectively" (from *Vital Signs,* 1992, L.R. Brown, C. Flavin and H. Kane, World Watch Institute).

Several timber companies in the United States have expressed interest in importing unprocessed larch logs from Siberia and the Russian Far East regions. Apparently, these interests in the importation of unprocessed logs from Siberia and the Russian Far East were stimulated by the loss of domestic timber supplies resulting from litigation by environmentalists to protect the "old growth" habitat of the Spotted Owl, and more recently, the Marbled Munelet. For example, George Schmidbauer, President of Schmidbauer Lumber Co., Inc., Eureka, CA stated that the availability of logs in Humboldt County has been reduced to well below half of the normal sup-ply (from minutes of meeting held on March 20, 1992, U.C. Forest Products Laboratory, Richmond, CA). Another apparent stimulant for importation of logs from this region is the United States government's desire to help Russia obtain foreign currency during its transition to a free market economy. We understand that these timber companies were prepared to barter unprocessed logs for outdated milling machinery. Test shipments of logs were transported on the Siberian Railway to the modern port of Nakhodka on the Sea of Japan. Logs were then loaded both below and above decks on Russian ships destined for ports in the western U.S.

Entomologists and pathologists at the University of California, Berkeley, California Department of Forestry and Fire Protection, California Department of Food and Agriculture and the Oregon Department of Agriculture, and the US Forest Service expressed deep concerns over the likely introduction of new pest organisms into North American forests. Because of pressures brought to bear by these professionals (and their respective local and national societies), and by state and federal regulatory agencies, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) took the lead in undertaking a "Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East." This risk assessment is now published as USDA Forest Service Miscellaneous Publication No. 1495 dated September 1991. "APHIS is the government agency charged with regulating international commerce into the United States to prevent the introduction of exotic pests and diseases via imported nursery stock, seeds, fruits and vegetables, or forest products. APHIS works to detect and, when feasible, eradicate exotic pests once they have been introduced .... At this time, the United States has no specific timber import regulations, and no permits are required. Currently, the U.S. Secretary of Agriculture has banned the import of unprocessed logs from Siberia. The small volume of low-risk timber that has been imported is detained at ports of entry for inspection. Importers are required to use mitigation measures to eliminate identified risk before the timber is allowed into the country. However, US. timber companies are now proposing to import such large quantities

of potentially high-risk Soviet timber that it is necessary to identify potential pest risks to determine whether Federal regulations are required .

Estimations of the amount of timber that could be imported into the United States range from 150 to 425 million board feet per year. The imported logs could include up to four softwoods - larch, pine, spruce, and fir. Preliminary discussions with industry officials indicate that logs from Siberia and the Far East will enter the United States at ports in the Puget Sound region of Washington State; Vancouver, WA; Portland, OR; and the Humboldt Bay area of California for processing. The larch logs are intended to be manufactured into veneer; all other species are to be processed into lumber.

Virtually all genera of trees, conifers and hardwoods alike, are found in both the Old and New World. Many groups of insects, both pest and beneficial, occur in each region. The same may be said for groups of disease organisms. However, the similarities between the Eastern Soviet Union and the Pacific Northwest are largely at the family and generic level; most species are restricted to one area or the other .... (A notable exception to this generality is the striped ambrosia beetle, *Trypodendron lineatum*, which occurs in both the Old and New World (Northern Temperate Region). This insect attacks standing trees, logs and recently cut lumber. The adult penetrates through the bark into the sapwood by excavating a 1-2 mm diameter tunnel. Lumber and plywood cut from attacked trees are riddled with small holes surrounded by a blue strained area ...).....Some of the most serious forest insect pests and pathogens of North American forests are believed to have originated in the Far East. Some examples include the gypsy moth, chestnut blight, Dutch elm disease, white pine blister rust, and Port-Orford-cedar root rot. Other pests that have been introduced from the Far East include the Japanese beetle and the blue alfalfa aphid (from Japan), Asian tiger mosquito, dogwood anthracnose, and larch canker (introduced into the Northeastern United States). Pests have been directly introduced into the Pacific Northwest, some through ship ballast and others on ornamental plant material.

