1997 WESTERN FOREST INSECT WORK CONFERENCE

PRINCE GEORGE,
BRITISH COLUMBIA
APRIL 14 - 17, 1997

PROCEEDINGS

1997

WESTERN FOREST INSECT

WORK CONFERENCE

INN OF THE NORTH
PRINCE GEORGE, BRITISH COLUMBIA
APRIL 14 - 17, 1997

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Poster Session:	Bob Setter

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FINAL CONFERENCE PROGRAM

Monday, April 14, 1997

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Tuesday, April 15, 1997

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08:00	09:20	Initial Business Meeting
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09:30	10:00	**Introduction** Larry Pedersen, Chief Forester, BC Ministry of Forests
10:30	12:00	**Panel: Forest Practices Codes and Forest Health** Moderator: Lorraine Maclauchlan, BC Ministry of Forests

- P. Wood, University of British Columbia
- P. M. Hall, BC Ministry of Forests
- P. Byrne, BC Ministry of Forests
- L. Livingston, Idaho Dept. of Lands

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- Fire and Insect Interactions — E. Smith
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- GIS - Industrial Forestry Services Ltd.

Wednesday, April 16, 1997

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	• Dr. R. F. Shepherd - *Three Short, Tall, Tales*	

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	• R. Cozens, BC Ministry of Forests
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	• E. Holsten, USDA Forest Service
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		• GIS Applications	K. Porter
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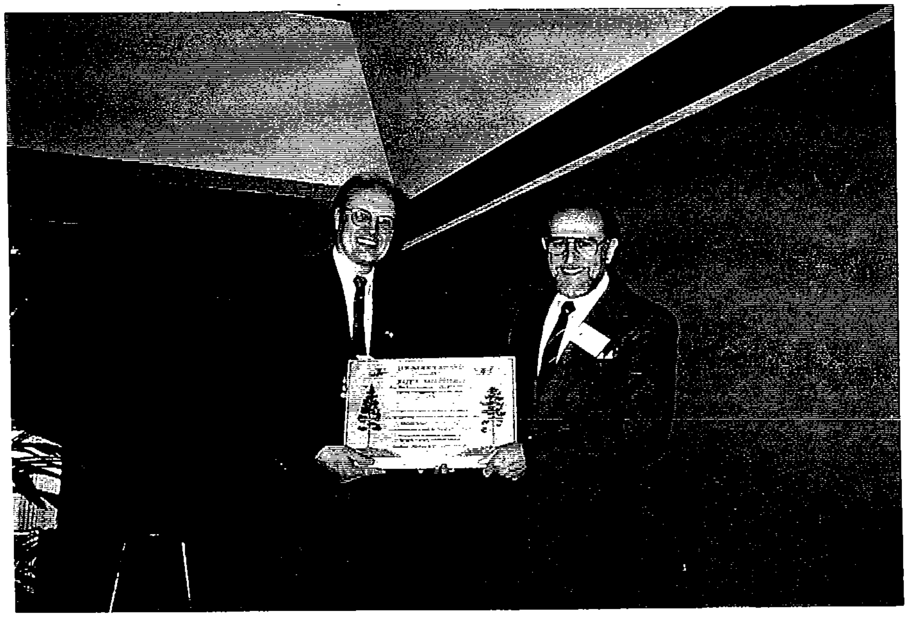
FOUNDER'S AWARD



Dr. R. F. Shepherd receiving 1996 Founder's Award from Dr. Staffan Lindgren at the 1997 Western Forest Insect Work Conference in Prince George, British Columbia, April 16, 1997.

Comments on the Career and Accomplishments of Dr. Roy F. Shepherd

Les Safranyik, Canadian Forestry Service, Victoria, BC

As a member of the Founder's Award Committee and a colleague of Roy's for some 30 years, it gives me great pleasure, indeed, to pay tribute to his career and accomplishments.

In approving Roy's nomination for the Award, the Committee formally recognised the long, productive career of an eminent forest entomologist and a scientist of international stature. In a career that spans some 40 years with the Canadian Forest Service, Roy has made significant contributions to the biologies and management of a long list of forest insects, a list that could be called the "who-is-who" of damaging forest insects of the west. Insects such as the lodgepole needle miner, the hemlock looper, at least three species of budworms, the mountain pine beetle, the Douglas-fir tussock moth, the larch casebearer, and the black army cutworm. Roy's approach to research problems had a definite ecology bent, even early in his career when such approach was not in vogue or particularly desirable in his place of employment. Throughout his career, Roy was keenly interested in the interactions of insects with host trees and the forest environment, and the consequences of these interactions regarding insect and stand dynamics. This approach is well described in a letter supporting Roy's nomination for the Founder's Award. I quote:

"I am most familiar with Roy's work on the Douglas-fir tussock moth. A most impressive aspect of his work on this insect, and for that matter, on other species, is the scope of his studies. He did not choose to focus only on population dynamics, sampling methods, biological control, population monitoring methods, pheromone related behaviours, pheromone-based population assessments, pheromone-based control approaches, and microbial pesticide development; rather, he chose to work on all of those subjects at different points in his career, and with considerable success on all fronts!

It was my good fortune to work with Roy on tussock moth pheromone work, including a field test in southern interior British Columbia, and on western spruce budworm work that included a mating disruption field test in north-central Oregon. I always found Roy to be a highly professional, helpful, and gracious colleague; and certainly a fellow entomologist that I hold in high esteem.

One further point deserves special recognition. A clear slant of nearly all of Roy's work was directed toward assisting the forest manager in preventing or mitigating the various adverse impacts that forest insects can cause. This is a professional bent that often requires extra time and effort, and I believe Roy often took special pains to align his program of work with the clear goals of developing practical methods of use to the forest managers and the public. This fit well with much of his active research as he was strongly oriented to on-the-ground, field oriented research. This is not to say that his research agenda did not include basic studies in both the laboratory and the field; but even in these cases, it appears there was a clear vision of why the work was necessary for improving technology and management of the land."

On the personal side, Roy was always highly supportive of young researchers and cheerfully and willingly shared his rich experiences with students and colleagues. In retirement, Roy remained very active in forest entomology research as indicated by the 15 or so scientific/technical papers published during the past two years. Roy and wife, Colleen, are avid outdoors people and enjoy hiking and skiing. The pursuit of this last hobby has cost Roy a few aches and pains through the years; He has contributed at least his share of support for enterprises involved in the manufacture and sale of shin splints and crutches.

Obviously, I could go on and on with this talk but, Roy, this is your special evening and we are here to hear you, and to celebrate with you and Colleen your contributions to our profession. In closing, on behalf of this Conference, your friends and colleagues, many thanks and congratulations on a richly deserved Award!

FOUNDER'S AWARD ADDRESS:

THREE SHORT, TALL, TALES

Roy F. Shepherd

April 16, 1997

Thank you, members of the Western Forest Insect Work Conference, for this great honour. I believe that the best appraisal of one's work is given by your co-workers who have interacted with you on a regular basis, meeting to discuss and compare ideas, which leads to better theories and better solutions. To be selected by those people for a distinctive award - that is the greatest honour of all. I will cherish it dearly.

I should like to point out two people who also deserve to be named in this award. The first is my wonderful wife who worked tremendously hard to provide a happy and gratifying home and supported me throughout my career. The second is my co-worker, Tom Gray, who worked ceaselessly to meet our objectives. He was always coming up with new ideas and better ways to accomplish things. Together, we used a team approach that was unbeatable. To them both I am highly indebted and give a heartfelt thanks.

Today I promised to tell you three short, tall, tales. They are short because I have reduced them to the barest of details, just enough to give you a hint of these intriguing, but true stories. They are tall because they represent some of the people who helped establish this country; people who stood very tall in courage and stature, people who accomplished their objectives in an unknown and very wild, rugged country.

THE LIFE OF FRANCES BARKLEY

The first tale is about a heroine, Frances Barkley, the first white woman to appear on the coast of BC Let me set the scene; in 1778, Captain Cook landed at Nootka Sound on the west coast of Vancouver Island. The Spaniards from Mexico had made some tentative explorations northward and the Russians had set up some fur trading posts in Alaska, but the central coast of western North America was essentially unknown to Europeans.

Although Cook's prime objective was to find the "Northwest Passage", he incidentally stumbled onto a potentially highly rewarding business opportunity. After Cook was killed in Hawaii, his crew continued to China and were astounded by the price the Chinese would pay for sea otter skins from the Northwest Coast. It was obvious that fortunes could be made by trading with the Chinese. Upon reaching England, word spread rapidly, and many commercial interests began fitting out ships. Among these was a group of business men who hired an experienced captain, Charles Barkley.

Charles had a ship built in England called the Imperial Eagle and brought it to Ostend, Belgium, for final outfitting. During this six-week stay in Ostend, twenty-seven-year-old Charles met, fell in love and married seventeen-year-old Frances Trevor who had long, golden-red hair. Frances was born in England but raised in Germany and Belgium. Her father was an Anglican minister serving small English communities in Hamburg and Ostend. When she was fourteen she entered a French convent to complete her education. Thus, her upbringing was extremely protected and structured. When the ship was ready, the newlyweds left Belgium immediately, and Frances' life changed abruptly. The sheltering convent walls vanished and Frances found herself married to a man she hardly knew, aboard a small ship with little privacy, bound for unknown coasts. As soon as they entered the Atlantic they experienced fierce seas sweeping over the ship, removing all poultry and animals on deck which were to supply fresh meat. Charles caught rheumatic fever and was confined to bed with little hope of recovery. The first and second mates took advantage of the situation and tried to force their attentions upon Frances. Eventually they put into Salvador on the Brazilian coast to allow Charles to recover and to take on provisions. Thereafter conditions improved. Due to Charles' sailmaster skills they rounded the Horn without incident and reached Hawaii six months after leaving Belgium. After provisioning they continued to Nootka, arriving nine years after Captain Cook.

Trading was brisk and a good number of sea otter skins were obtained. Copper was the main item desired by the natives. After a stay of a month, they sailed south-east along the west coast of Vancouver Island, where they discovered Clayoquot Sound and Barkley Sound. Charles named the latter after himself, as he was the first European to discover and chart its shores and named many landmarks. Again, trading for sea otter skins was quite successful. Continuing south the Barkleys rediscovered the Strait of Juan de Fuca which had been vaguely reported by the Spaniards, but missed by James Cook.

At times, dealing with the natives was often difficult and risky. They were a proud and warlike race of people. As an example, near Cape Flattery, six men were sent ashore to contact natives for trading purposes, but, to everyone's horror, they were massacred and cut to pieces. On another occasion, a large number of natives came on board the Imperial Eagle supposedly to trade. When they became dangerously aggressive, Frances suddenly appeared from the cabin with her hair blowing free like a golden cloud. The natives fell down before her, thinking she was a goddess and left in terror. The Imperial Eagle left North America and sailed for Canton, China with 800 sea otter skins on board. White women were not allowed in China, so Frances had to remain alone in Macao while Charles spent two months in China selling the skins and obtaining another cargo for transport to Mauritius, in the Indian Ocean.

They enjoyed these French islands. Frances had learned to speak fluent French in the convent and she in turn taught Charles. Frances remained in Mauritius, while Charles sailed to Calcutta, only to find that the other partners, unknown to him, had sold the ship. Charles was released and much of his funds lost. By the time he returned to Mauritius, Frances, all alone, had given birth to a son after a difficult labour. They left Mauritius as passengers on an American ship bound for England. The captain was incompetent and they were shipwrecked off the coast of France. The officers and crew took the lifeboats and abandoned the passengers on the wreck. Fortunately, the cargo of cotton kept the wreck afloat until they could be rescued.

After seven months in England the Barkleys decided to go to India to set up a business. Charles was given command of a ship to sail to Bombay. They met violent gales off the Cape of Good Hope during which Frances gave birth to a daughter. The storms delayed progress and they ran out of supplies. They stopped at Mauritius to restock. Off the coast of Bombay another storm made landing impossible, forcing them to sail around India to Madras to unload. They then sailed to Calcutta, where Charles was persuaded to lead another expedition to the North Pacific in search of sea otters. All friends and relatives advised Frances to remain in Calcutta with her children but she refused, preferring all the dangers of the sea to being separated from her loving husband.

The ship Halcyon was much smaller and considerably inferior to the Imperial Eagle. As soon as they left Calcutta they spent ten days in a hurricane tossed about in their tiny craft with all port holes and hatches secured in spite of extremely high temperatures and humidities. This was hard on the sea-sick children. They were too late to catch the trade winds and spent three weeks becalmed in the East Indies with terrible heat. Charles contracted a tropical fever with excruciating pain. After many weeks he survived, but their twelve-month-old daughter also contracted the fever and died.

After six months they arrived at Kamchatka, where cold rain and icy fog caused considerable suffering, particularly for the crew from India. They left after a month, frustrated, because the Russian governor and army blocked their attempts to trade for skins with the local natives.

From Kamchatka they travelled across the North Pacific to Sitka, Alaska. Having received bad treatment from previous traders, they found the natives here, also, quite threatening and warlike. Bartering was more difficult as the natives were by now more conscious of the value of otter skins and were demanding muskets, shot and powder. Although they obtained some skins, they left with only a partial load, as they were running short of supplies. After spending six weeks selling the skins in China, they embarked for Indo-China, where they sailed forty miles up the river to Saigon, which, at that time, was the rich, thronging capital of Southeast Asia. Frances was the first white woman to enter that city. When she travelled in an open sedan-chair with her young son to the Cochin Chinese court, an armed guard with whips had to precede her through the masses of people gathered to see this pale-faced, red-haired stranger.

After Indo-China they headed for Bombay with a cargo, but were blown too far south and put into Mauritius for food and water. Unknown to them, England and France were again at war and the Halcyon with its cargo was seized as a prize of war. They were kept there for a year and were released only by travelling on an American vessel to the States and thence to England. These two voyages lasted eight years and by then Frances was twenty-five years old. She remained in England thereafter and died at age seventy-six after bearing a total of seven children, of whom three died before adulthood.

Today, if you sail north-west of Victoria, as I have done, up the Pacific coast side of Vancouver Island, you will arrive at a beautiful Sound which contains a National Marine Park. This is Barkley Sound, named and originally charted by Charles Barkley. Names like Imperial Eagle

Channel and Frances Island bring to mind this courageous woman who experienced so many dramatic events in her first eight years of marriage.

For our second tall tale let us move north of Vancouver Island to the Queen Charlotte Islands, to the Haida people and to Charles Newcombe who witnessed their near extinction:

HISTORY OF THE KUNGHIT HAIDA

The Haida of the Queen Charlotte Islands were composed of four linguistic groups, one of which was the Kunghit of Moresby Island. Because they lived off the sea on shell fish, halibut, cod, etc., they built their villages in the first protected spot inside a reef or inlet and paddled their hand-carved cedar canoes out along the exposed Pacific coast on a daily basis to collect food. Their houses consisted of split cedar planks set into large corner posts. Living was good and they were able to devote some of their time to carving large totem poles.

In the mid-eighteen hundreds, it is believed there were about four thousand people in this nation when tragedy struck in the form of successive waves of smallpox which decimated the population. What was one of the most feared and independent aboriginal nations proved to be one of the most susceptible races to this disease. As populations decreased, villages were abandoned and survivors grouped into a few remaining villages. Where possible, they took their long house planks and totem poles with them. After twenty years of disease outbreaks, only thirty-seven people remained of the original four thousand. They were clustered into one village called Skang'wai at the southern tip of South Moresby. About 1875 this last village was abandoned and the remaining people moved to Skidigate where Haida from other groups had collected. They left behind an amazing cluster of poles standing on a beautiful village site. Subsequently this location has been declared a World Heritage Site and the southern part of Moresby Island has been designated another National Park.

Twenty-five years after the abandonment of Skang'wai, Dr. Charles F. Newcombe realised that this once proud nation had all but disappeared along with the wooden artefacts of their culture. The better artefacts were being scavenged for museums and the remainder were rotting away rapidly. Newcombe was a medical doctor from England who travelled widely up and down the coast. As far as we know, he never practised medicine in BC, but followed a deep interest in native cultures. By 1901, only six of the Kunghit people were left, of which one was a chief of Skang'wai called Ninstints. Newcombe organised a small expedition of himself, Ninstints and Newcombe's young nephew to circumnavigate Moresby Island and record the location of all abandoned villages, long houses, totem poles, protective forts, etc. He sketched important views with landmarks to locate villages; he also took many glass plate photographs of sites, homes and totem poles. They did all of this in an open eighteen-foot rowing and sailing dinghy in cold, wet, windy weather on the open Pacific shoreline, fighting strong tides and currents with huge waves and surf. They took turns rowing, and sailing when possible, and recorded tens of village sites, fished for food and camped ashore. It took them only about three weeks to travel well over three hundred miles of uncharted wilderness and they produced the best records that anthropologists have today of this vital and dynamic nation.

In May, 1996 I had the great pleasure of following in the footsteps of Newcombe and Ninstints in the company of an anthropologist from the Royal BC Museum as we sailed around Moresby Island in a ninety-foot sailing vessel. Using Newcombe's records, we visited many old village sites, and spent a whole day studying the totem poles at Skang'wai. We learned to locate house sites by distinctive Sitka Spruce, which had germinated on top of the cedar corner posts of the house. Roots had penetrated down the centre, splitting the posts, while other roots encompassed the posts outside and down to the ground. Thus, evenly spaced spruce at the four corners with swollen butts and a rotting post sticking out at an angle were the distinguishing clues. We also had a great opportunity to hike through the unique "moss forest", characteristic of this archipelago of islands. This is a huge undisturbed temperate rain forest except for one factor - deer. About 1925 blacktail deer were introduced to provide a food source for natives and settlers. The deer population exploded and nearly all brush disappeared, leaving the huge trees above and thick moss on the ground. This is an interesting contrast to the salmonberry-devil's club jungles in the nearby rain forests of Vancouver Island and the mainland, where deer are controlled by predators.