Many of these introduced pest organisms have had enormous environmental and economic effects. For example, the introduction and establishment of the gypsy moth and the fungi that cause white pine blister rust, chestnut blight, Dutch elm disease, beech bark disease, and larch canker have changed the structure and species composition of North American forests for-ever. In summary, the great similarity between the climate, forests, disease organisms, and insects of Siberia and the Pacific Northwest poses enormous risk of introducing pest organisms with great potential economic impacts" (USDA For. Serv. Misc. Pub. No. 1495).

In January 1992, APHIS asked the Forest Service to assemble a Test Shipment Advisory panel to evaluate the effectiveness of a protocol developed by Texas Timber and Exporting Company for mitigating pest risk in Siberian larch logs to be imported as "test shipments". This technical panel proposed the following procedures in the revised test shipment protocol:

At the port of origin, the logs shall be debarked.

At the port of origin, a heat treatment shall be used to bring the temperature of the center of the largest log to 160° F (71.1 ° C) for a minimum of 75 minutes.

Immediately after the heat ticatment, the log shall be submerged in a fungicide/insecticide solution. Logs shall be retreated every 30 days until shipment to the United States.

Shipping dates will be scheduled to avoid vessel movement during high risk periods of Asian gypsy moth (July 1 to September 30).

The vessel shall proceed directly to Humboldt Bay, California.

Siberian logs will be stored and processed separately at Schmidbauer Lumber, Inc. (SLI).

All resulting finished lumber products shall be kiln dried at temperatures sufficient to eliminate deep wood diseases and other pests.

Chips will be transported in enclosed APHIS-approved trucks to a processing plant within Humboldt County, California. All residual products will be consumed within 24 hours of sawing.

Sawdust, bark, and other mill debris will be processed on site at SLI. All residue products will be consumed within 24 hours of sawing.

Appropriate agriculture officials shall monitor all aspects of the importation and processing. Sampling, to demonstrate the efficacy of the protocol, shall occur at the following times:

before treatment at the port of origin

after prophylactic treatment at the port of origin

after discharge at the port of entry

after processing at the port of entry

(From Final Report, Scientific Panel Review of January 10, 1992 "Proposed Test Shipment Protocol for Importing Siberian Larch Logs", USDA Forest Service FPM, AB-2S, April 15, 1992.)

These mitigation procedures were published in the Federal Register on September 22, 1992 (Vol. 57, No. 184). Consideration of comments on the proposed rule making on the importation of logs and lumber and certain other wood products was accepted until November 23, 1992. Thus, our deliberations over procedures to allow importation of larch logs from Russia have been expanded to include importation of all wood products. On November 5, 1992 we for-warded to APHIS our conclusions regarding mitigation procedures:

"All unprocessed wood materials should be treated in the following manner to eliminate all known and potential pest organisms:

A. Unprocessed logs - debark and treat with heat at 160°F for 75 minutes at the center of the log.

B. Processed wood products - same as above but kiln-drying techniques may be used. Proof of efficacy must be provided if the above temperature and length of exposure are varied.

C. Fumigation with toxic gases may be used if proof of efficacy can be demonstrated, i.e., the same results can be achieved as in A."

The primary biological reason for acquiring such rigorous treatments i.e., heat to 160°F at the center of the log for 75 minutes, is to kill pathogenic and wood rotting fungi. Insects and probably plant pathogenic nematodes would be killed by lower temperatures. The major taxa of insects that can be found tunneling in the center of a log are the rounded-headed borers *(Coleoptera Cerambycidae),* wood wasps *(Hymenoptera Siricidae)* and ambrosia beetles *(Coleoptera Scolytidae).* The following pest scenarios could occur:

1. Known pests from Siberia and the Russian Far East, for example, the staining/vascular diseases in the genera *Ophistoma* spp. and *Leptographium,* spp., would likely become established in North America. These pathogens are vectored (carried) by bark beetles.

2. Taxa that are not generally pests in the U.S. or other regions of the world could become pests if introduced from Siberia or the Russian Far East. The most well-known example is the wood wasp, *Sirex noctilio,* which is a non-pestiferous species from Europe. However, it became a very serious tree-killer when introduced into the Monterey Pine Plantations of Australia and New Zealand. Another example is the introduction of the pine wood nematode to Japan from the U.S. In native forests of the U.S., this nematode is not the cause of tree mortality, but it has devastated the native black and red pine forests of Japan. It is now found on the Chinese mainland.

The potential economic benefits of importing foreign logs must be enormous. In a recent article in *Nature* (Siberia's Threatened Forests. Vol. *355* [6358]: pp. 293-294, 1992.) Rosencranz and Scott from the Pacific Energy and Resources Center in Sausalito, CA report the following: "The forests of Siberia cover 2.3 million square miles, an area the size of the continental United States. They represent 57 percent of the World's coniferous forest volume and 25 percent of the world's total inventoried wood volume. In comparison, the Amazon rainforests of Brazil are almost 50 percent smaller .... Forested Siberian lands may represent as much as 40,000 million tons of stored carbon .... This compares impressively with .... the Amazon Basin, which accounts for approximately 80,000 million tons of the World's stored carbon .... Currently, 410 million m^3 of wood, representing the felling of more than 4 million hectares of forest, are harvested each year in Siberia." Thus, the world's need for wood products and Russia's need for the economic benefits derived from these wood products, present another serious concern about the effect of this activity on the local and global environment.

Since this early interest in Siberian timber, so-called test shipments of unprocessed logs have been shipped to California ports from New Zealand and Chile. Fungal isolations taken from Monterey pine logs from New Zealand on a dock in Sacramento and identified by Professor Thomas C. Harrington of Iowa State University, revealed *Leptographium procerum,* which is a root pathogen reported from the eastern United States. He notes further, that "A *Graphium* species that is very likely the anamorph (a different morphological form) of *Ophiostoma picea* was identified from two of the plates. This fungus is very cosmopolitan and essentially world-wide in distribution, but it is also highly variable. It is not possible to say whether or not these isolates are genetically similar to isolates indigenous to California. It may also be noteworthy that Brasier (1990, *Plant Pathology 39:* -16) has suggested that *Ophiostoma ulmi* (the Dutch elm disease pathogen) recently evolved from *Ophiostoma piceae."* Professor Harrington further observes: "It does not make biological or economic sense to be shipping these logs from

hemisphere to hemisphere. Last December, I was visiting with Australian officials over similar quarantine issues, and they lamented the fact that debarked logs of Douglas-fir from our Pacific Northwest are still being exported to Australia. Given the similarity of New Zealand and Australian ecosystems (and the similarity of Pacific Northwest ecosystems with California's), wouldn't it make sense to ship logs from Washington to Sacramento and from New Zealand to Australia?" New Zealand now wants to ship Douglas-fir logs to the United States. Economics may still explain this illogical flow of logs between continents. In September, 1992 the unprocessed Chilean hardwood logs, *Nothofagus dombeyi* and *Laurelia philippiana,* were delivered to Fiberboard Corporation in central California. This wood is being used for interior ply-wood laminae. Exterior hardwood laminae such as maple and birch are brought in from the eastern U.S. A risk assessment has been completed for New Zealand unprocessed logs, both Monterey pine and Douglas fir, and work on a risk assessment for the Chilean logs has recently been completed.

I hope that the mitigation measures proposed by the technical committee are adopted by the Secretary of Agriculture. Such procedures will be likely interpreted as restraint of trade. However, we must prevent the flow of foreign organisms into our native forests. As I stated earlier, the impact of introductions like the gypsy moth, Dutch elm disease, chestnut blight and white pine blister rust have forever changed our native North American forest ecosystems where these organisms now occur.