The last short, tall tale is a modern one, involving a couple of young people in Jasper National Park. It is best told in a verse penned by John W. Chalmers of Edmonton:

IN JASPER PARK

Two, imbued with sudden passion,
By a mountain highway parked,
Locked their car in careful fashion,
Sought a glade that they had marked.

Hidden by a screen of bushes,
Underneath the summer sun,
By a lakelet edged with rushes,
Shed their garments one by one.

But a disapproving critter,
Clothed in fur like other bear,
Muttered imprecations bitter,
Though it wasn't his affair.

"Dress as I do" was his motto.
(Bruin was a hide-bound prude).
Swift he chased them to their auto,
Ending their behaviour lewd.

Naked though they were, they scampered,
Leaving all behind them far.
Lacking keys, they then were hampered,
Gained no entrance to their car.

To escape the angry ursine,
Climbed they to their car-top high.
Long that bear they stayed there cursing,
But delighting passers-by.

It is interesting to compare the characters in these three tales: the tremendous courage of the seventeen-year-old Frances in her pioneering adventures around the world and the foresight and seamanship of Charles Newcombe in his search for the last remains of the Kunghit culture. I think, however, you must have the greatest admiration for the fellow who had the patience and fortitude to train a bear to come out of the woods at just the right time, follow the transgressors to their car and circle around and around the rooftop aerie to clinch the couple's embarrassment!

INTRODUCTION AND WELCOME

Larry Pedersen, RPF
Chief Forester
British Columbia

April 15, 1997

Thanks, Al, for the welcome to Prince George. I would also like to welcome the 1997 Western Forest Insect Work Conference to British Columbia and to Prince George. I sincerely hope that you all enjoy your stay here and that the conference meets all your objectives.

I understand our BC Forest Service staff consider this particular symposium to be one of the best, most interesting, and most productive entomology conferences that they participate in. Of particular value is that this one deals specifically with forestry issues and concerns. It routinely brings together researchers and managers to formally and informally discuss current approaches to reducing or dealing with the actions of forest insects. Experiences from various jurisdictions are shared, and foundations are laid for co-operative and relevant approaches to common issues.

These conferences allow us to find out what has worked and what has not worked in other jurisdictions dealing with similar issues. The conference and interactions with other jurisdictions also provide us with a window through which we see new emerging issues or changes in philosophies in dealing with forest insects and trends in management approaches.

This will be the fourth time since 1970 that the conference has been held in British Columbia. The 1974 conference was held at the Empress Hotel in Victoria and was mostly organised by scientists from the Canadian Forest Service. We have come a long way since then. At that time, Mike Finnis was the only person employed by the BC Forest Service whose job was wholly dedicated to pest management and forest health issues.

Then in the early 1980's we got into pest management and forest health in a big way, staffing entomologists and even pathologists at regional offices and at headquarters. The 1986 conference was also held in Victoria. By that time, the BC Forest Service was an equal partner in the organisation of the conference, and several of our staff were involved with the organising committees, and in moderating and participating in panels and workshops.

The third conference in BC was the Penticton meeting in 1992 where BC Forest Service staff from headquarters, regions, and districts participated and attended in large numbers. The level of interest in and commitment to forest health in the province was steadily increasing. Now, in 1997, the conference has come to Prince George, and again includes a large commitment in support and attendance by the Forest Service.

Victoria and Penticton are two of the most popular tourist destinations in the province. Many types of conferences are routinely scheduled there to take advantage of the climate, the scenery, and the many amenities available to conference attendees. I guess the question that immediately springs to mind, then, is, "so why are we here in Prince George instead of at one of these garden spots?" Well, there are a number of reasons why Prince George was selected as the site of this conference.

First, Prince George is an attractive city in its own right, with many amenities that will make your week's stay a pleasant one. It's the fourth largest city in British Columbia, after Vancouver, Victoria and Kelowna. And Prince George is also an important centre in the province because of the forest industry, with many forest management and forest health challenges. The sawmills in this region produce about 30 percent of the total provincial output. It is because of the size and nature of the forest industry in Prince George that it was selected as the site of the conference.

Prince George is also no stranger to issues revolving around forest health and forest insect pests in particular. The region has seen some of the largest outbreaks of spruce beetle on record and, later in one of the panels in the conference, you will be hearing how the province has reacted to such challenges. Other insects that are, or have been, active in the region include mountain pine beetle, Douglas-fir beetle, hemlock looper and terminal weevils. Prince George is also blessed with the province's only real outbreak of eastern spruce budworm!

For these reasons, Prince George is an ideal place to hold this conference. After all, dealing with forest insects within the context of our management objectives is, and will be, an ongoing activity and challenge. In fact, one of the main messages I want to leave you with for the week is that while timber harvesting is a very important activity in British Columbia today, the way it's changing to meet emerging concerns about important non-timber values creates some new and difficult challenges, particularly for *you*, as I'll explain later.

The forest sector is still the most important industry in the province. Direct and indirect revenues from this industry continue to support health, education, and social programs, and we confidently expect the importance of this industry to continue far into the future.

But we are also in the business of responsible forest and resource management guided by the principles of sustainable use and resource stewardship. The Ministry of Forests is not operating alone in these primary business objectives. We have partners, including the provincial Ministry of Environment, Lands and Parks, and the Crown agency Forest Renewal British Columbia (FRBC).

The days when the Ministry of Forests and the Ministry of Environment Lands and Parks wore different coloured hats and championed jobs against environmental protection have been replaced by overlapping responsibilities for all parties. The Forest Service is still in the business of providing fibre for processing, but we are also equally in the business of managing the environment, protecting habitat, and ensuring that important non-timber resource values are not threatened.

So what I would like to do for you this morning is to set the stage for your discussions, and give you a further sense of what forestry means in British Columbia, and how we are committed to the practice of sound forest management, which includes consideration of forest health issues. I would like to place British Columbia in context of the world's forest community and illustrate for you our feelings of responsibility for the resource that we manage.

For this I'd like to note the economic value of the industry, and place its socio-economic benefit in context of some of our environmental realities. I'll touch on the legal framework that requires us to maintain biodiversity while integrating the management of the range of forest values and management objectives. Lastly, I want to note some of the conundrums that the socio-economic and environmental objectives raise for forest health experts such as yourselves.

Beginning with a BC overview, first and most obviously, we have a very large area to manage. The province is over 95 million hectares (almost 240 million acres). Yet this large area supports a population of only 3.8 million, although this is growing rapidly.

The province has great biological, cultural and geographic diversity, and includes an extraordinary diversity of both water- and land-based ecosystems.

Very roughly half of BC is considered to support productive forests, and about half of this again is considered to be harvestable. About one percent of the timber harvesting land base—around 200,000 hectares or 500,000 acres—is harvested annually.

Unlike a number of other developed countries today, we still have some very large areas of original forest, and these afford us some welcome planning options and opportunities for conservation. But at the same time, they present us with difficult management choices, and make us the subject of increasing world attention.

Under this spotlight we must manage to meet a broad spectrum of public demands and objectives which range from:

- protecting old-growth forests that are reputed to sing;
- providing habitat for threatened and endangered species;
- maintaining an economically competitive presence in international markets for forest products; to,
- maintaining employment and social structure in our forestry-dependent communities.

We also have to manage:

- range lands and forage for domestic livestock;
- riparian habitats, for fisheries;
- outdoor recreation areas of many kinds;
- botanical forest products;
- domestic watersheds for drinking-quality water;
- visual quality in scenic areas; and,
- cultural and heritage resources.

These demands take many forms and require complex approaches to management. And in everything we do, we must keep in mind the need to protect our natural heritage of biodiversity. In fact, we are ***required*** by the *Ministry of Forests Act* to balance and integrate the management of our forest resources and values, and by the *Forest Practices Code of British Columbia Act*, to do so sustainably. The spirit of the Forest Practices Code Act is summed up best in its preamble:

> WHEREAS British Columbians desire sustainable use of the forests they hold in trust for future generations;
>
> AND WHEREAS sustainable use includes
>
> a. managing forests to meet present needs without compromising the needs of future generations,
> b. providing stewardship of forests based on an ethic of respect for the land,
> c. balancing productive, spiritual, ecological and recreational values of forests to meet the economic and cultural needs of peoples and communities, including First Nations,
> d. conserving biological diversity, soil, water, fish, wildlife, scenic diversity and other forest resources, and,
> e. restoring damaged ecologies;

As you can see, this preamble to the *Forest Practices Code of BC Act* predicates all our forest management on the requirement for sustainability.

Our Forest Practices Code is relatively new, and has come about, with other initiatives, in response to the early history of development in the province. Sustainability has not always been a foremost objective of forestry in the province - in our early days, timber harvesting was primarily a tool for the development of our social services and infrastructure, and as I mentioned, it continues to be an important source of revenues and export earnings for the province today.

So let's take a look at the current economic and social value of forestry to BC

The world-wide softwood harvest in 1993 and 1994 was 1.1 billion cubic metres.
BC's harvest was 7 percent of this, the same as our percentage of the world's softwood growing stock.

In 1995, 62 percent of all BC's exports were forest products.

And here's where they went:

US	46%;
Japan	23%;
European Market	14%;
Other Pacific Rim	10%;
Rest of Canada	4%;
All other	2%.

BC's softwood harvest in 1995 was 76.5 million cubic metres:

lumber mills	78%;
chip mills and pulp mill woodrooms	11%;
veneer, OSB and panel mills	7%;
shakes and shingles	2%;
other mills	2%;
log exports	<1%.

This produced revenues of 17.7 billion dollars in 1995.

Of this, labour received 36 percent; the provincial and federal governments received 14% and 2% respectively; and capital and net earnings were 9% and 7% respectively. Other production costs accounted for 32%.

Wood and paper and allied products make up over half the value of BC's manufacturing shipments.

The BC timber harvest currently supports approximately 106,000 direct jobs, and another 159,000 indirect and induced jobs, for a total of 265,000 jobs, or about 15 percent of BC's total employment.

As a side note of interest to this conference, a substantial portion of the pine and spruce harvested in this region in recent years was due to infestations of mountain pine and spruce beetle. In many areas of the province, harvesting priorities routinely incorporate considerations of infestation levels and potentials for spread. There is also the incentive to harvest and process the wood before it loses commercial value; so both sanitation and salvage objectives are met.

Historically, as you would expect, the economic benefits of forestry have played an extremely important role in developing and shaping the province. There are many communities in BC that grew up around forestry operations and currently depend on them for employment and economic sustenance.

So you can see that the economically derived social benefits of timber harvesting are very important to British Columbia.

At the same time, due to its extensive and varied terrain, and the variety of climates and ecosystems here, our province is also very rich and diverse *biologically*.

BC is home to vertebrate species that include 458 fish, 20 amphibians, 19 reptiles, 448 birds, and 143 mammals. We have at least 2,850 vascular plant species, which is 69 percent of all those in Canada. I understand we also have somewhere between 15,000 and 35,000 insect species in the province - though I'm sure I don't need to tell you that, since you undoubtedly talk about them all in Latin and know how many legs they have and what they like for breakfast. We also have one of the most biologically diverse marine environments in the world.

But here's the rub. The BC Ministry of Environment, Lands and Parks reports that a number of our species, including 68 species of vertebrate animals and 224 vascular plants, are threatened or endangered, or are potential candidates for these designations. Another 451 species are reportedly vulnerable or at risk. BC Environment identifies urban and agricultural developments as the greatest threat to vertebrate animals and vascular plants in BC Logging poses the second greatest threat to vertebrates, but its impact on vascular plants is unknown.

To review, in BC we have a very valuable forest land resource on which we must integrate the management of wildlife, fisheries, range and forage, outdoor recreation, botanical forest products, domestic water supplies, scenic areas, cultural and heritage resources, and timber harvesting - and in all of this we must conserve biodiversity for the future.

So how do we manage to assess a desired amount of each forest value and then set and attain appropriate objectives that are publicly acceptable?

Well, the answers aren't black and white, and the only fair way to assess these things is with the help of a lot of input from the public.

To achieve this, the BC government has undertaken a number of initiatives designed to do two basic things. The first is to carry out appropriate, publicly supported land use planning, that includes identifying areas both for protection, and for timber harvesting at various levels of intensity. And the second objective is to ensure that where timber is allowed to be harvested, the operational practices are sustainable.

We don't claim perfection in these initiatives, since there will likely always be controversy where uncertainty exists, and our forest management will continue to evolve as knowledge improves. But the initiatives have transformed our planning and practices over the last five years, and helped us both to gain new knowledge and to identify where more knowledge is needed.

We completely overhauled our land use planning through the introduction of new initiatives such as the Protected Areas Strategy, Land and Resource Management Plans, the Commission on Resources and Environment, the Forest Practices Code and related initiatives such as Forest Renewal BC, the Forest Land Reserve and the Timber Supply Review. Today, government will make those portions of a land-use plan that have a bearing on forest management operations legally binding under the *Forest Practices Code Act*.

A very significant component of this process is our Protected Areas Strategy.

The Protected Areas Strategy was established by government in July, 1993. This strategy establishes a vision for protected areas in British Columbia, such as the 317,000-hectare Kitlope Valley, and commits the government to increasing protected areas from 6% to 12% of the provincial land base by the year 2000.

Strategic land-use planning is either completed or underway for 75 percent of the province.

Throughout the land-use planning processes, forest-sector interests and communities have been "loud and clear" about needing enhanced security and a long-term vision for forestry. As a result, we now also have a Forest Land Reserve to assist in managing forest lands, a commitment to timber management priority zones, and a program for investments under Forest Renewal BC, all intended to meet the clearly expressed priorities of forest communities.

So that's a *very* brief synopsis of our planning processes.

Now, wherever our land-use planning has identified provincial lands as available for timber harvesting, the harvesting itself must be in accordance with the need for sustainability and the conservation of biodiversity. To help achieve this, in 1994, the BC government legislated new rules for harvesting on Crown land.

The resulting *Forest Practices Code of BC Act*, which is a comprehensive Code of conduct to protect the full range of forest values, took effect in June 1995. The complexity of the Code is causing some administrative problems in its implementation, which we're looking at closely, particularly since the industry is currently having a difficult time financially. So the Ministry of Forests is undertaking a review, to identify options for reducing the up-front administrative burden of the Code.

The legislation supporting the Code sets out clearly the obligations of forest companies and government agencies for careful stewardship, and the role of the public in forest management decisions. It is supplemented by regulations and guidebooks on the appropriate management of provincial forest and range lands. Together these form a forest management system that is consistent, enforceable, and auditable.

Amongst many other things, the Code requires the use of silvicultural systems that are ecologically appropriate and that meet management objectives for each forest site. In many parts of the province, BC is moving toward the use of partial retention harvesting systems to meet biodiversity, wildlife habitat, recreation and other objectives.

And this brings me to the crux of what I want to leave with you today.

Our Forest Practice Code, which is now a formal part of the provincial statutory framework, requires that we leave wildlife trees to maintain biodiversity at the stand-level. It requires that we leave untouched riparian reserves, and cut only partially in management zones adjacent to them. And coarse woody debris must be left on the forest floor for nutrient cycling and habitats.

Now I can assure you that these laws were not actually written by insects. But each of these provisions I've mentioned effectively contributes to a legislative entrenchment of insect rights and increased insect housing. So you can bet that if you explained these laws to all our little friends out there, their reaction would be pretty positive!

And particularly so if you also explained that we're leaving large areas of parks protected as condominiums for them. Further, we're not using fire as a management tool as much as in the past, and, in response to public demand, we're also using smaller amounts of pesticides in forest management.

And this brings me to the challenges for you that I mentioned earlier. Land-use patterns and management practices have changed dramatically. We used to think that managing forest health under the old, but comparatively simple regime, was a tough job. Are you ready for the new challenge?

We still need to optimise our fibre production because the public expects to obtain economic and employment benefits from the forest. But we have to do it at the same time as we're inviting the insects in for dinner. In this changing situation, as I see it, we're looking at a whole new definition of forest health.

We now have a whole new range of responsibilities. And I include myself in this consciously because when I review the timber supply and set allowable annual cuts, as I am required to do by law, one of the factors I must expressly consider is abnormal infestations and planned salvage programs. So with your help, I must determine an appropriate timber supply that continues to provide short-term social and economic benefits while providing for environmental protection.

But your challenge, while we're doing that, is to ensure the overall health of the forests, while managing in a much more complex regime, that protects the rights of critters that we consider harmful at certain population levels.

And we have to do this at a time when fiscal constraints are making themselves evident in reduced budgets in most areas of forest management.

So, I think you and I both have some very difficult and interesting times ahead, and I sincerely wish you the very best, and every success in your discussions of these and other issues at the conference this week.

Thank you very much. If you have any questions I'll be happy to try to answer them.

PANELS

Panel 1: Forest Practices Codes and Forest Health

Moderator: L. E. Maclauchlan, BC Ministry of Forests, Kamloops, BC

The following four speakers presented views and perspectives on the application of forest health under new legislation:

1) Paul. M. Wood, Assistant Professor, Faculty of Forestry, University of British Columbia, Vancouver, BC;
2) Peter M. Hall, Provincial Entomologist, British Columbia Ministry of Forests, Victoria, BC;
3) Pat Byrne, Forest Health Officer, British Columbia Ministry of Forests, Merritt Forest District, Merritt, BC; and,
4) Ladd Livingston, Idaho Department of Lands, Coeur d'Alene, Idaho.

The presentations covered a wide range of topics relating to new approaches in applying forest health principles under enabling legislation, as well as discussion as to the need for such legislation and the changes occurring in the practice of forestry and changing resource management objectives. The presentations were followed by questions from the audience.

1) Forest Health in Context: Economics, Ecology, and Ethics
(Paul. M. Wood)

There is an urgent need to expand the concept of forest health to include the conservation of biodiversity. This is no trivial matter. The current rate of biodiversity loss is one of the most serious issues facing humanity, and forest entomologists have a special, proactive role to play in the conservation of biodiversity.

Sixty-five million years ago the dinosaurs, along with most of the world's species in existence at that time, suddenly met their demise in a cataclysmic event, probably caused by a large meteor hitting the planet. Five mass extinctions of a similar magnitude occurred in the deeper past. These mass extinctions were probably due to a number of different causes, but in each case half or more of the species on Earth at the time suddenly ceased to exist. Each time, it took tens of millions of years for the world's biota to evolve to its former level of diversity. We are now witnessing a new mass extinction on Earth, a mass extinction unprecedented in the past sixty-five million years. But this time the cause is human activity as we usurp the ability of other species to live on Earth.

How is this relevant to a work conference on forest health? And how in particular does it relate to forest practice codes regarding forest health? I suggest that the *purpose* of what we used to call forest pest management, and now see from the perspective of forest health, is changing. It has evolved in parallel with a number of historical stages in forest management in general. Each stage was a little more complex and more inclusive than the one before. We have now entered a new stage in forest management that emphasizes the conservation of biodiversity. In consequence, the concept of forest health is now more complex.

Forest management in Canada has progressed through six over-lapping stages and is now trying to find out how to implement a seventh stage. I'll briefly review these stages:

1. **The Subsistence Stage:** In this stage forest resources, especially food resources, were hunted and gathered by small groups for personal consumption. This stage had considerable impact on our current pattern of forest ecosystems, largely by way of the use of fire by indigenous peoples.
2. **The Exploitation Stage:** This is the stage in which timber and other forest products were rapidly harvested. It was a stage in which the biggest and best were taken first, in what we now call "high grading."
3. **The Regulatory Stage:** Realizing that forest resources were finite in quantity, this stage saw the imposition of regulations designed to limit the amount of resources harvested in any one year, and to allocate resources among competing interests. It is at this stage that a pattern started to emerge: forest resources were perceived as being under some sort of threat. The first threat was the human thirst for easily obtainable resources, and this was manifested in a frenzy of overharvesting. Regulatory control was therefore needed to ensure some vision of sustainability.
4. **The Protection Stage:** In this stage, forest resources were seen to be threatened not by human agents alone, but also by fire, insects, and diseases. Thus various forest service agencies grew to become effective fire suppression machines. At the same time, forest entomologists were developing new technology and methods for detecting and suppressing insect outbreaks.
5. **The Renewal Stage:** This stage was marked by yet another resource-threatening factor: a lack of sufficient forest regeneration. Thus new silviculture policies and practices were implemented to help ensure that cutover areas were regenerated by one means or another.
6. **The Species Management Stage:** This stage was marked by the perceived need to concentrate forest management efforts on only those species that were of commercial interest. The perceived threat was a looming decline in timber supply as old growth forests were replaced with second growth forests in what we know as the "falldown effect." To mitigate this effect, we focused our attention on site selection guidelines, provenance testing, the development of genetically superior planting stock, and the implementation of intensive silvicultural practices, and what we might call intensive pest management practices - all oriented toward growing healthy trees big and *fast*.
7. **The Habitat Management (or Ecosystem Management) Stage:** This is the stage we are now entering, and it too is marked by a perceived threat: the loss of biodiversity. Ironically, it is precisely those forest management practices, in which we diligently concentrated our efforts on a few commercially valuable species, that are now seen to be the threatening factor. The problem is not necessarily any individual action, but rather

the overall pattern of human-induced changes in forest ecosystems. In the aggregate, these can lead to losses in biodiversity.

Both the idea of biodiversity, and especially its value to society, are amongst the most misunderstood concepts in forest management. Biodiversity is often defined as the diversity of life forms, and includes the diversity of genes, species, and ecosystems. And the value of biodiversity is usually expressed in terms of the potential value of future resources that we might discover if biodiversity is conserved.

Unfortunately, these concepts fail to convey the full reasons for the urgent need to conserve biodiversity. A better approach is to see biodiversity as an *environmental condition*. Take other environmental conditions for example: the rate of solar influx, the world's average temperature, the Earth's rate of rotation around its axis, and the trajectory of the world's orbit around the Sun. A sudden and large change in any one of these conditions would spell disaster for humankind. But we don't need to worry about such changes; we can presume that they will remain much the same from year to year (with the possible exception of global warming).

Biodiversity is another environmental condition. It is not simply the sum total of genes, species and ecosystems. Rather it is an emergent property or condition that emphasizes the differences among these biological entities. The maintenance of this environmental condition we call biodiversity is also essential for humankind. It differs from the other conditions I mentioned above (like the rate of solar influx) precisely because humans, quite inadvertently, are eroding the structure of this essential condition.

What is the value of biodiversity? Far from simply representing the chance of discovering some new medicines or useful new resources, biodiversity is the *source* of all biological resources. For a number of technical reasons, it is now clear that the condition we call biodiversity is absolutely necessary for the long term maintenance of all the biological resources upon which humans depend.

The main point here is that the conservation of biodiversity is not the sole responsibility of forest ecologists and operational planners. Every subdiscipline in forest management needs to move beyond the species management stage into the habitat, or ecosystem management, stage. And of course, this includes forest entomology. There is a need, therefore, to articulate the extent to which the practice of forest entomology has moved from the species management stage to the habitat management stage. We should be asking ourselves questions like this:

- To what extent is the practice of forest entomology attempting to conserve not only the diversity of forest insect species in particular, but all forest species in general?
- To what extent do management operations aimed at forest insect control incorporate design principles for the conservation of biodiversity at the stand and landscape levels?

I suggest this is your responsibility, not the responsibility of someone else.

What all this means is that the concept of forest health itself needs to evolve: it should now include the conservation of biodiversity as a matter of priority. It needs to take priority over social and economic issues. In this talk, I can't begin to explain the full line of reasoning that supports this assertion of priorities. But I can say that when we look at forest health in the context of the larger human enterprise, we need to look beyond the day-to-day economics of our current forest health practices, we need to understand the larger ecological trends that threaten us all, and we need to act in a professionally ethical manner by shouldering some of the responsibility for ensuring that biodiversity is conserved.

2) Forest Practices Code of British Columbia Act and Forest Health
(Peter M. Hall)

The *Forest Practices Code of British Columbia Act* was enacted in June, 1995. This legislation marks a significant change in the legislation pertaining to the application of forest management in the province. The preamble to the Act sets out the spirit and intent of the *Code*:

> "WHEREAS British Columbians desire sustainable use of the forests they hold in trust for future generations;
>
> AND WHEREAS sustainable use includes
>
> - (a) managing forests to meet present needs without compromising the needs of future generations,
> - (b) providing stewardship of forests based on an ethic of respect for the land,
> - (c) balancing productive, spiritual, ecological and recreational values of forests to meet the economic and cultural needs of peoples and communities, including First Nations,
> - (d) conserving biological diversity, soil, water, fish, wildlife, scenic diversity and other forest resources, and,
> - (e) restoring damaged ecologies;..."

In short, the *Code* is intended to ensure that what happens in our forests is well-planned and takes all values into account. It provides certainty in our forests as government, industry and the public know what standards of management are expected, and that the penalties for breaching those standards are strong, fair and effective.

The Forest Practices Code encompasses three components:

- *Forest Practices Code of British Columbia Act*;
- regulations pertaining to the Act; and,
- guidebooks.

The full text of all three components of the *Code* can be found on the internet at the following address:

http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpc.htm

The provisions of the *Code* and regulations are required by law. The *Code* provides guidance to licensees in regard to planning requirements and implementation of forest practices. Many of its sections deal with planning at different scales, from landscape to site prescriptions. Sections of the *Code* dealing with each of these planning levels specify the information that is required to be included within a plan or a prescription.

There is only one discrete section of the legislation which deals specifically with forest health. That section specifies that, at the discretion of a district manager, a private landowner or license holder must carry out forest health treatments as required, primarily to deal with forest health problems on non-Crown lands that could spill over and affect adjacent timber producing Crown lands. Other sections that are directed primarily towards forest health include those sections of the Act and Regulations pertaining to exemptions and emergencies to deal with unforeseen catastrophic events. However, the lack of sections dealing with forest health specifically does not imply that forest health is taken lightly in the *Code* and regulations.

Forest health considerations are scattered throughout all sections of the legislation. Licensees developing plans at all levels, from landscape management plans to specific site prescriptions, must consider forest health agents and address hazards and risks within short and long term plans. The intent of the code, regulations and guidebooks is to incorporate forest health, along with other major forestry disciplines, into comprehensive, integrated management. It also officially shifts much of the responsibility to deal with forest health issues to the licensees who are now required to identify forest health issues within their planning areas and incorporate strategies to deal with these issues into all their planning levels.

The guidebooks developed as part of the Forest Practices Code "package" are intended to support the regulations, but are not part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but, hopefully, are intended as current, "state-of-the-art" guidance to practising foresters on a wide variety of topics that must be addressed. However, once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable.

In total, there are 43 guidebooks dealing with a wide variety of issues such as biodiversity, riparian zone management, road standards, and others. Nine guidebooks deal specifically with forest health. Management of bark beetles, defoliators, terminal weevils, root rots, dwarf mistletoes, and other potential pests are dealt with in specific guidebooks - each providing recommended survey methods as well as strategies and tactics to deal with the specific topic.

The Forest Practices Code was not developed in isolation. All components of the legislation, regulations and guidebooks were developed and reviewed by both the Ministry of Forests and the Ministry of Environment, Lands and Parks, as well as other relevant agencies. Other, existing legislation, such as the *Forest Act of British Columbia*, were reviewed at the same time and amended to ensure that there were no conflicts or overlaps. The new legislation replaced the older legislation so there would be no confusion.

All components of the *Code* are "living" documents in that they are constantly changing and evolving as government, industry, and interest groups become familiar with the implementation. Implementation of the *Code* is complex, greater effort and care are now required when carrying out any activity that modifies the forests. Similarly, forest health concerns may increase as a result of new forest practices. The level of harvest in the province is not expected to greatly decline; yet the harvest will be more dispersed due to smaller cutblock sizes and more emphasis on selection harvest. We will therefore be impacting a greater number of stands.

3) Forest Health Operations Under the *Forest Practices Code of British Columbia Act*

(Pat Byrne)

Prior to the *Forest Practices Code* taking effect in BC, most pest work was done by Protection, or the fire and pests section of the Forest Service (FS). In the summer, crews fought fires and in the fall and remainder of the year the same crews picked up axes and chain saws and treated pests with the same "fire mentality". This was not necessarily such a bad attitude, for it definitely got the job accomplished, but if it wasn't a bark beetle and didn't kill trees it wasn't a problem. At this time in the history of pest management, Forest Service crews carried out virtually all of the pest work in the district including ground probes, pheromone placement, fall and burn and MSMA (monosodium methanearsonate) treatments. Forest companies were asked to help out when the FS overachieved in the baiting department or an infestation was identified that had become too big to treat in any other way except by harvesting (>20ha). But this often interfered with planned harvest schedules so, therefore, was not a desirable activity.

As the program matured, pest management technicians became forest health officers and added the review of operational plans and silviculture prescriptions to their work load. However, the most common entry in silviculture prescriptions was: "no pest problem." Similarly, in Forest Development Plans there was little more than phrases like "pests will be addressed at the time of harvest" and if there were no bark beetles present, there was usually not much mention made of pest management regimes.

However, the forest health community was trying to make it known that there were significant impacts being caused by various insects and diseases and these impacts were not being fully recognized. Implementation of the *Forest Practices Code* changed the attitude towards pests and pest impacts.

The most significant changes as a result of the code occurred in the Operational Planning requirements. Forest development plans, silviculture prescriptions and stand management prescriptions all required:

1. an adequate evaluation of forest health factors both currently and anticipated to have an impact on resource management objectives;
2. prescriptions that would appropriately deal with those forest health factors; and,
3. treatments that would not intensify impacts of any other forest health factor.

An adequate evaluation of forest health factors had 4 main components:

1. Assess forest health factors and quantify their incidence and occurrence;
2. Quantify and qualify impacts of each forest health factor and establish strategic goals to reduce those impacts over the term of the plan;
3. Assign an overall focus or strategy to attain these goals and identify resource issues which may conflict; and,
4. Assign tactics consistent with strategic goals and those of adjacent landscape units.

The forest health content of development plans now reflects a proactive, as opposed to reactive, approach to dealing with forest health factors.

Another significant change in the role of a district forest health officer is that forest companies now do most of the treatments with the district acting as a resource and monitoring agency. A bark beetle responsibility matrix has been implemented that outlines the obligations of a Forest License holder to carry out detection, pheromone placement, harvesting, single tree treatments and monitoring activities (within 400m of an existing or proposed development). The district forest health officer and industry forester now jointly draw up a forest health plan which outlines responsibilities for each agency with site specific goals and deadlines for carrying out forest health activities. This plan is used both as a planning tool and a guide to monitor performance and compliance.

Other significant changes are that rather than just prescribing treatments for individual pests, an ecosystem and landscape level approach is taken to forest management which integrates the roles and function of these forest health factors and their respective impacts. There are guidebooks available that deal with pest factors and their management and hopefully these will be just that - guides, and not cook books. The code also protects riparian areas but allows for some pest treatments to occur when necessary. New biodiversity guidelines allow for leaving areas with identified pests if they enhance other resource values.

There is a significant cost to the Forest Service and forest companies in applying the *Forest Practices Code*. The ability to act quickly and aggressively has become somewhat impaired. Gone are the days of the fire suppression mentality of pest management. Hopefully, a balance will be achieved as we become more familiar with code requirements and the functioning of our ecosystems.

4) Forest Practices Act in Idaho
(Ladd Livingston)

The State of Idaho has a *Forest Practices Act* which was passed by the 1974 Legislature to assure the continuous growing and harvesting of trees and to maintain forest soil, air, water, vegetation, wildlife and aquatic habitat. The initial driving force behind the establishment of the Act was a concern to protect water quality. Today, in Idaho, clean water continues to be the principle concern. The Act also requires forest practices rules for state and private lands to protect, maintain, and enhance natural resources. Federal land practices must also meet or exceed the requirements of the state rules.

The Act provides for an advisory board of forest owners, operators, informed citizens and environmental and fisheries experts to recommend rules and Best Management Practices (BMP's) to the State Land Board which provides oversight to these activities. The advisory board meets three to four times per year to review the rules, and to suggest changes, additions or deletions. The Board also directs the Idaho Department of Lands which, in turn, provides enforcement of, and technical assistance for, the rules associated with the Act. Every four years the Idaho Department of Environmental Quality conducts an audit of selected forest practices to assure compliance with the rules.

The rules regulate the following forest management practices:

- conversion of forest lands to other uses;
- annual review of the rules and consultation with other state agencies to assure that the goals are being met;
- notification of forest practices. When an operator plans any activity, the Department of Lands is to be notified;
- emergency forest practices. No immediate notification is required for practices necessary due to catastrophic events;
- duties of purchasers of forest timber products. Purchasers are required to obtain and keep on file a copy of the notification of forest practice prior to purchasing any timber products;
- storage, leakage or accidental spillage of petroleum products;
- timber harvesting;
- road construction and maintenance;
- residual stocking and reforestation;
- use of chemicals;
- slash management; and,
- prescribed fire.

Within these various categories there are specific rules, or BMP's, that provide for having a healthy stand after harvest; reforestation to acceptable stocking levels; protecting soils from compaction and movement; maintaining water quality through stream protection zones and preventing wastes or chemicals from entering streams. Aquatic habitats are protected with riparian management plans; critical wildlife habitats are preserved with specific guides for escape cover; air quality is protected with smoke management plans for prescribed fires. The risk from wildfire or outbreak of insects is reduced through treatment of slash resulting from forest practices.

Forest practices are inspected regularly by Forest Practice Advisors of the Idaho Department of Lands. When a violation of the rules is found and corrective action is not taken in a reasonable time, the Department will take enforcement action against the responsible operator, thus assuring that the situation is corrected. These same Forest Practice Advisors also have the responsibility of providing technical assistance to woodland owners in developing forest management plans. They also determine if non-industrial private woodland owners qualify for Federal assistance programs such as the Stewardship Incentives Program and Forestry Incentives Program. These programs provide cost share funds to help with practices such as thinning, planting, forest improvement, soil and water protection, riparian area protection, fish and wildlife habitat enhancement and agroforestry. This dual responsibility provides the opportunity to address all aspects and concerns related to forest management.

Looking beyond Idaho, many other states have some level of regulations for forest practices. According to a study conducted by the University of Minnesota, depending on the forestry objective being considered, state-wide regulatory programs exist in as few as 16 percent to as many as 54 percent of the states. These programs are most commonly used to protect forests from wildfire, insects and disease, and to protect the habitat of rare and endangered species. In the northwestern states, protection of clean water has been the main emphasis behind the enactment of forest practice acts. This need has been stressed with the Federal Clean Water Act and more recently with concerns such as Cumulative Watershed Effects and the designation of water quality limited stream segments for specific beneficial uses such as salmonid spawning or domestic water supply.

State wide regulatory programs are most commonly used in the northeast and the far west, and least commonly in the south.