Despite our best quarantine efforts, we now suspect that the Asian gypsy moth has been introduced into western North America. In 1992 massive treatments were aimed at the eradication of this pest, i.e. *Bacillus thuringiensis* was applied three times to 8,000 acres in Portland, OR, 114,000 acres in Tacoma, WA and 43,000 acres in Vancouver, British Columbia ...." For damage caused by the introduction of defoliators .... worst case damages (were estimated to be) .... $58.41 billion, assuming a net growth loss of 25% per decade. Best case damages are estimated at $35.05 billion, assuming a 15% net loss in growth per decade:" (from USDA Forest Service Miscellaneous Publication, No. 1495, September, 1991). "On July 1, 1992, *Tomicus piniperda,* the pine shoot beetle, a bark beetle native to Europe, was discovered in a Christmas tree plantation in Ohio. Subsequent surveys have detected the insect in New York, Pennsylvania, Indiana, Michigan, and Illinois. Most detections have been made in Scotch pine with a few in Eastern White pine. This beetle is reported to be the second most destructive shoot-feeding species in Europe and the most destructive pest of *Pinus spp*.....The preliminary estimate of potential losses and increased production costs in the U.S. over the next 30 years caused by T. *piniperda is* .....estimated to be $861 million." (from New Pest Advisory committee Report, USDA-APHIS, September 9, 1992). The USDA-APHIS has recently enacted a quarantine of the infested area.

"Pitch canker, a disease caused by *Fusarium subglutinans,* was discovered in Santa Cruz Co., CA, in autumn 1986, on Monterey Pine *(Pinus radiata),* Bishop pine *(P. muricata),* Italian stone pine *(P. Pinea),* and Aleppo pine *(P. halepensis)* (McCain et al. 1987, California Agriculture 41: 22-23). The disease quickly spread among trees along a major freeway corridor and into nearby residential areas and state parks." (from Fox et al. 1990, Canadian Entomologjst 122: 1157-1166). The fungus infects branch tips of trees, causing the tip to wilt and die. It also infects the bole of trees, causing a canker to form, from which copious quantities of pitch exudes. Tree mortality results from secondary attack by bark beetles.

Insects feeding on tree tissue are strongly implicated in transmitting the disease. Small twig beetles *(Pityophthorus* spp.) and cone beetles *(Conophthorus* spp.) transmit the disease to the tips of branches and cones, respectively and bark beetles *(Ips* spp.) transmit the disease to the main bole and large limbs. The extent to which the disease can spread within trees and between trees without the assistance of insects is not clear.

Monterey pine is the predominant species infected in California, though the fungus has been isolated from other species. Ornamental plantings of Monterey pine in Santa Cruz County have been severely infected, with localized severe damage in other areas. Pitch canker also presents a serious threat to Monterey pine Christmas tree plantations.

Pitch canker fungus is known to naturally infect landscape plantings of the native California pines, Monterey pine *(P. radiata),* Bishop pine *(P. muricata),,* Coulter pine *(P. coulteri),* ponderosa pine *(P. ponderosa),* Torrey pine (P. *torreyana),* and shore pine *(P. contorta contorta).* This pathogen is also a serious threat to Bishop pine and to the three small populations of native Monterey pines in California. Recently the fungus has been isolated from native stands of these pine species. It also infects the introduced pines, Aleppo pine *(P. halepensis),* Italian stone pine *(P. pinea),* and Canary Island pine *(P. canariensis).* Infection and damage have been observed in all age classes of most of these species.

Other conifer species have developed disease symptoms after artificial inoculation with spores of pitch canker fungus under laboratory conditions, i.e. knob cone pine (P. *attenuatta),* Eldarica pine *(P. eldarica)* (not native to North America), Jeffrey pine *(P. jeffreyi)* sugar pine (P. *lainbertiana),* digger pine *(P. sabiniana),* Scots pine *(P. sylvestris)* (not native to North America) and Douglas fir *(Pseudotsuga menziesii).* It should be noted that the list of susceptible and naturally infected trees includes species with considerable commercial value, such as Douglas-fir and ponderosa pine, as well as native California species with very restricted ranges. In our extensive studies of this pathogen over the past five years, we have discovered insect species which carry propagules of this fungus to Monterey pines. These species are also known to infest Douglas-fir (Coleoptera: Anobiidae, *Ernobius punctatus* - the dry twig beetle) and Ponderosa pine (Coleoptera: Scolytidae - *Ips paraconfusus* - the California 5-spined ips).