Situations that tend to promote the development of forest practices regulatory programs include careless application of forest practices, the general increase of public interest in environmental issues, the regulatory climate created by numerous federal environmental laws, and the increase in land-scape-level programs of land management.[a]

Addressing the question of the potential influence of forest practices on forest insects and diseases, the following are examples of Idaho's rules and BMP's that could directly influence their occurrence:

- Stream Protection Zones (75' and 30' respectively for Class I and Class II streams) are required for protection of water quality and aquatic habitats. These have minimum stocking requirements that generally leave more trees than might be left on a managed area adjacent to the stream. Sometimes these zones have served as sites for increased bark beetle activity due to the more dense nature of the stands. Spruce beetle attacks have often been concentrated in these zones and have left very few live trees on the stream banks.
- Wildlife escape routs are required in certain situations. These may be more densely

[a]Regulation of Private Forestry Practices by State Governments. Paul V. Ellefson, Anthony S. Cheng, Robert J. Moulton. University of Minnesota, Station Bulletin 605-1995. Minnesota Agricultural Experiment Station. (Distribution center item No. SB-6585-S)

stocked than is appropriate for optimum resistance to bark beetle attacks.

- On any forest practice, trees left for future harvest shall be of acceptable species and adequately protected from harvest damage to enhance their survival and growth. Acceptable residual trees should have a minimum live crown ratio of thirty (30) percent, minimal basal scarring, and should not have dead or broken tops. These requirements can influence species left in a root disease pocket, or the eventual incidence of heart rots in trees damaged by logging equipment.
- When making aerial applications of chemicals there will be a minimum of one swath width or 100' untreated on each side of all Class I streams, flowing Class II streams and any open water. In outbreaks of defoliators these untreated zones can harbour populations that may serve to repopulate the treated area.
- Treatment of slash is primarily aimed at reducing the risk of fire. Slash must be treated within specific time frames, but this will not necessarily prevent the build up of certain bark beetles if the conditions are right. Also, an operator can get an extension on the time requirement for treatment of the slash, again allowing any potential insect problem to occur. An operator can also qualify through a point system based on factors such as availability of water for tankers, good access roads, closures to the public and fuel breaks, so that there will be no actual slash disposal required. In the case of ponderosa pine slash, this could easily contribute to increased pine engraver populations with subsequent tree killing.
- While prescribed fire is regulated mainly for control of smoke and air quality, its use is increasingly being encouraged, and can dramatically contribute to vigorously growing forests thus reducing the potential for insect and disease problems.

Panel 2: Old and New Approaches to an Insect Outbreak

Moderator: L. Safranyik, Canadian Forestry Service, Victoria, BC

Perhaps it is self evident that one of the main motivating factors for the creation of this work conference was to develop and exchange information regarding approaches to cope with insect outbreaks. Naturally, operational methods for combating epidemic infestations of specific pests can change through time for a variety of reasons such as:

- increased knowledge of pest epidemiology;
- issues of jurisdiction/ownership;
- changes in pertinent regulations;
- availability of resources;
- environmental concerns; and,
- changed management objectives.

These changes often can have significant effects on the operational effectiveness of control programs. With this background in mind, the four speakers were asked to address at least some of the following points:

- changes through time in approaches to outbreaks (current *vs* recent past);
- motivating factors for change;
- how changes affected administration, implementation, and operational effectiveness of programs; and,
- expected future trends.

Due to the short time available, I decided to restrict the subject matter to bark beetles, specifically the spruce beetle and the mountain pine beetle. The first speaker will describe a case history of actions relating to a large spruce beetle outbreak that occurred in central British Columbia some 15 years ago. This was designed so that the next speaker could better reflect subsequent changes in the management of this insect. The third speaker will describe approaches to spruce beetle management in the United States and the final presentation will deal with mountain pine beetle management.

I. The Upper Bowron Spruce Beetle Outbreak: A Case History (R. Cozens, Senior Forester, Evaluation and Assessment, Forest Practices Branch, BC Forest Service, Victoria, BC)

The upper Bowron River valley is located 80 kilometers south east of Prince George, British Columbia. The Bowron River flows from Bowron Lake to its confluence with the Fraser River, some 110 kilometers to the north. Bowron Lake is part of the very popular Bowron Lakes canoe route. The Bowron River has significant salmon spawning values.

Strong winds caused widespread blowdown in the upper Bowron River valley and, to a lesser extent, in adjacent valleys, in October 1975. Steady wind speeds reported at 75 kilometers per hour (kph), with microbursts producing winds approaching 150 kph, uprooted and broke-off trees throughout the area. Patches of up to 250 hectares were totally flattened by the winds. As well, the wind storm toppled a more-or-less uniformly distributed 3-5 stems per hectare over a widespread area.

Mature to overmature interior spruce (*Picea glauca* x *engelmanni*) and interior spruce-balsam (*Abies lasiocarpa*) mixes, with volumes approaching 350 m^3 per hectare, typified the forests of the upper Bowron. These forests continue to provide a high quality raw material to the processing facilities that are located mainly in Prince George.

All of the land in the upper Bowron River drainage is owned by the Province of British Columbia, and is managed for the people of the province in a manner that is consistent with the *Ministry of Forests Act*, the *Forest Act* and, since July 1995, the *Forest Practices Code of British Columbia Act*. Forest management operations are conducted by the holders of various agreements with the Crown. In the late 1970s, the management agreement was a timber sale harvesting licence (TSHL). These have now been replaced with forest licences, which are similar in nature to TSHL's but place increased management responsibility upon the licensee, in return for increased security of tenure.

The TSHL holders in the upper Bowron were confident that they could remove the patch blowdown before it deteriorated. However, much of the area was inaccessible. Access development began almost immediately. Fortunately, road construction was quite straightforward and the only problems encountered were those associated with hauling logs over newly-constructed roads.

Discoloured spruce trees were noticed by Forest Service staff in mid-April of 1979, when returning from field work on the "last" blowdown block. Subsequent ground inspections showed significant spruce beetle activity in the area of the discoloured trees. Further examination showed a substantial problem throughout the upper Bowron and a somewhat lesser problem in adjacent drainages. This "discovery" took place 3½ years after the initial blowdown event.

Outbreak Characteristics

Population build-up took place in the more-or-less uniformly distributed 3-5 mature spruce trees per hectare that were felled by the wind storm of October 1975. The population did not build in the patch blowdown, for two reasons: 1) most of the patch blowdown had been removed in the 1975/76 - 1978/79 logging seasons; and, 2) spruce beetles did not aggressively colonize the patch blowdown material, presumably because of inhospitable host bark temperatures due to prolonged exposure to direct sun. This second point is extremely important in refuting claims that the unharvested patch blowdown in the Bowron Lakes Provincial Park was where spruce beetle populations built to epidemic proportions.

Several warm winters with heavy snowpacks resulted in very low overwintering mortality in the spruce beetle populations. Early springs and warm summers set the conditions for one-year life cycles. Overlapping one and two-year cycles resulted in huge dispersion flights and dramatic expansion and intensification of the infestation. The general boundaries of the infestation encompassed about 175,000 hectares, not all of which was attacked by spruce beetle.

Decision Making Challenges and Processes

Staff training and awareness in pest management was minimal prior to 1980. Understandably, it became a high priority item to enable both the Forest Service and the forest industry to meet the "challenge" with which we were presented.

Detection of insect activity essentially had been dependent upon the Canadian Forestry Service's Forest Insect and Disease Survey overview surveys and "random" observations by Forest Service and industry personnel. Early detection, infestation quantification and population monitoring became a very high priority so that both the Forest Service and the forest industry could determine the ever-changing extent of our "challenge."

The overall goal in addressing the spruce beetle outbreak in the upper Bowron River area was that of limiting the expansion of the infestation by harvesting green-attacked timber. Harvesting the green-attacked timber would remove the beetle populations from the area, thus reducing the potential for expansion, and would also maximize the value of the trees at the mills since they were still in good condition (*i.e.* not "checked", no sap rot, *etc.*).

Action

The Bowron was only one of the several "hot spots" in the Prince George Forest Region in the early 1980s. Spruce beetle, mountain pine beetle(*Dendroctonus ponderosae* Hopk.), and Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopk.), were keeping region and district staff busy in all but two of the nine forest districts in the Prince George Forest Region. The region includes about 32 million hectares of land and occupies about one third of the province of British Columbia.

Control of the spruce beetle outbreak was to be accomplished through harvesting the green-attack spruce trees. Removal of beetle populations with the attacked trees would limit the outbreak expansion. As well, the timber would be utilized while it was virtually undamaged, thus maintaining its value to the licensees, the secondary manufacturers, and to the people of British Columbia.

The licensees that traditionally operated in the upper Bowron River area realized very early that they were not able to address the problem in an appropriate manner on their own. Thus, it was necessary to relocate licensees from adjacent areas to provide more harvesting "horsepower" and allowable annual cut (AAC). (TSHLs had a specified volume of timber to be harvested each calendar year, which is the AAC. Forest licences also have an AAC.) A memorandum of understanding was drawn up with each of the relocated licensees to state clearly the terms of the relocation, including the important provision that they would return to their normal operating area at the completion of the Bowron project.

Planning, referral and approval processes were streamlined to the maximum so that a problem area could be addressed shortly after it was identified. Commonly, attack areas were identified from ground surveys in late summer/early fall, and cutting permits were issued to the licensees by "freeze-up" in November. Harvesting would take place during the winter; site treatment, which generally included broadcast burning, would take place in the late summer or early fall. It became evident very early in the project that full and complete cooperation between the Forest Service and licensees and among the licensees was critical to success. We most certainly did not want "process" to create more problems or compound the ones that we were addressing.

Coordinated harvesting operations removed 15 million m^3 of green attacked timber between 1981 and 1987. This amount of raw material could produce enough lumber to build 900,000 average 1,200 square foot homes! Logging trucks, with radiator caps touching the red flag of the truck in front, carrying 15 million m^3 of logs would stretch for 5,300 miles. The peak of the harvesting activity saw some 700 loads of logs coming from the Bowron every day. One-way transportation patterns were established, and were particularly necessary during the very busy winter logging period. As well, off-highway access was developed into the Prince George mill sites so that truck loads could be larger, thereby reducing the total number of trips required, the cost of each cubic metre of delivered wood, and road congestion.

In mid-1980's figures, about C$870 million of product was removed in the 1981-1987 period. C$27 million was returned to the province in the form of stumpage and direct taxes. At today's significantly higher stumpage rates, that amount would be close to the C$250 million range.

Within the 175,000 hectare outbreak area, 48,000 hectares were harvested and an additional 3,300 hectares were burned by wildfire. Clearcut harvesting is the best prescription for these boreal forests and was prescribed throughout the Bowron. Ground-based skidding systems were employed, primarily using rubber-tired skidders.

Trap trees, both conventional and lethal, trap logs and trap decks (commonly used in road construction) were utilized outside of the main outbreak area to prevent smaller areas from expanding. We could ill afford another large scale beetle control/sanitation salvage project at this time.

Assessment of Program Effectiveness

The assessment of the program effectiveness was quite simple: did the expansion continue?? Essentially, we "chased beetles" until the populations were not killing significant numbers of mature spruce trees. The assessment was subjective in nature only, since we couldn't afford to have a control area by which to judge our performance.

A New Forest

The plantations of the upper Bowron River valley are extensive. They can be seen from space! Some 62.5 million trees have been planted on 43,500 hectares. The remaining 650 hectares scheduled for planting will be completed by 1999. Natural regeneration is expected on 1,200 hectares of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia*) sites. Safety and environmental concerns precluded about 2,800 hectares from planting.

The plantations are comprised of 70% interior spruce, 28% lodgepole pine and 2% Douglas-fir. Thus far, 13,100 hectares of these plantations have received some form of stand tending.

Epilogue

The upper Bowron River windstorm and spruce beetle outbreak provided the Forest Service, licence holders and the public with challenges and opportunities. Access into the area was developed, in relatively short order, that could be used to facilitate forest management activities including insect and disease detection and control, fire management and control, and harvesting and related activities. The public could extend their pursuit of recreational activities into previously inaccessible areas. Employment opportunities in the logging, milling, manufacturing and support sectors were increased due to the concentration of operations in the upper Bowron.

Techniques for the detection, control and management of spruce beetles, and other bark beetles, were developed and fine-tuned in the upper Bowron and adjacent areas. Many of these techniques have been used in other areas of the Prince George Forest Region and British Columbia with success.

Most important, the upper Bowron spruce beetle outbreak raised the awareness of pest management (= forest health) in both the Forest Service and the forest industry. Media coverage during the project served to bring an awareness of certain forest pest issues to the general public. An industry colleague, responding to claims of "beetle eradication" in a particular area (not in the Prince George Forest Region!), perhaps summed up the pest awareness issue most appropriately:

"The beetles aren't gone; they're just resting."

II. New Approaches to Spruce Beetle Management in British Columbia (R. S. Hodgkinson, Forest Entomologist, BC Ministry of Forests, Prince George Forest Region)

The spruce forests of the central interior of BC are occasionally subjected to wind storms and, given the shallow-rooting properties of spruce, blowdown can average 1-2 trees per ha over widely scattered areas. This can lead to rapid increases in the beetle population such that standing trees are attacked and killed over large areas particularly when weather conditions are favourable. In "the old days," control efforts usually began after an infestation had caused substantial tree mortality (hundreds of trees).

Prompt aerial detection of newly attacked spruce is difficult because trees often retain much of their green needles for more than a year. On rich sites in the central interior, such trees can occasionally appear green for up to 24-30 months after attack.

The harvesting strategy for spruce beetle management in the early 1980's was often a *"combination of progressive clearcutting, burning, and planting."* In the absence of visual quality objectives, *"negative visual impacts"* were recognized but accepted.

The BC Ministry of Forests now conducts annual detailed aerial sketchmapping at a scale of 1:50, 000 in all operational areas followed by ground surveys of two intensities: "walkthroughs" and "probes." The knowledge, training, and experience of forest health staff in BC is much higher today with forest health staff in each of our 41 district offices. Forest entomologists are stationed at each of our 6 regional offices and there is 1 in Victoria. A few industrial and consulting companies also have experienced entomologists, foresters, and technicians.

Today we distinguish between salvage harvesting (no beetles remaining) *vs* sanitation harvesting (infested trees) in order to maximize beetle control. Our new *Forest Practices Code Act of BC* and attendant *Operational Planning Regulations* require licensees to conduct pest incidence surveys and propose and carry out management actions within certain zones of their tenures. Our cutblocks in the interior can not exceed 60 ha unless they incorporate structural characteristics of natural disturbance. However, with landscape level planning, a number of larger openings in the Sub-Boreal Spruce Biogeoclimatic Zone can be ecologically appropriate if they mimic natural disturbance. So residual shape and structure of the cutblock after sanitation/salvage harvesting can be more important than size. The Ministry of Environment, Lands, and Parks must now approve of any cautious pest management proposed for riparian reserve zones.

Our District Managers now have flexibility to:

- waive public review periods "to address an emergency" or expedite extraction of timber in *"imminent danger of being lost or destroyed"*;
- order control measures on private or tenured land;
- exempt planning requirements for harvesting blowdown and beetle-attacked timber;
- waive cutblock size and *"green-up"* restrictions for damaged timber; and
- exempt paperwork for deployment of trap trees and the removal of small, remote, or inaccessible patches of attacked timber.

Some of the greatest challenges with present-day management of spruce beetle are in riparian reserve zones, old growth reserves, wildlife tree retention patches, and parks which often act as sources for beetle migration. Consequently, we are working more co-operatively with other resource agencies to limit the spread of spruce beetle from such zones with use of conventional and lethal trap trees and discrete single tree sanitation harvesting.

We are also striving to maintain proper utilization standards on sanitation-logged blocks by ensuring the prompt treatment or disposal of blowdown, large diameter slash and high stumps. Tracking the inter-district transportation of infested wood and ensuring it is milled expeditiously is now recognized as important.

Our choice of spruce beetle management strategies depends on the size and pattern of the infestation, severity of attack in the last 3 years, vigour and survival of the new broods, stand hazard, integrated resource management issues, existing and planned access, and harvesting operability.

Deployment of conventional trap trees to mop-up residual beetles after sanitation harvesting is now a normal procedure provided such traps can be extracted after the beetle flight. Right-of-way wood from pre-developed roads and landings is often left on site to serve as additional trap trees before being extracted the following season. In inaccessible locations, monosodium methane arsenate (MSMA), at 80 g/L, is injected into standing live spruce in mid-May and these lethal trap trees are felled two weeks later.

Factors used to derive spruce beetle hazard in BC are:

- biogeoclimatic zone;
- site quality;
- percent spruce;
- stand age; and,
- spruce dbh.

Stand risk rating is the probability that a stand will be attacked or re-attacked based on the proximity and incidence of a spruce beetle infestation. Any susceptible stand within 2 km of an infestation is considered at high risk of being attacked.

The current era of forest management is considerably more complex with numerous competing demands on the landscape. Some of these demands can conflict with removal of post harvesting debris and potential beetle habitat. For example, creation of 3 metre high wildlife trees for bird perching and cavity nesting after clearcut logging is now becoming popular. The following article appeared in the BC Trapper's magazine (Spring 1997) entitled: *"Bug Kill is Beautiful, Mistletoe is Marvellous, but Blowdown is Best"*. The author stated: "*. . . nothing compares to blowdown when it comes to year round furbearer habitat.*"

The challenge is trying to reconcile such demands and still achieve an acceptable level of beetle control. One industry forester stated in 1980, and his comments are still valid today: *"The ability to be flexible and react quickly is essential for an effective beetle management program. A more rapidly responsive procedure for issuing cutting authority is required, and a reduction in the number of people involved in approvals would expedite this."* The Ministry of Forests in BC is now revising the *Forest Practices Code Act* indeed to simplify and expedite cutting authority.