II. Urbanization of Forest Ecosystems in California.

On September 12, the State Senate of California approved Senate Resolution 30, which called for the creation of the Senate Task Force on Bark Beetle Remediation. The purpose of the task force was to study the impact of pests and disease on forest lands in California and to make recommendations to the Legislature with respect to possible solutions and courses of action.

The composition of this committee was as follows:

Two representatives of the United States Forest Service. **F**
Two representatives of the California Department of Forestry and Fire Protection.

Two representatives of the California Department of Corrections.

Two representatives of California timber owners.

Two representatives of independent energy producers.

One representative of the California Environmental Protection Agency.

One representative of the academic community.

One representative of an environmental organization.

Two representatives of the public at large.

California contains 100 million acres of land, of which 19 million acres are forested. Nine million acres are owned by the federal government. Elevated tree mortality in California forests has been observed since 1988. This tree mortality continues to accumulate as California enters the sixth year of an extended drought. As the drought weakens trees, bark beetle densities have increased dramatically. The following species are the principal agents of tree mortality: the fir engraver beetle, *Scolytus ventralis* in white and red fir *(Abies concolor* and *A. magnifica),* the mountain pine beetle, *Dendroctonus ponderosas* in sugar pine *(Pinus lambertiana),* and ponderosa pine *(P. ponderosa),* the Jeffrey pine beetle in Jeffrey pine *(P. jeffreyi)* and the western pine beetle *(D. brevicomis)* in ponderosa pine. Tree mortality is highest in areas that are over-stocked and in areas with dry or shallow soils. In some forest areas there are contiguous stands were 30-80 percent of the trees are dead or dying. Cumulative mortality through 1991 exceeded 8 billion board feet of saw timber.

"The original forests in the Sierra's were a mixture of sugar pine, jeffrey pine, ponderosa pine, incense cedar, and white and red fir that had adapted themselves to specific climate and environmental conditions, including droughts that are common in our Mediterranean climate. The forests that exist today have evolved as the result of 100 years of aggressive fire suppression and harvesting practices that allowed drought susceptible species like white fir to flourish.

As dead trees begin falling to the forest floor, forestry experts predict a change in the character of the forest ecosystem. It is estimated that the volume of down, dead material will increase to more than 150 tons per acre in the worst areas even if salvage logging occurs. Greater amounts of fuel can be expected in unsalvaged areas. This significant increase in dead woody material is extremely vulnerable to wildfire, and the large volume of woody material on the forest floor will make fires many times more difficult to control. Although fire is a natural part of forest ecosystems, the increasing number of human developments in forested areas makes wildfire an extreme threat to life and property. Therefore, we cannot rely on the natural process of fire. Instead some human intervention is necessary to reduce the fire hazard caused by the high amount of tree mortality.

The Task Force identified short and long range goals for dealing with the drought/bark beetle caused mortality.

Short-range: Because of the increased fire danger associated with dead and dying trees, salvage followed by fuels reduction treatments must be accelerated especially in the urban/wildland interface where human lives and property are at risk. It is important to recognize that immediate salvage harvesting of trees beginning to fade (turn yellow) maintains the lumber value.

These revenues from salvage harvesting of dead and dying trees are needed to help off-set the cost of fuels treatments in the sale area. The Task Force also agreed that salvaging the trees for the highest value products is the primary benefit of salvage because harvesting dead and dying trees does little to reduce the beetle population.

Long-range: Long range actions are needed to improve forest health so that we have resilient, diverse, and sustainable forest ecosystems. Although there are no definitive studies conducted in California forests that show thinned stands are less susceptible to bark beetle outbreaks than overstocked stands, scientists agree that reducing stand densities increases tree vigor. Forest Service scientists also have a number of permanent plots in thinned and unthinned stands that were established before the current drought. Surveys of these plots show that tree mortality in thinned stands is 50-90 lower than in unthinned stands. Therefore, the Task Force advocates an aggressive program of stocking control treatments especially in even-aged overstocked stands or in stands that are predominately white fir that were historically a mixture of conifer species.