As a "parting shot," I offer a quote from Schmid and Frye (1977): *"We have enough knowledge of the beetle and suppression techniques to prevent large infestations if we desire. Basic to the development of a control strategy is a need to know the objectives for the particular stand(s). If the objectives are known, then we can begin to integrate beetle management into forest management."*

III. Spruce Bark Beetle Management in the US with Emphasis on Alaska (E. Holsten, USDA Forest Service/FHP, Anchorage).

Spruce beetle, *Dendroctonus rufipennis*, infestations are increasing in the Intermountain Region of the United States and have been in outbreak condition in Alaska's boreal forests for more than a decade. More than one million acres of active infestations are now occurring in Alaska. Past management of spruce beetle was limited to salvage/sanitation operations aimed at capturing resource (timber) value with little effort(s) at managing spruce beetle populations or minimizing impacts to non-timber resources such as scenic quality, wildlife habitat, watershed hydrologic changes, regeneration, etc.

With the agency and public "acceptance" of ecosystem management, more concern is being given to the management of high risk spruce stands. However, delays brought about by NEPA, lack of understanding of the impacts to non-timber resources, and the significant reduction in western forest insect and silvicultural research (staffing & funding) do not provide an optimistic "picture" for future management of spruce forests.

IV. Mountain pine beetle management in stands in the U. S. Northern Region (K. Gibson, USDA Forest Service, Missoula)

The Mountain pine beetle, *Dendroctonus ponderosae* Hopkins (MPB), is by far the most destructive insect pest of pine species in western North America. Although most pine species within its range will serve as host, lodgepole pine is the preferred - and most devastated - host species. Populations of the beetle have existed in an " outbreak" condition in much of the lodgepole pine type from northern Utah to British Columbia for most of the past 30 years. As a result, MPB has had a significant effect upon management philosophy, decisions, and activities throughout that period of time.

In the Northern Region, MPB epidemics have been reported with some regularity since early in the 20th century. The current series of outbreaks began concurrently in large expanses of unmanaged lodgepole pine in western Montana. In the mid-1960's, an infestation developed in Yellowstone National Park (NP). Within a few years, major outbreaks developed on the Gallatin and Beaverhead National Forests (NF) to the north and west. In the early 1970's, MPB epidemics were first observed within Glacier NP. Within a few years, additional outbreaks were noted on the Flathead, Kootenai and Lolo NFs and adjacent lands of other ownerships.

By 1978, major MPB outbreaks existed on the Beaverhead, Gallatin, Flathead, Lewis and Clark, Lolo, and Kootenai NFs, in Yellowstone and Glacier NPs, on several Indian Reservations in Montana, and on much intermingled State and private land. In total, nearly 820,000 acres were infested. Extensive ground surveys in 1979 showed an estimated 33.4 million trees had been killed, to that date, on slightly less than 986, 000 acres. Total infested area continued to increase until 1981. At the peak outbreak level, almost 2.5 million acres were infested.

Beginning in 1981, there was a gradual, but steady decline in area infested. By 1991, an estimated 163,300 acres contained trees killed by MPB during 1990. Declining to a low of 22,000 acres in

1994; modest increases in some areas resulted in the total infested area in 1996 being just over 53,000 acres.

A combination of aerial survey and ground collected data suggest more than 3 million acres, in the Northern Region, have been infested during the past 30 years. A conservative estimate indicates an average 80 trees per acre have been killed. Of those (nearly a quarter-billion trees) in excess of 90% were lodgepole pine.

Until approximately the mid-1970's, pest managers somewhat naively believed that MPB-killed trees were a manifestation of a pest problem - and that the solution to the problem was simply one of removing the pest. Attempts at that solution were many and varied - ranging from cutting, piling and burning of infested trees to wide scale applications of pesticides. Virtually all were unsuccessful.

Finally, during the mid-1960's to latter 1970's, we realized that the problem was not a plethora of beetles, but a preponderance of susceptible host type. We noted that lodgepole pine stands in which beetle-caused mortality was the greatest shared similar characteristics. Nearly all were older, densely stocked with large diameter trees and growing at a combination of elevation and latitude conductive to optimal beetle development. Further, the most devastated stands were those growing on the best sites—having grown sufficiently well to develop thick phloem, prior to their slowing in growth and becoming susceptible to beetle attack. Recognizing these commonalities was a significant step towards the development of more feasible means of reducing tree losses to MPB.

One of the first major accomplishments was the advent of a "hazard-rating" system for unmanaged lodgepole pine stands. Developed by Gene Amman, and others, in 1977; it was used until very recently. That system enabled us to identify those stands most likely to support MPB outbreaks as:

- stands in which the average diameter is greater than 8 inches;
- age exceeds 80 years; and,
- which are growing at lower elevations and more southerly latitudes.

Unfortunately, that recognition also led to the realization that - as a result of effective fire control over the past several decades and the "unmanaged' condition of most lodgepole pine stands - there were literally tens of millions of acres of susceptible stands in the western United States and Canada. We knew that lodgepole pine mortality caused by MPB would be significant - and that because the beetles would move through stands more rapidly than we could - even our best efforts wouldn't do much to " stem the tide."

Still, the knowledge of which stands were exposed to the greatest risk enabled us to concentrate in the areas of highest priority. Our first "silvicultural recommendations" were identification and removal of high hazard stands. Removing a stand prior to it being infested, accomplished at least two worthwhile objectives: 1) realizing better return on investment by selling timber at a "green" rate rather than a "dead" one; and 2) more importantly, reducing the food supply of the beetle.

The latter would have been more effective had we moved more rapidly than we did; but undoubtedly there was a net benefit in some local areas.

Though our ability to remove high-hazard stands was limited, the combination of stands regenerated and those killed by MPB - which were salvaged as often as could be practicably done - resulted in overcutting in some areas. In a number of seriously affected drainages, other resource values were being threatened. That provided the impetus of exploring other silvicultural opportunities.

Some of the first researched were "diameter-limit" cuts, in which the largest trees in the stand were removed. Those treatments often left stands of questionable quality and were subsequently replaced by "basal area reduction" cuts. Impressive results were obtained by initial treatments. In several replicated studies, uncut "control" stands experienced beetle-caused mortality exceeding 90% of the trees over 5 inches in diameter. Nearby treated stands, subjected to similar MPB pressure, showed average mortality rates of 38% for the 120 BA cuts, and less than 10% for the 100 and 80 BA thinnings. These studies provided a broader range of alternatives for MPB-threatened lodgepole pine stands. They ultimately led to the development of guidelines for selecting stands in which such treatments might be successful. These guidelines have become an important part of our recommendations to the land manager for lodgepole pine stands threatened by MPB.

Beginning in 1984, the availability of semiochemicals for MPB provided a tool which made silvicultural treatments even more effective. Aggregative pheromones have the ability to effectively concentrate beetles into stands scheduled for removal. Antiaggregative ones, while still being evaluated, may eventually provide the means of protecting high-value stands.

To date, management recommendations for MPB address stand conditions rather than beetle depredations, *per se*. We still recommend hazard rating of host stands - now using a much-improved system developed by Shore and Safranyik. In that way, management activities may be directed, in a preventive strategy, towards stands of greatest susceptibility. Stands judged to be high hazard are further subjected to analysis using the "rate of loss" model which fairly accurately predicts the amount of mortality expected in a period.

It has been extremely useful directing silvicultural treatments to those stands in which losses are expected to be greatest. Once stand hazard and anticipated loss (risk) has been established, we recommend analyzing the best alternative for that stand(s) in the larger context of associated drainage, landscape or ecosystem. Ultimately, the best mix of treatments will be those that create a mosaic of age and size classes and species best suited to the site. The final objective is to create, or maintain, a healthy forest ecosystem - not entirely devoid of pests - but one in which pest-caused mortality is balanced in such a way that no derived amenities of the system are threatened.

Because we believe the state of our knowledge regarding the management of lodgepole pine stands to reduce losses to MPB is, if not perfected, sufficient to prevent large-scale mortality; we envision only minor modifications in our methods in the future. Perhaps the refinement of hazard rating systems to better define stand susceptibility; and development of more accurate computer models to describe stand risk (potential beetle-caused mortality) will enable us to more adequately prioritize stands for preventive treatments. Though there may be times when truly "suppressive" activities are warranted, the greatest long term benefit will almost always be realized through the prevention of MPB outbreaks by silviculturally altering stand susceptibility.

Though MPB populations in the Northern Region are currently much less than in the recent past, we have hundreds of thousands of acres of lodgepole pine which will grow into size and age classes susceptible to MPB within the next couple of decades. We continue to emphasize the need for hazard and risk rating, and stand alteration prior to MPB outbreaks, in order to significantly reduce beetle-caused mortality. Further, we hope that lessons of the past - as we become more adept at "ecosystem management" - will make future treatments even more timely, efficient and effective.

WORKSHOPS

Stand Management Impacts on Insects

Moderator: Bruce Hostetler, USDA Forest Service

Participants: Over 50 attendees participated in discussions related to the effects of stand management on insects. The following informal presentations will provide some examples and some food for thought and discussion when considering the effects of management on insects.

Introduction: When considering the topic of *stand management impacts on insects*, most forest entomologists would immediately translate that to mean, "how does management affect insects that feed on or in trees?" In this workshop we will talk mostly about insects that feed on trees. However, increasing numbers of entomologists are approaching this question from a broader perspective, looking at effects of silvicultural management on "non-pest" arthropod species and on arthropod species biodiversity. An example of how horizons are being broadened can be illustrated by the requirements laid out in the Northwest Forest Plan which covers a large portion of federally managed forest land in the Pacific Northwest area of the United States. This document resulted from northern spotted owl and old growth issues, and lays out some guidelines which are to be followed in much of the forested areas of western Oregon, Washington and northern California. This document contains a list of "survey and manage" species, defined as those species to be protected through survey and management standards and guidelines which fall into four categories:

1. Manage known sites;
2. Survey prior to activities and manage sites;
3. Conduct extensive surveys and manage sites; and,
4. Conduct general regional surveys.

The "survey and manage" organisms were listed by species for all taxa except the arthropods. This group was classified by guilds, with the following four being included in category four (conduct general regional surveys) of the standards and guidelines:

1. Canopy herbivores;
2. Coarse wood chewers;
3. Litter and soil dwellers; and,
4. Understory and forest gap herbivores.

Thus, federal land managers are required to conduct general regional surveys of these guilds and are at this time struggling with how this should and will be done.

We are embarking on an era during which untested methods of silvicultural manipulation (e.g., creation of coarse woody debris by falling and leaving the largest Douglas-firs in second growth coastal forest stands) will be tried in an attempt to satisfy the many different resource objectives. The onus is upon all of us, then, to insure that monitoring is in fact done, and that management adapts to the findings of the monitoring.

Ladd Livingston, Idaho Department of Lands, discussed issues from his area. The red turpentine beetle generally causes little or no damage. However, it is very common attacking cut stumps and fire-scorched ponderosa pine. It also attacks the lower bole of standing green ponderosa, but it does not seem to cause any significant damage in these trees. Large trees verified to have been killed by the red turpentine beetle have not been seen; it has been noted to attack and kill scotch pine Christmas trees and small pine trees in plantations. In these instances, the beetles attacked right at the ground line and tunnelled into the roots, apparently girdling the trees. Even this has not been a common occurrence, and may be associated with stressed trees.

Recently, there has been considerable work with western white pine to develop genetic resistance to blister rust. Resistant trees are being planted, reintroducing the species back into its natural range. Even with the genetic resistance, there is still concern for the survival of these trees. Pruning the lowest branches of young trees has been demonstrated by the US Forest Service to be a viable tool for reducing blister rust caused mortality. However, in recent studies, the red turpentine beetle has been found to be attracted to the pruned white pine, attacking and killing a number of them.

The attacks were at the ground line, penetrating into the roots. Attacks of pruned trees ranged up to 41%. Attacks were higher in trees larger than 1.5 inches dbh and in trees severely pruned (having only one whorl of branches left). Mortality of attacked trees ranged from 0 up to 26%. Attacks and mortality dropped to near zero levels two years after the pruning, presumably due to depletion of the resin odours from the cut surfaces. Additional surveys of newly pruned plantations are planned for 1997.

Ken White, British Columbia Ministry of Forests, discussed increased levels of intensive management of lodgepole pine stands in the province. Most pine stands are spaced and pruned at age 15-20, and then not examined again for many years, often until rotation. Five examples from BC where intensive management has caused, or exacerbated, insect problems were discussed.

The first case involves a spaced and pruned stand being attacked by the red turpentine beetle. Attack ranged from 9-22% in 6 surveyed stands. No mortality has been noted to date, but there is a possibility that the entrance wounds and subsequent boring could become infection courts for fungal diseases. The second incident occurred when *Hylurgops rugipennis* killed 17% of the lodgepole pine in a spaced and pruned stand. *Pityophthorus* sp. were the agent of mortality in the third case. This stand had been spaced and pruned over two winters. It is believed that the beetles were able to build up large populations in the slash produced, and then mass attack and kill up to 10% of the trees.

The fourth case involves Northern pitch twig moth. Incidence of this insect increased from approximately 4% to 41% following spacing. The final incident involved Warren's root collar weevil incidence increasing dramatically after spacing. Attack incidence of up to 80% has been noted.

The following reasons are suggested to explain why spaced and pruned stands may be more susceptible to insect attack:

- increased release of volatiles from both pruning scars and stumps attracts the insects into the stand;
- pruning greatly increases the stress on trees, especially if they are severely pruned
- (less than 50% live crown);
- the increase in temperature at the tree bole likely increases the stress on trees;
- increased slash and recently killed stumps provide ideal breeding sites for some beetles; and,
- in the case of root collar weevils and pitch twig moth, the existing insect populations concentrate on the trees remaining after spacing.

Spacing and pruning are expensive activities, and if they are increasing pest problems, this must be considered. Insect problems may occur in combination with diseases (root rots, rusts, foliar diseases, etc.), which could further increase losses in the stand. Most stands are spaced to target stocking standards, and trees killed after spacing will leave voids which will likely remain unproductive until rotation. More surveys are required to clearly define what effect spacing and pruning are having on insect pest populations in lodgepole pine stands in British Columbia.

Dan Miller, D.R. Miller Consulting Services, is attempting to develop a funnel-trap based protocol to evaluate the effect of stand management tactics on a broad range of arboreal beetles, particularly wood- and bark-boring guilds, under the current view that forest health and insect biodiversity are largely synonymous. Results of trials conducted in areas underburned to control ingrowth of Douglas-fir and silviculture trials in southern British Columbia demonstrate that approximately 40 families of beetles can be evaluated in this manner. At least five of these families are species rich and closely linked to the degrade and decomposition of trees and woody material.

Bruce Hostetler, USDA Forest Service, discussed western spruce budworm in Region 6. In 1986, permanent plots were established in 33 stands in northeastern Oregon to monitor effects of a western spruce budworm outbreak. Included in these 33 stands were seven pairs of thinned vs. unthinned stands. Annual measurements of defoliation, topkill, and mortality were collected, with the primary objective being to develop topkill equations for the budworm damage model which links to the Forest Vegetation Simulator (formerly known as PROGNOSIS). Results are not yet available, but topkill and mortality data have been summarized which should give some food for thought (and will probably generate more questions than it answers).

Mortality: The statistics have not been run, but it appears that, overall, there is no significant difference in mortality of trees per acre between thinned and unthinned stands. Mortality ranged from about 2% to 60% of host trees per acre, with thinned stands showing the same or less mortality than unthinned stands in all pairs but one. In that pair, Douglas-fir beetle killed more trees in the thinned stand than in the unthinned, which accounted for the greater mortality in the thinned stand. Thus, the jury is still out regarding the influence of thinning on subsequent mortality resulting from western spruce budworm defoliation.

Topkill: In unthinned plots, it appears that the percentage of trees with some topkill is greater than in thinned plots. This, of course, is in the trees that were still living in 1995. Many of the trees with significant topkill in earlier years died before the 1995 samples and, thus, are included in the mortality chart. Most of the significant topkill (i.e., greater than 20%) occurred in the smaller trees (intermediate and suppressed). The largest trees in the stands, in general, had little or no topkill. Further analysis of the data will occur after final measurements, which will include radial growth estimated from increment cores collected from a subsample of trees in each stand. This will provide information regarding topkill and defoliation in relation to radial growth. Reduction of radial growth will have an effect on wood volume, but may have little effect on many of the other resources of concern.

Fire and Insect Interactions

Moderator: Eric Smith, USDA Forest Service

David Ganz, UC Berkeley, reported on his dissertation research: "Measuring Fire Intensities from Prescribed Fires and the Extent of the Tree Mortality from the Bark Beetles in Sierra Nevada Mixed Conifer Ecosystems." Fire suppression policies have produced species composition changes in the Sierra Nevada, particularly an ingrowth of shade and fire intolerant species such as fir. Prescribed fire is seen as the management tool to help remediate the forest health problems caused by these unnatural stand conditions. The concern is that besides the mortality caused by prescribed fires, additional tree mortality may be induced by bark beetles. The study will pay special attention to the fire effects on trees, which may predispose them to beetle attack, and the effect on natural enemies of the beetles.

Les Safranyik, Forestry Canada, reported on prescribed burning studies to reduce brood survival of mountain pine beetle in Tweedsmuir Provincial Park, British Columbia. Attacks were about one half of the control, and brood survival was reduced 48%. These results were judged to be not good enough to be practical to reduce tree mortality.

Lynn Rasmussen, USDA Forest Service, discussed the survey results from burned areas in the Greater Yellowstone Area's 1988 fires. Delayed mortality from fire injuries was larger than from insects, with Douglas-fir and lodgepole pine having the highest proportion of insect caused mortality. Both causes of mortality greatly increased the total tree mortality apparent immediately after the fire. The insect mortality was positively correlated with the proportion of the tree's basal circumference killed by fire.

Sherry Smith, UDSA Forest Service, discussed controlled burning in California. As is common throughout much of the American West, fire suppression in California has created dense stands with high fuel loads and high pest hazard. Bark beetle mortality has added to the fuel loads. Forest Service management guidelines in the Sierra Nevada forests emphasise retaining large trees where they exist, and reducing densities from below through burning or thinning. Strict air quality standards are making it difficult to meet burn prescriptions and air quality regulation simultaneously.

Pat Shea, USDA Forest Service, discussed Black's Mountain Experimental Forest plots. Black's Mountain is the site of long term experimental treatments testing stand management prescriptions' effects on pine beetle mortality. After 50 years of observations, this experiment has been concluded and new plots have been installed. New treatments will test the effects of grazing, prescribed fire, and tree removal alternatives on a wide range of flora and fauna. Pat will continue to be involved in this study.

Eric Smith, USDA Forest Service, described the current work being done to develop a Fire Model for the Forest Vegetation Simulator (FVS) and its linkage to the Westwide Pine Beetle Model (WWPB). The Fire Extension is being developed by the USDA Forest Service Rocky Mountain Research Station, primarily through the Missoula Fire Sciences Laboratory. The Fire Model provides four major analyses: 1) Fuel loadings, 2) Fire intensity, 3) Fire effects, and 4) Smoke production. The fuel analysis calculates fuel loadings and standard fuel model class based on current stand conditions and fuel conditions for the current time. It dynamically models these conditions into the future, based on decay rates, inputs from live trees (such as needles, twigs, and branches) and mortality, and fuel treatments. Snags are modelled separately. The model calculates fire intensity, given burning conditions, based on existing models. The fire intensity information is used to calculate fire effects, including tree mortality, crown scorch, fuel consumption, and mineral soil exposure. The smoke production module uses information about the burning conditions and the fuel consumption. The multi-stand version of the model is based on the Westwide Pine Beetle Model's multi-stand structure. The Fire Model is designed to share information with the WWPB Model.

Bill Schaupp, USDA Forest Service, gave a presentation of the Forest Service's fire hazard analysis for the Colorado Front Range. The analysis was designed to locate areas with the highest potential for catastrophic wildfire damage. A geographic information system was used to rate areas, based on several criteria, including presence of residences, natural fire frequency, and years since last fire. The areas with the highest ratings have been designated the "Red Zone", and the maps and concept is being used for planning and public education. The Front Range is prone to periodic mountain pine beetle attacks, and many of the areas in the Red Zone are in pine types. Beetle outbreaks will, of course, add to the fuel load if the tree mortality is not removed. Conversely, stand management through prescribed burns or other treatments can not only reduce fire hazards but also reduce stand susceptibility to beetle attacks. The analysis area is being rapidly being developed, with many expensive year around residences being built. The challenge for managers is to educate these new residents of natural processes of fire and bark beetles which effect the forests in which they live, and to develop management strategies which are both biologically and socially acceptable.

Mixed Wood/Hard Wood Entomology

Moderator: Jan Volney, Canadian Forestry Service

The panel was chosen to represent work being conducted in several contrasting locations where insects in broad-leafed-tree stands were investigated. The studies described varied in complexity from single species feeding on a single host to those feeding on several hosts and dead plant material. Geographically, the studies covered the range from northwest Europe to the Boreal forests of Canada and south to the water tupelo system of the South in North America. Aspects of principles on herbivory were described and illustrated by several speakers. An open discussion was held at the end of the session that ran well beyond the allotted time.

The first speaker was Dr. Helena Byland, formerly of the Swedish University of Agricultural Sciences, Uppsala and now at the University of Alberta, Edmonton. She described the interaction of the autumnal moth, *Epirrita autumnata* (Bkh.), with the large unmanaged tracts of mountain birch (*Betula pubescens* ssp *tortuosa*) in Sweden where outbreaks recur every ten years. It was suggested that many mechanisms influence the population cycles. Whereas delayed density dependence may be responsible for maintaining the cycles, this feedback was not responsible for regulating the populations. Depletion of food reserves, the reduction of food quality and possibly parasitism could be responsible for population regulation while low winter temperatures served to synchronize outbreaks over large areas.

Dr. Richard A. Goyer of Louisiana State University discussed his work on the insect herbivores of the Louisiana's wetland forests. These forests are populated mainly by bald cypress (*Taxodium distichum* L.) and water tupelo (*Nyssa aquatica* L.). Where these forests are inundated continually the woody plant species richness is poor, there is virtually no understory and the natural enemy fauna of the dominant defoliator populations is depauperate. As a consequence there are virtually continuous epidemics of the dominant defoliators of the system which are the forest tent caterpillar (*Malacosoma disstria* Hbn.) on water tupelo and the fruit tree leaf roller (*Archips argyrospila* (Wlkr.)) on bald cypress. The crash and recovery observed in this system seems to be regulated by the ability of the host trees to produce foliage following an episode of defoliation. By contrast the areas that are seasonally flooded have a higher woody plant diversity and more complex natural enemy community and consequently herbivore population survival is lower. The long-term stability of this system may be threatened by the mortality of trees in the chronically defoliated stands and the lack of adequate recruitment to the water tupelo and bald cypress populations.

Dr. William J. Mattson of the USDA Forest Service, East Lansing, Michigan described the effects of insects feeding on leaves and their impacts on bud demography. It has been observed that folivore feeding can activate dormant buds. The timing of this feeding can have either a positive or negative effect on the initiation of these buds. Thus early feeders may damage buds and activate axillary meristems producing a profusion of buds in subsequent years. This, of course, can serve to augment the folivore population's chances of survival. A contrast was made between the spruce budworm (*Choristoneura fumiferana* (Clem.)) which feeds early in the spring and birch leaf miners that attack developing leaves. Whereas the budworm emerges and feeds before bud break, it is able to enhance the bud population in subsequent years by killing the current year's buds and thus activating latent buds which develop in the following year. The leaf miner is unable to feed until well after budbreak and thus has little influence on bud dynamics.

Dr. John R. Spence of the University of Alberta and his students, Andrea Durand, Rob Lucas and Jim Hammond described their studies in mixed wood forest stands. Experimental work on the population dynamics of the forest tent caterpillar with Dylan Parry, now at Michigan State, suggested that bird predation may be singularly responsible for maintaining populations at endemic levels. Bud ablation and defoliation work with Durrand suggests that the caterpillars may be able to influence the degree of refoliation following defoliation. Indeed, the insect may be altering the architecture of trees by this process. By integrating the results of these studies it is hoped that the mechanism responsible for releasing tent caterpillar populations can be discovered. Work with Lucas seeks to investigate the biophysical limitations to aspen growth which is being investigated in a controlled experience study to evaluate the effects of defoliation history, soil conditions, stand age and stand conditions on the net primary productivity of young aspen stands. Work with Hammond on the saproxylic insects of mixed wood stands demonstrated the importance of forest disturbance in determining the species richness and diversity of this component of the ecosystem. Taken in combination, the studies aim at developing a foundation on which management issues such as sustainability of forestry practices can be evaluated.

Urban Forest Pest Management

Workshop moderator: Don Dahlsten, University of California at Berkeley

There were 10 participants in this workshop

Timothy Paine, University of California Riverside, discussed a number of critical issues that characterise pest management in the urban forest. The community structure of the urban forest and the ecological function of that environment are particularly important. The plant community is often an artificial assemblage of native and non-native species collected from many parts of the world with a great species diversity that rivals any natural ecosystem. The habitat structure is also artificial in density of species, their spatial distributions, and the structural diversity. In addition, structures, roads, and physical contours of the land associated with urbanisation impose barriers, regularity, and physical diversity on the community structure. The invertebrate populations may also be "unnatural assemblages," and may reflect the consequences of both accidental and intentional introductions of species.

Integrated pest management programs must reflect the ecological communities and the ways in which those communities functions. However, these programs must also account for the differences between biological damage, economic damage, aesthetic damage, and "public perception" of insect activity. Resolving the conflicts between these different types of insect damage requires both learning from and educating the general public. Several examples of IPM programs with different solutions to the problems were discussed in this context. Issues relating to defining and organising potential clientele for the purposes of generating support for research efforts were also discussed.

Elwood R. Hart, Department of Entomology, Iowa State University, presented information on mimosa webworm management in central Iowa: a history of an ecosystem approach. Following the decline of the American elm as an urban tree in the midwestern states, ornamental honeylocust selections have been one of the more widely-planted replacements. By the mid 1970's, the mimosa webworm had become a very devastating defoliator on these selections. An ecosystem approach was adopted as a means of understanding the problem and working toward a solution over a 15-year period. This included: 1. biological studies to determine the phenology and behaviour of the insect; 2. overwintering studies to determine the effects of temperature regimes and tree placement on overwintering survival; 3. cultivar studies to determine any evidence for resistance; 4. biological control studies to determine the impact of and potential for management by natural enemies; 5. *B.t.* efficacy studies. Collectively, these studies defined the key factors in the environment sufficiently, so that recommendations on planting site, monitoring, and conservation of natural enemies have reduced notably the potential for outbreak in central Iowa.

Andrew Lawson, University of California Berkeley, reported on the implementation of integrated pest management for the elm leaf beetle in a large urban area (Sacramento). The University of California Berkeley in co-operation with the City of Sacramento Department of Neighborhood Services and the Sacramento Tree Foundation has undertaken an integrated pest management program to control the elm leaf beetle. The program seeks to base control decisions on the life cycle development and population density of the insect as well as seek alternatives to chemical treatments.

Eleven areas of the city with at least ten English elms each were left untreated in the summer of 1996 and were used as experimental blocks. Each area was sampled for ELB eggs at the egg peak of each generation. Of the 11 areas, only one site had egg populations that warranted treatment in the first and second generations. The treatment trees were sprayed with *Bt* (M-Track) combined with Sunspray ultra fine oil at the peak of the first instar and sprayed again one week later. Larva counts on sprayed trees dropped significantly after the sprays and damage at the end of season was below 40% defoliation. Over 20,000 *Oomyzus gallerucae* Granada strain were released over the summer at the City Cemetery and nearby South Side Park. The parasite became established in the field by the third generation.

Plans for 1997 include expansion of the untreated areas of the city. These blocks will then be sampled at egg peaks and trees with high egg counts will be injected with Merit. Some blocks will be treated with *Bt* and oil. Egg parasites will be evaluated and releases made as necessary.

Group discussion:

The issue of funding research for urban forest pest management was discussed. Tim Paine and Woody Hart felt that funding was often difficult and required public education to gain support. Don Dahlsten has had the experience of increased availability of funding in urban environments. The difficulties associated with working in the urban environment caused by political pressures were stressed.

Graduate Student Reports

Moderator: Darrell Ross, Oregon State University, Corvallis, OR

Participants: Approximately 25 attendees listened to four graduate students describe their thesis or dissertation research projects. Each presentation was followed by discussion among the audience and presenter.

David Ganz, a graduate student in the College of Natural Resources at the University of California Berkeley, described a project that he has just started to measure the effects of different fire intensities from prescribed fires on tree vigour and susceptibility to bark beetle attack at three study sites in the Northern Sierra Nevada of California. Measurements of the change in cambium and soil temperatures will be used to calculate the extent of burn damage on mixed conifer species from the fire treatments while stand and fuel parameters will be measured before and after the treatments to characterise fire intensity. Bark beetles and their natural enemies will be monitored for their response to host odours following the fire treatment and for three years after the burn. The proposed research will evaluate the claims that some prescribed fires may perpetuate insect problems in the mixed conifer system of the Sierra Nevada. The goal is to provide forest managers in this region with an idea of the severity of tree mortality associated with prescribed fires burned under a variety of environmental and fuel conditions.

Trevor Hindmarch, a graduate student in the Department of Biological Sciences at the University of Calgary, described a study in which marked pine engraver bark beetles were released at the centre of commercially thinned (ca. 600 trees/ha) and unthinned lodgepole pine stands (ca. 1800 and 2100 trees/ha) and captured at 50 m intervals up to 200 m away in commercially baited pheromone traps. Fat reserves of both sexes did not significantly change due to dispersal in the thinned stand. Fat reserves of females were significantly higher after dispersing in the thinned stand than in the unthinned stands. This difference in "fitness" may affect their reproductive strategies, and, in turn, population sizes of pine engravers.

Andrew Lawson, a graduate student at the University of California Berkeley, presented a talk entitled, IPM in the Urban Forest: Obstacles for Sampling and Implementation, with co-authors Donald L. Dahlsten, David L. Rowney, William A. Copper, Anne Fenkner and Martin Fitch. In 1996, the University of California Berkeley in co-operation with the City of Sacramento Department of Neighborhood Services and the Sacramento Tree Foundation undertook an integrated pest management program to control elm leaf beetle in Sacramento, CA. The program seeks to base control decisions on the life cycle development and population density of the insect as well as seek alternatives to chemical treatments. Specifically we wished to evaluate the efficacy of *Bacillus thuringiensis* San Diego variety (M-Track) and to establish an egg parasitoid of the beetle (*Oomyzus gallerucae*). One of the largest obstacles for sampling has been the numbers and scale of the elms in Sacramento. Sampling methods have been established based on small groups of trees, but these methods must be extended to include over 4,000 elms over a very large area. Obstacles for implementation of the IPM program have been largely political. The goals of the agencies involved in this program are different. One of the goals of the city's treatment program is to reduce the number of complaint calls by citizens. The goal of the university group is a reduction in pesticides used in the urban environment. Public perception of the pest is also a problem which we are trying to overcome through education. Many people believe the beetle must be treated for as soon as they see even the slightest signs of beetle activity.

Chris Buddle, a graduate student in the Department of Biological Sciences at the University of Alberta, described a study that he is conducting to look at spider diversity and abundance in aspen-mixedwood stands originating from harvesting and wildfire. Litter dwelling spiders (Araneae) were collected by pitfall traps in aspen-mixedwood stands in north-central Alberta. The forest stands differed in their origin (harvest or wildfire) and age (1 year, 15 years, and 30 years following disturbance). The objective of this research is to compare spider assemblages between wildfire and harvest-origin stands. 2410 spiders from 11 families and 79 species were identified from the 1996 pitfall trap samples. One year harvest stands had the highest abundance of spiders. Open habitat specialists from the family *Lycosidae* were common in recently disturbed sites; small micro-web spiders from the family *Linyphiidae* were dominant in older stands. Preliminary analyses suggest that the spider fauna converges after 30 years of forest growth following disturbance by wildfire and harvest. The 1997 field season will involve collecting aerial web-building spiders as well as continuing the pitfall collections of litter-dwelling spiders.

Insects on the Web

Moderator: John McLean, University of British Columbia, Vancouver, BC

Presenters: Doug Corrin, Paul Bell, John McLean, Dezene Huber

19 workshop attendees (live link to the web and videoprojector were organised by Bob Hodgkinson and Staffan Lindgren)

The World Wide Web (WWW) has provided a very useful medium over the last two years for multimedia communications in many interesting areas including forest entomology. In a plenary session address to the Second North American Forest Insect Work Conference in San Antonio in April 1996, I issued a challenge to all forest entomologists to consider creating a web site after they had finished writing up their papers and before they lost the figures and the slides that they could scan and use to communicate their story to interested persons. We are seeing new coherent sites that give full reviews of targeted insects.

Before launching into the internet proper, we had a presentation by Doug Corrin of Malaspina University College, of his CD-ROM based Tree Doctor v2.0. In this detailed and fully illustrated product that currently emphasises forest fungi and diseases, students are able to use biogeoclimatic zone and host tree specific data that aids them in identifying causative agents. Modules are currently being added that will include the major forest insect pests in BC There are many interesting diagnosis modules also included in Tree Doctor. Any one who is interested in further details or who is interested in obtaining a copy can contract Doug at the following email address:

corrin@faculty.mala.bc.ca

Paul Bell, from Sir Sandford Fleming College presented his experiences in not only supplementing his Forest Entomology course with internet materials but also the development of his course to the point where it can be taken completely via the internet.

BUGNET hatched on the World Wide Web early in 1994. It was nothing more than a list of hyperlinks to electronic journals, entomological job banks, and speciality web-sites, such as the Gypsy Moth pages in North Carolina. Currently the courses Forest Entomology, Forest Pathology as well as Bio-Art: The Art of Nature, are the "fully accredited courses" that Paul offers through Sir Sandford Fleming College, the School of Natural Resources web server. All of these courses are complete with illustrated lecture notes, all assignments and evaluations. Every project can be completed via email, in a totally paperless manner. You can even register on-line. For more details, visit BUGNET at the following address:

http://gaia.flemingc.on.ca/~pbell/welcome.htm

John McLean, from the Faculty of Forestry at the University of British Columbia described his web site FETCH21 (Forest Entomology Textbook CHallenge for the 21st Century). The site was created to serve as a supplement to the regular forest entomology courses at the University of British Columbia. The initial links were to the BC Ministry of Forests Forest Practices Code booklets that are available through the Ministry of Forests internet project in Victoria (**http://www.for.gov.bc.ca**), along with 600mb of other Forest Practices Code materials. FETCH21 has a main menu based mainly on feeding guilds as is the laboratory course in the third year course. In addition there is a page of General Site Addresses that guide students to interesting URLs around the world. FETCH21 can be found at the following address:

http://www.forestry.ubc.ca/fetch21/fetch21/FETCH21.html

How useful are web sites like BUGNET and FETCH21? Dezene Huber, a graduate student from Simon Fraser University, gave the following presentation entitled: *Researching Insects on the Web: A Graduate Student's Perspective*.

As a teaching tool, the world wide web has a great deal of potential. It is able to offer a wide range of viewpoints from a variety of sources on a given topic. Other advantages include the ability of a user of the web to access quickly and directly certain documents which would normally take a great deal longer to obtain through standard means and the fact that web pages can be easily kept current in terms of the information which they carry. The two web pages which I reviewed (FETCH21 by John McLean and BUGNET by Paul Bell) are good examples of well designed web-based teaching tools. As a research tool for graduate students, however, the web still has a long way to go. Three of the main difficulties of the web in this regard are:

1. there is no really efficient way to search for precise information on the web,
2. much of the information contained on web pages is unreferenced; and,
3. a lack of refereed journals specific to entomology.