A number of problems or barriers to implementing needed actions were identified by the Task Force. On private forest lands managed by larger timber companies beetle killed trees are identified as they fade and action is taken quickly to harvest the dead and dying trees before serious deterioration occurs. It is not uncommon for loggers to enter the same area twice in a single logging season as newly attacked trees fade later in the year. Although small landowners are granted an exemption from filing a timber harvest plan (required by state law), such a plan is necessary if green trees are to be cut as preventive measure, to reduce stand densities and increase tree vigor or change the composition of the stand.

On National Forest lands specific analysis and public involvement are required by the National Environmental Policy Act. The Administrative Appeals process can prevent expeditious harvesting of a area while deterioration continues to reduce the value of the logs.

Economic constraints pose another barrier to implementing needed actions. The market value of salvage products will not, in all cases, be sufficient to cover the costs of salvage logging, stocking control treatments, and removal of fuel to reduce the threat of wildfire.

The market value is site specific to any area being considered for treatment and depends on the marketable products which can be produced (sawlogs, pulpwood, hardboard, or fuel), the distance to the market and the quality of the product. In many instances, alternate funding from public sources reflecting the benefits of forest health, namely, decreased fire danger, improved wildlife habitat, and improved long range forest sustainability must be made available to implement the needed actions.

The ability to salvage an infestation quickly reduces degradation of infested trees ....and higher market values from the products can be realized. Accordingly, overcoming institutional and administrative barriers to implementing the required forest health action lowers the economic barriers as well (The above is taken from a preliminary report of the Task Force on Bark Beetle Remediation, November, 1992, Region-5, U.S. Forest Service, San Francisco, CA). **t**

In a Senate joint resolution, the legislature has been debating the following Task Force recommendation: .....That the Tahoe Basin be used as a scale model for the development of forest health management improvement dbjectives by the United States Forest Service, which would imnact favorably on forest land manaᵍement in California and in the rest of the United States.

The following resolution was passed in the Legislature:

Resolved by the Senate and Assembly of the State of California, jointly, `That the Legislature of the State of California respectfully memorializes the Congress of the United States to enact legislation to develop the Lake Tahoe Basin as a working model for other forests, as a means to develop a forest health management plan.' The Lake Tahoe Basin was selected by the Task Force because the region represented the most complex mixture of ownerships and regulations governing management activities. Basically, there has been a ban on timber cutting except for dead trees that pose a hazard to life and structures. Also management of the timberlands and development is under a multiagency organization called TRPA, i.e. Tahoe Regional Planning Agency. During assembly hearings in August, only one group filed a dissent with this plan, the "League To Save Lake Tahoe". Although they agreed with the need for action, they did not trust that logging activities on U.S. Forest Service lands would be "low impact" logging.

Tree death due to diseases and insects is inevitable because of the extreme overstocking in these forests. As my colleague, Professor Robert E. Martin (Department of Forestry and Resource Management, University of California, Berkeley, CA), a fire ecologist, states, "It is not a matter of whether or not the urbanized regions of the Tahoe Basin will burn, it is only a matter of when they will burn." The holocaust in the Oakland hills one-year-ago is a grim reminder of the current risks for people living in our natural forests of California. The Oakland forests, how-ever, were comprised mostly of planted highly flammable Monterey pine and eucalyptus, which together with the critical weather conditions, resulted in this disastrous fire. I am hopeful that the Task Force's plan can be implemented. I am also hopeful that the logging necessary to remove the dead and dying trees and to reduce the volume and density in these forests will be accomplished with minimal degradation to the fragile environments surrounding this magnificent body of water. If such stand management actions are not taken, high levels of tree mortality caused by bark beetles will continue with or without a drought.

CONCLUSION

Today, I have tried to illustrate the role of a professional entomologist in two highly complex and multidimensional forest resource management issues, i.e.: (1) importation of unprocessed logs and manufactured wood products, and (2) the urbanization of our natural forest ecosystems. In both issues, the major ecological role played by insects (and pathogens) has greatly influenced the array of options being evaluated by regulatory agencies. In turn, the option or options selected will determine which group or groups will derive the socioeconomic benefits that are at stake in this brief moment of human evolution.

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