It is possible, and likely, that over time the web will become a much better research tool, but as it stands at present, the web is not as optimal as it could be in this regard.

It is apparent that web sites can be created to stimulate interest by the public and by students. As a research tool it has yet to prove its worth although there are now some 400 electronic journals available. The catch is that to read the articles, dollars are usually requested.

One area in which the web is really proving useful is in extension. Many of the land grant universities in North America have found the web to be a very effective way to reach their clientele. The point and click generation is, however, quite discerning and needs to be able to reach high quality pages that don't need forever to load through their phone line modems on to the home computer.

Research Directions and Efforts

Moderator: Terry Shore, Canadian Forest Service, Victoria, BC

Presenters: Bob Bridges (USDA Forest Service); Mike Wagner (University of Northern Arizona); Ian Wilson (Phero Tech Inc.); and Terry Shore (Canadian Forestry Service).

Participants: Approximately 40 people attended.

The Canadian Forest Service (CFS) has gone through a re-organisation in the past two years. This has resulted in a reduction from eight to five research centres located in Fredericton, New Brunswick, Ste. Foy, Quebec, Sault Ste. Marie, Ontario, Edmonton, Alberta, and Victoria, British Columbia. There are approximately 40 research entomologists in the organisation.

Research has been focused on 10 subject areas or networks: Biodiversity, Biotechnology, Climate Change, Forest Health Monitoring, Ecosystem Processes, Landscape Management, Fire Management, Forest Practices, Pest Management Methods, and Socio-economic Research. One of the centres assumes lead responsibility for each of the networks, although the scientists remain distributed regionally. The entomologists can participate in more than one network to a maximum of 3, but are officially assigned to the one where most of their work lies.

Entomologists are currently working in all networks except Fire, Forest Health Monitoring and Socio-economic Research. General trends in the CFS are in downsizing permanent research staff and internal budgets, increasing emphasis on partnerships and international responsibilities, decreasing emphasis on operational activities (e.g. surveys), and increasing emphasis on the subject areas of biodiversity, climate change, criteria and indicators of sustainable forest management, and the Canadian database infrastructure.

In the USDA Forest Service, funding for research, when adjusted for inflation, has declined in the last several years. Declining budgets and reduced buying power of appropriated funds have resulted in the loss of permanent full time scientists with Forest Service Research from about 713 scientists in 1987 to about 548 by the end of 1996. Reductions in funding in fiscal year 1996 resulted in termination of about 25 Research Work Units and the closure of about 8 laboratories.

The Forest Service re-directed funds in fiscal year 1997 to enhance research on insect and disease problems. These funds were used to increase research programs to develop technology related to exotic pest problems and to expand research on the role of micro-organisms and arthropods in maintaining health and productivity of forest ecosystems in the West. Priorities for research for the Forest Service related to forest entomology include the following: addressing forest health and sustainability issues, exotic pests, disturbance ecology, and understanding the role of insects and other arthropods in ecosystems processes. The research approach involves scaling up from trees and stands to the landscape level.

The university environment varies considerably and the comments relating to the University of Northern Arizona may not be applicable generally. In general, forest entomology research is seen as stable, however research areas are changing. Work on chemical control of insects is in obvious decline and there appears to be a slight decline in basic biological studies. Biodiversity research is increasing rapidly. Insects lend themselves well as ecological indicators. Ecosystem management in forest health is another mega-trend in entomology research. Identifying new control strategies and scaling up from trees to stands are current trends. Another area in which entomology is gaining popularity is in the rapid increase in butterfly zoos. We may be approaching the time where entomologists are required to manipulate populations of insects such as butterflies to increase the outdoor experience of hikers, etc.

There seems to be fewer of the young and single graduate student enrolling in entomology in recent years. This results in less flexibility in research programs especially where travel and irregular hours are involved.

Overall, funding of university research is relatively stable to slightly declining. Care has to be taken to focus on applying for funding in core research areas and not become too widespread simply because of the availability of funding in other areas. There is a shift away from federal funding of research to university funding. There is more money from endowments - up to 60% of funding for some universities comes from this source today.

Phero Tech Inc. represents a relatively small company which produces semiochemicals and traps for forestry and agriculture, as well as does consulting work in a number of areas. Most of their research and development efforts today lie in the areas of semiochemical identification, synthesis and testing, pest management strategy and tactic development, and biodiversity research. Like the government and universities, there is a shift away from sole "in house" research to collaborative research or to contracting out research. The main difference in the private sector is that the research has to be oriented towards a final product which they can sell.

Up to 30% of Phero Tech's gross income goes to R&D. Funding of research, as for the other groups, is tending to be less from federal sources and more from regional programs.

In summary, some of the recurring themes brought up in the workshop were that there is a general decline in the number of permanent research entomologist positions and an increasing trend towards completing short term projects using temporary staff/ post docs etc. There is some concern as to the lack of continuity and loss of longer term research projects that this entails. It was also noted that the day of the specialist may be gone - where one scientist would work on a single pest for most of his/her career. There is a strong trend towards more collaborative research between the universities, governments, and private sector. Ecosystem management and biodiversity research are the key research topics today.

Pests in Western States and Provinces

Moderator: Ladd Livingston, Idaho Dept. of Lands

Representatives of the western states and provinces presented information concentrating on major insect outbreaks, expansion of old problems and new introductions or problems. Summaries of these presentations follow:

US Forest Service, Region 10, Alaska (Ed Holsten, Anchorage): There are approximately 130,000,000 acres of forest land in Alaska; 27% of the total land area. Two distinct forest ecosystems make up these forests: the boreal forest ecosystem of south-central and interior Alaska, and the temperate rain-forest of southeast Alaska and Prince William Sound. Each distinct ecosystem has its specific forest health concerns:

<u>Boreal Forests:</u> (1) Spruce beetle, *Dendroctonus rufipennis*, infestations continue to be the most dramatic disturbance factor. Ongoing and new spruce beetle infestations now cover more than one million acres; more than three million acres being affected in the last five years. Annual tree mortality is estimated at more than 25 million spruce! Spruce mortality is approaching 80% in many areas. Changes to boreal forest ecosystems include: wildlife habitat, hydrology, scenic quality, increased fuel loading, and significant changes in plant species composition; (2) Eastern spruce budworm, *Choristoneura fumiferana*, defoliation now covers approximately 250,000 acres of interior white spruce type. This is the fifth consecutive year of heavy defoliation. Engraver beetles, *Ips perturbatus*, are beginning to build up in these defoliated stands.

<u>Temperate Rain Forests:</u> Yellow-cedar decline/mortality of yellow-cedar is the most spectacular forest problem in southeast Alaska. Approximately 600,000 acres of decline/mortality have been mapped to date. Decline is occurring in forests that have not been visibly altered by timber harvesting or other human disturbances. Cause of this decline is not fully understood, it appears to be naturally occurring and caused from some environmental stress.

British Columbia Ministry of Forests, British Columbia (Tim Ebata, Victoria): Responsibility for annual disturbance data and provincial summaries has switched from the Canadian Forest Service to the BC Ministry of Forests.

Generally, no major changes in the populations sizes of economically important bark beetle species have been noted in the province. However, several notable defoliator outbreaks are worth reporting. Both western spruce budworm, *Choristoneura occidentalis*, and Douglas-fir tussock moth, *Orgyia pseudotsugata*, are at low levels with a few small infestations of mostly light western spruce budworm defoliation noted in the summer of 1996.

"Surprise" defoliator outbreaks were located on the coast and in the north. On the Queen Charlotte Islands, multiple infestations of blackheaded budworm, *Acleris gloverana*, on scattered islands amounted to 133 infestations totalling over 9,500 ha of mature and immature forest. It is expected to expand further north but so far is mostly in the National Park reserve. The southern coast has 20,000 ha of a conifer sawfly, *Neodiprion* spp., located in two distinct 10,000 ha infestations on the mainland and on northern Vancouver Island. Up north, in the northern limit of the Interior Cedar Hemlock biogeoclimatic zone, an outbreak of a green striped forest looper, *Melanolophia imitata*, was discovered to cover about 20,000 ha of light to severe defoliation. No significant parasitism was noted in pupae collected on site which indicates further expansion next year. Two-year cycle budworm, *Choristoneura biennis*, is found throughout the central interior causing over 200,000 ha of light defoliation on subalpine fir.

Other pests of note are:

- Gypsy Moth, *Lymantria dispar* - 19th year of survey, 10,500 traps placed. 52 males caught, none in Hope following a spray of 112 ha with *Btk* in 1996. Twenty seven caught in New Westminster. The Pesticide Use Permit was appealed successfully, thereby losing spray opportunity for 1997, potential for increase in 1998. Additional catches throughout lower mainland and on Vancouver Island.

- Balsam woolly adelgid, *Adelges piceae* - surveys have found BWA as far east as the border of the Vancouver Forest Region and the Meritt and Lilloett Forest Districts, well beyond the legislated quarantine zone.

- European elm bark beetle, *Scolytus multistriatus* - found for the first time east of the Okanagan valley. Trap catches in New Westminster and Port Coquitlam. However, BC remains free of Dutch elm disease.

- Post-treatment mortality - unusual occurrences of post-pruning and spacing mortality in lodgepole pine due to secondary bark beetles *Dendroctonus valens, Hylurgops rugipennis* and *Pityophthorus* sp. We are not sure what stimulated them to cause mortality other than treatment stress.

US Forest Service,Region 6, Oregon and Washington (David Bridgwater, Portland): The return of normal to above normal rainfall for the past two years has resulted in a marked decrease in insect activity in both Oregon and Washington.

The 1996 aerial insect detection survey did not detect any defoliation caused by the Douglas-fir tussock moth. Adult male pheromone trapping did not produce any plots where the threshold value of an average of 40 moths per trap was reached. There were, however, some fairly high plots. In Washington, one plot on the Colville Indian Reservation and one near Chelan had averages of 35 and 36 respectively. In Oregon, two plots on the Wallowa-Whitman National Forest averaged 35 and 22, and one on the Malheur National Forest averaged 21.

- Western spruce budworm was reported defoliating trees on 180,000 acres in Washington and 7,500 acres in Oregon. Most of the defoliation in both states was classified as light.

- Western pine beetle was reported killing 21,000 ponderosa pine trees on 29,000 acres.

- Douglas-fir beetle caused mortality was way down with only 7,000 trees reported killed on 14,000 acres. Most of this was in old budworm defoliation areas.

- Fir engraver continued to kill significant number of trees, but at a much reduced level. Overall, 800,000 trees were killed on 380,000 acres. Most of this was in south central Oregon.

- Mountain pine beetle was found killing 585,000 trees on 169,000 acres. Most of the mortality was in lodgepole pine in north central Washington and near Bend in Oregon.

In Oregon, one gypsy moth eradication project is scheduled on 70 acres. Treatment will consist of three aerial applications of *Btk*. In Washington, five areas are scheduled for eradication treatment of gypsy moth. One will be three applications of *Btk* applied from the air in an area where Asian gypsy moth was found. The remaining treatments will be ground eradication treatment using *Btk* against the European strain of gypsy moth.

California Department of Forestry, California (Jesse Rios, Sacramento): In general, tree mortality and top-kill from bark beetles decreased in 1996. Total mortality on National Forests was 755.1 MMBF over 1,138,674 acres. Mortality associated with the western pine beetle is down considerably from previous years. Jeffrey pine beetle is down considerably from previous years. Jeffrey pine beetle and the fir engraver were the most troubling species, and the Southern Cascade, northern Sierra Nevada, and Lake Tahoe Basin remain the areas with the most problems.

Mortality of all size classes of sugar pine still seem disproportionately high in comparison with the tree species. The lingering effects of drought, overstocking, and attacks by mountain pine beetle appear responsible for the mortality.

Numbers of male Douglas-fir tussock moths trapped in early-warning detection traps continues to increase, but defoliation remains difficult to find. For the first time since 1985, the budworm, *Choristoneura carnana californica*, has caused light defoliation in the vicinity of Trinity Lake in Trinity County, but damage by the Modoc budworm remains difficult to detect in the Warner Mountains.

Gypsy moths were trapped in seven counties; numbers were in line with the very low incidence of recent years with the exception of a location in Nevada County. There was a control project in Santa Cruz County in the spring 1996; no moths were trapped following treatment.

Pine pitch canker has been found in 17 counties from Mendocino to San Diego. The disease is killing seedlings and predisposing larger trees to bark beetle attack. The stand at Ano Nuevo showed a dramatic increase in mortality due to pitch canker in 1996. Spittle bugs (Cercopidae) were added to the list of insects vectoring the disease.

In Southern California, precipitation in the year beginning July 1, 1995, was well below the mean as measured for the past 118 years. However, this dry year was preceded by three very wet years and trees did not appear to be particularly drought stressed. Mortality associated with attack by bark beetles was low on the four southern California National Forests. However, the fire season was severe.

The Eucalyptus longhorned beetle has extended its range northward to Shasta County. Research entomologists at the University of California, Riverside, have found a tiny wasp from Australia to be a highly efficient at parasitizing eggs.

The Africanized honey bee, *Apis mellifera scutellata*, is established in the Southern California desert. The region currently considered Africanized is comprised of all of Imperial County, most of eastern Riverside County, and the northeastern portion of San Diego County.

Alberta Land and Forest Service, Alberta (Hideji Ono, Edmonton): In 1996, the extent of spruce budworm, *Choristoneura fumiferana*, infestations in Alberta decreased by 46 percent compared to 1995. Spruce beetle, mountain pine beetle, and forest tent caterpillar populations remained at endemic levels during 1996. Pheromone trap catches and second instar budworm surveys predict substantially lower levels of budworm infestations in the province in 1997 compared to 1996.

Undiluted Foray 48B was aerially sprayed over more than 110,026 ha in northern Alberta and based on the second instar larval survey results in 1995, nil-light (below 35 percent) defoliation is expected in most of the sprayed stands in 1997.

Aerial spraying of Mimic provided excellent spruce budworm control. Spraying of Thuricide also provided satisfactory spruce budworm control. There was no significant difference between the average number of spruce budworm moths trapped in Multi-Pher I traps baited with standard pheromone compared with those baited with pheromone produced by Phero Tech Inc.

Today, Dutch Elm Disease (DED) has not been found in Alberta. So far, the small European elm bark beetle (SEEBB) has been collected from Calgary, Edmonton, St. Albert, and Vauxhall. Firewood infested with SEEBB has also been detected at several ports of entry to Albert.

US Forest Service, Region 1, Northern Idaho, Montana, and Northwestern South Dakota (Tim McConnell, Missoula): Bark beetle activity in 1996 was generally down from 1995, since 1995 followed a dry summer which caused a sharp increase in pine engraver, fir engraver, and Douglas-fir beetle. A significant increase in mountain pine beetle caused mortality to lodgepole pine was observed in far western Montana. This outbreak area will continue to see additional high levels of mortality in 1997. Douglas-fir beetle outbreak acres decreased by two-thirds in 1996, but tree mortality was slightly higher than 1995. Subalpine fir mortality in southwest Montana continues in the same area due to a complex of causal agents including western balsam bark beetle.

No western spruce budworm defoliation was observed from the air for a second straight year. A total of only eight Douglas-fir tussock moths were trapped in Montana at 33 plot sites. Western false hemlock looper caused heavy defoliation to Douglas-fir on the same 97 acres near Helena, Montana for the second straight year. New areas of balsam woolly adelgid continue to appear across north central Idaho.

Gypsy moth traps in Missoula, Montana caught 5 moths in one trap and 1 moth in another trap about one mile away. An intensive delimitation trapping will be done in the summer of 1997 in Missoula.

US Forest Service, Region 4, Southern Idaho, Nevada, Utah, and Western Wyoming (Julie Weatherby, Boise): During the 1980s, much of the bark beetle activity in the Intermountain Region was concentrated in Southern Idaho. A significant shift occurred during the 1990s, and, presently, the heaviest concentrations of bark beetle activity (spruce beetle, subalpine fir mortality complex including western balsam bark beetle and fir engraver beetle) are found in Utah. Douglas-fir beetle continues to cause heavy mortality in Southern Idaho within and adjacent to areas which have been defoliated by Douglas-fir tussock moth in 1990-1992. A significant outbreak of fir engraver beetle continues to kill red fir on federal, state, and private lands in the Tahoe Basin and adjacent areas of the Toiyabe National Forest. Conifer defoliators remain at extremely low levels. A localized and minor outbreak of larch casebearer was reported in McCall, Idaho. Larch needle disease was detected throughout the range of larch. Heavy aspen defoliation was detected in Utah and aspen leaf diseases were epidemic in Southern Idaho.

US Forest Service, Region 2, Colorado, Eastern Wyoming, South Dakota, Kansas, and Nebraska (Bill Schaupp, Denver):

- <u>Douglas-fir beetle</u> - An extensive outbreak in western Colorado and eastern Utah has been in progress for several years. In western Colorado approximately 7,246 trees were killed in 1996. Because previously killed snags outnumber current faders, it is likely that this outbreak is declining. Areas with scattered mortality are expected to have continued beetle activity. Many fire scorched trees were found to be heavily infested. It is possible that this may spawn an outbreak in the South Platte River drainage. Nearby, additional mortality is occurring in areas heavily defoliated from 1993-1995 by the Douglas-fir tussock moth. Mortality along the Colorado Front Range continues to occur in small, widely scattered groups. Most mortality is on steep inaccessible slopes where western spruce budworm had defoliated trees over the past decade. On the Shoshone NF, Wyoming approximately 1000 tees were killed in 1996.

- <u>Douglas-fir tussock moth</u> No defoliation was detected in 1996, showing that the epidemic of 1993-1995 has completely collapsed. An early warning system using pheromone traps detected no areas of Douglas-fir tussock moth increase. It appears that Douglas-fir beetle populations increased in heavily defoliated stands and are now attacking trees in adjacent areas.

- Mountain pine beetle In Colorado, mortality continues to increase in ponderosa and lodgepole pine. Aerial survey results from 86 percent of this area identified 12,891 dead trees on 10,879 acres. The tri-county area of Summit-Grand-Eagle (Frisco/Keystone area) saw a 180 percent increase in mountain pine beetle activity in 1996 from 1995. A total 3425 trees were infested in 1996. The populations are expected to increase. Along the Front Range of Colorado, a general increase of mountain pine beetle activity was reported in ponderosa pine. Activity of the mountain pine beetle in the Black Hills was very low with 1500 ponderosa pine trees being killed on 2900 acres. Mountain pine beetle activity associated with pine tussock moth defoliation on ponderosa pine declined for the third consecutive year near Edgerton, Wyoming. Statewide, mountain pine beetle activity increased slightly throughout Wyoming.

- Pine engraver beetle Activity along the Front Range of Colorado continued, with high levels reported in the Black Forest. *Ips confusus* activity was reported in pinon pine on the western slope, particularly in areas west of Durango and south of Montrose, Colorado. *Ips hunteri* was reportedly responsible for urban Colorado blue spruce top and tree mortality in Denver, Greeley, and Colorado Springs. Small pockets of top kill and tree mortality continued to be present in ponderosa pine in the Black Hills. In Wyoming, very little *Ips* sp. activity was reported.

- Spruce beetle Activity in southern Colorado was minimal and occurred only in very isolated areas. Slight population increases were associated with spring blowdown in western Wyoming.

- Western balsam bark beetle Mortality was common throughout the spruce/fir cover type from the Wyoming / Colorado border south throughout the Rocky Mountains. Additional factors, especially Armillaria root disease and possible other biotic and abiotic components, are acting together to produce this mortality. Aerial survey of 86 percent of Colorado documented 327,993 dead subalpine fir on 147,244 acres. Efforts are underway to determine the causes, effects, and mitigation measures possible to deal with this mortality complex. Mortality was also common on both the Shoshone and Bighorn National Forests in Wyoming where over 12,500 trees on 7,000 acres were affected throughout the spruce/fir cover type.

- Western spruce budworm Widespread defoliation of Douglas-fir, true firs, and spruce continued throughout the forests of southern Colorado. Current year defoliation in this area was in the moderate category. Other areas reported for Colorado were between South Fork and Wagon Wheel Gap and north of Lake City. No significant activity was reported in Wyoming in 1996.

- Gypsy moth Surveys continue region-wide on state, private, and federal lands. A total of four moth catches were made in detection traps in 1996. Delimitation trapping will be done around all 1996 catches. In Wyoming, a total of 554 detection traps were deployed. An additional 80 delimitation traps were placed surrounding the previously positive trap sites. Single moth catches were made in Cody, Jackson, and Sheridan. On Warren Air Force

Base in Cheyenne, one trap caught eight gypsy moths and an adjacent trap caught three moths; an additional single catch was made nearby, for a total of 12 moths caught on the base. An extensive delimiting survey is planned in 1997 on Warrent Air Force Base, as well as around the three other single catches. In South Dakota, four moths were caught from 697 detection traps. In Nebraska, four moths were caught--two in Omaha and one each in South Sioux City and Harlan County.

US Forest Service, Region 3, Arizona and New Mexico (Jill Wilson, Flagstaff): From mid-1995 to mid-1996, the Southwest Region experienced one of the worst droughts recorded this century. In addition to causing record catastrophic fires, the drought also precipitated a sharp rise in bark beetle activity, particularly those species affecting ponderosa pine such as the roundheaded pine beetle, western pine beetle, mountain pine beetle, and pine engraver species. Overall, bark beetle-caused mortality increased from 39,375 acres in 1995 to 53,610 acres in 1996.

Defoliator activity decreased from 205,095 acres in 1995 to 173,415 acres in 1996. The large majority of this defoliation was caused by western spruce budworm (126,985 acres) and a complex of large aspen tortrix, western tent caterpillar, marssonina leaf blight, and abiotic factors (35,650 acres). The spruce aphid also caused 10,780 acres of defoliation. The spruce aphid is a relatively new report for the Southwest. First reported in 1988, defoliation has been relatively insignificant until the winter of 1995-1996 when extensive heavy defoliation appeared following the mild, dry winter. Another defoliator was the pinyon sawfly, *Zadiprion rohwerii*, which caused about 3000 acres of defoliation on the Navaho Indian Reservation near Canyon de Chelly. All size classes of pinyon pine were affected. Defoliation ranged from 30 to greater than 90 percent.

The spruce aphid, *Elatobium abietinum*, was first reported in the Southwest in late 1988 and early 1989 on the Fort Apache Indian Reservation located in the White Mountains of Arizona and on ornamental spruce in Santa Fe, New Mexico. At the time, approximately 100 acres of Engelmann spruce, *Picea engelmannii*, were defoliated. The spruce aphid is an unusual insect in that it feeds and reproduces from fall through spring and populations drop to undetectable levels in the summer. Heavy feeding can result in spectacular defoliation to spruce.

In the winter of 1989/90, 100,000 acres of defoliation were found throughout the lower elevation range in the Fort Apache area. While no aphids were found in the summer of 1990, defoliation was observed along with some discoloration, presumed to be caused by aphid feeding. The damage was not detectable from the air after new foliage had expanded. In 1990 and 1991, low populations and light defoliation were observed in Santa Fe, New Mexico. No tree mortality was reported in any of these cases; defoliation was reported to be heaviest on understory trees.

The aphid went undetected until the winter of 1995-1996, which was very mild and dry, a condition favourable for outbreak development. At that time, populations and defoliation increased to spectacular levels in the White Mountains of Arizona. About 10,782 acres of defoliation were detected during aerial survey; however, the total affected acres is probably greater since light defoliation levels are difficult to see from the air. Some mortality has been reported, however, at this time amounts are unknown. All size classes of spruce were affected, including large overstory trees. The defoliation appears worse in the lower elevation ranges where Engelmann spruce occurs mixed with Douglas-fir, white fire, and ponderosa pine. While aphids have been found on both Engelmann and blue spruce, defoliation appears to be more severe on Engelmann.

It is unclear at this time if the insect is exotic or indigenous to the area. If exotic, it appears there may have been multiple introductions. We are still actively checking to see if the insect might have been spotted here prior to 1988. It is also unclear whether the recent discovery of the insect and the more extensive defoliation is associated with recent unusual weather events (warm, dry conditions) or reflective of a developing problem. There has been no management activity on public lands, though concerns are high on the White Mountain Apache Indian Reservation about the amount of defoliation. Efforts to learn more about the insect and its effects are ongoing. A joint study, initiated by Ann Lynch will look at site and stand interactions with defoliation.

Ed Van Randen, Forest Health Forester, Yukon, also gave a brief report of conditions.

Using Susceptibility and Resistance

Moderator: David Overhulser, Oregon Dept. of Forests

Tree improvement programs involving both conifers and hardwoods are providing a wealth of information on genotypes possessing resistance to forest pests. This workshop focused on examples of resistance mechanisms (constitutive, induced, and engineered), and strategies for deploying susceptible and resistant stock. Six speakers presented information at the workshop and responded to the questions of approximately 25 attendees.

Elwood R. Hart discussed areas of research on pest resistance and tolerance in short rotation *Populus.* In the United States, short-rotation plantations, especially utilizing *Populus*, are now operational in several areas and under development in others. A major approach to pest management in these systems is the definition and incorporation of pest resistant and tolerant clonal selections. At this time, the following resistance mechanisms are being explored by several research programs for use against insect attack: 1. proteinase inhibitor II gene insertions; 2. Coleoptera-and Lepidoptera-effective *B.t.* gene insertions; 3. chitinase gene insertions; 4. breeding and selection for leaf surface chemicals affecting adult feeding and oviposition; 5. breeding and selection for phytochrome response to maximize defense mechanisms. Any field deployment of these resistant mechanisms must include strategies to sustain the effectiveness of these mechanisms through time.

Darrell W. Ross presented preliminary information on ponderosa pine resistance to western pine shoot-borer infestation. In 1995, a graduate student at Oregon State University, Sara Prueitt, sampled 15-year-old progeny test sites on the Malheur and Ochoco National Forests to determine shoot-borer infestation levels. There were significant differences among the 30 half-sib families sampled in infestation levels ranging from about 20% to 60%.

These data are currently being analyzed as part of Sara's M.S. thesis research. The preliminary analyses suggest that families resistant to the shoot-borer could be selected by tree improvement programs along with other desired characteristics.

Don Heppner discussed approaches for the operational deployment of Sitka spruce resistant to white pine weevil on BC Ministry of Forests' coastal lands. Both research entomologists and geneticists are contributing heavily to the development of this strategy. Current thinking is that the resistance mechanisms are polygenic, and, therefore, more durable than if they were only controlled by a single gene. A primary concern is maintaining the durability of the resistance. To maintain resistance, the current recommendation is to include at least 10% susceptible spruce genotypes in operational plantings. To further insure the durability of the resistance, the resistant spruce population must contain a number of different resistant genotypes and a number of different resistant mechanisms. The actual deployment of resistant spruce will be within an IPM system. Sitka spruce is no longer planted in monocultures, but in mixtures with other local tree species. In areas where the hazard of weevil attack is low, normal spruce stocks could be used. Attack levels of 5% to 10% annually can be tolerated. In high hazard areas, a high level of resistance would be desired.

Michael A. Hulme presented information on how planting site determines if translocated spruce or pine will be resistant to white pine weevil damage. Basic ecology dictates that the planting site (environment), the weevil, and the tree are the major components of any weevil/tree interaction. However, the pivotal effect of the planting site has been largely ignored in past examinations of tree resistance to weevil damage. Provenance trials in coastal British Columbia show how a Sitka spruce genotype can be resistant at one site, but be as susceptible as other trees at a second site.

On sites where tree genotypes show resistance to weevil damage, they also develop earlier than other trees. Similar observations have been made with eastern white spruce which shows resistance and develops earlier than local trees when planted in interior British Columbia. Parallel observations in eastern North America also show how earlier developing eastern white pine shows resistance.

Experiments altering the timing of weevil attack at a western Canadian plantation of Sitka spruce further showed the importance of timing of weevil and tree development in determining tree resistance to weevil damage. At this plantation a number of tree families showed resistance to weevil damage. When the time of weevil attack was advanced (to eliminate the advantage of early tree development), any of the resistant trees could be damaged. When the time of attack was retarded (so that trees could develop further before being challenged), even susceptible trees became resistant. In any plantation, weevil and tree phenology are determined by the tree provenance (genotype) and planting site. There will be no universally resistant trees. One phenological mechanism of resistance involves resin production. (This seasonal behavior should not be confused with so-called pseudo-resistance, where an insect simply starves because it develops ahead of its food). Clearly, to exploit resistance, suitable phenology must be arranged by matching an appropriate tree to an appropriate planting site. The planting site is crucial in determining the outcome of weevil/tree interactions.

T.S. Sahota and J.F. Manville discussed the nature of resistance in spruces in British Columbia against *Pissodes strobi*; is it genetic resistance or pseudoresistance? Resistance in Sitka, white, and Engelmann spruces against the white pine weevil, *Pissodes strobi*, is widely considered to be genetic. If resistance is genetic, the magnitude of the resistance factor must differ among resistant and susceptible trees. Consequently, much of the existing research has looked for differences in physical and chemical attributes of trees and where these were associated with the observed resistance they were claimed as mechanisms of resistance for the purpose of incorporating into spruce breeding to "make resistance robust and durable". While **associations and correlations** may be useful for identifying trees with resistance, they cannot identify mechanisms of resistance. Mechanisms must, however, be identified individually if a number of them are to be brought together in one tree.

Sahota *et al.* (Can. Entomol., 1994) have shown that feeding on resistant trees inhibits or blocks weevil reproduction, and affects behavior and progeny development of the weevil. Effects of resistance can be reversed by manipulating weevils' juvenile hormone system, providing **cause and effect** evidence for how this mechanism works.

A recently published paper (Hulme 1995 J. Econ. Entomol.) Claims that resistance is transient, caused by a temporal displacement of expression of resistance factor due to differences in phenology. Thus, if trees express resistance during the peak of weevil reproduction they are resistant, but they are susceptible if expression of resistance occurs outside this period. Consequently, trees cannot be distinguished as genetically resistant or susceptible on the basis of resistance measured at one fixed time of the year because all trees may have this factor at a sufficient magnitude to cause resistance, albeit at different times.

It is uncertain whether resistance in spruces to the white pine weevil is genetic or phenological. The possibility of phenological resistance makes it necessary to identify resistance mechanisms by showing their deleterious effect on weevil survival. Irrespective of whether resistance is genetic or phenological, selection of resistance must be based on cause and effect relationships before incorporating that trait into a breeding program.

Genetic resistance and phenological resistance are not complementary. Painter (1951, Insect Resistance In Crop Plants) recognized that genetic resistance was distinct from phenological resistance--which he called pseudoresistance. He deemed it necessary to determine the nature of resistance early in the life of a project's planning to utilize resistance because both the selection of resistant trees and deployment strategies will differ depending upon whether resistance is genetic or resistance is pseudoresistance. Characterizing the nature of spruce resistance against *P. strobi* will help clarify directions for future research and its application.

Rene I. Alfaro presented information on screening spruce for genetic resistance to white pine weevil. In cooperation with J. King of the BC Ministry of Forests, a Sitka spruce progeny trial at Jordan River was screened by creating an artificial infestation in the plantation. This method allowed fast screening for progeny testing: 4 years, compared to 10 or more, if we wait for a natural infestation to develop. Results indicated that families originating from Qualicum Beach area of Vancouver Island yielded trees with a high degree of resistance (confirming earlier results).

Earlier work demonstrated an induced defense reaction to weevil wounding in spruce whereby the cambium switches from producing normal xylem to the production of traumatic resin canals. Artificial wounding experiments, in collaboration with E. Tomlin of Simon Fraser University, demonstrated that resistant trees are capable of a faster and multiple response, relative to susceptible trees. We feel that artificial wounding could be useful as a screening test for resistance.

In an earlier report, M. Hulme, of the Pacific Forestry Centre found that resistant Sitka spruce clones flushed earlier than susceptible clones. These results were re-confirmed at the Jordan River trial. Thus, it appears that the physiological processes that underlay some of the resistance mechanisms may not be active the entire year, but they may be linked to phenology and gradually activated in the spring. Alfaro, working with Y. El-Kassaby and C. Lewis (Pacific Forest Products) demonstrated high heritability of flushing dates in Sitka spruce. Although selection is yielding resistant genotypes, deployment of this material should, at all times, take into consideration the need for avoiding the risk of insect selection leading to a biotype capable of overcoming the resistance mechanisms.

Western Balsam Bark Beetle Management Issues

Moderator: Tim Ebata, BC Ministry of Forests, Victoria, BC

Approximately 60 people attended this loosely structured workshop discussing our current understanding of the biology, impact, and management of the western balsam bark beetle (WBBB), *Dryocoetes confusus*.

Sandy Kegley, USDA Forest Service (Coeur d'Alene, Idaho), presented some beetle flight data from three years of trapping performed by her and Ken Gibson. Their results appeared to support the two flight period emergence pattern described in the literature; however, there was a wide annual variation in both timing of flights and numbers emerging.

The next presentation was by Leroy Harder, an Master of Pest Management student from Simon Fraser University, who has worked with Lorraine Maclauchlan in the Sicamous Ck. Alternative Silviculture Systems trial in the Kamloops Forest Region, British Columbia. He did detailed examinations of beetle attack patterns within baited trees. He also collected mensurational data on live and recently killed trees and on snags in various conditions of decomposition.

Within trees, exit holes were observed from about 2m from the ground up to 11 m. Resin flow, presumably caused by the tree attempting to pitch out the beetle, occurred between 5 to 13 m on the tree. Exit holes were not found above the 21 cm diameter point; resin flow stopped at 19 cm. This could explain why beetles do not regularly attack small diameter trees as they do not produce brood in stems <21 cm. His mensurational data indicated that in the stand he examined, 25% of the basal area were snags with evidence of WBBB The attack appeared to be on most (but not all) of the large diameter trees although some small diameter trees had also been killed.

He also presented some of Roberta Parish's (BCMoF, Research Branch) results from an intensive dendrochronology study done in the same area. She found that red trees on average were dead for about 4 yrs, greys 17 yrs, and three snag classes were dead for 29, 44 and ? (too much variablility) years, respectively. The longest a snag had been dead was 60 yrs.

Leroy's work attempted to determine if mortality in the stand he examined was due to an epidemic of WBBB. His conclusion was that he couldn't tell the difference between a long term outbreak or a chronic infestation. As John Borden says "it is like an above ground *Armillaria ostoyae*". Some problems Leroy faced were in determining what contribution downed trees made in the rate of loss calculation since these trees are too decayed to use for dendrochronology.

Another interesting result from Parish's work was the discovery of substantial release of trees that were over 100 yrs old that remained suppressed in the understory. Release was determined to occur when ring widths increase by 200% and, since no evidence of fires was found to correspond with the release period in the 1860's, it is hypothesized that a spruce beetle, or other bark beetle epidemic may have removed the overstory.

What are the management options for this beetle? Because of the diffuse nature of the attacks, large landscape units should be managed. Ideally, partial cutting could be utilized to salvage damaged patches as well as mimic the beetle's attack behaviour. Baiting could be used to enhance the efficacy of tree removal, if warranted. Low log quality and value discourages practising partial cutting in stands where extensive cutting requires a larger road network that is not paid by the value of the harvest as with conventional clear-cutting. There was some discussion that partial cutting subalpine fir, *Abies lasiocarpa*, may exacerbate problems with *Armillaria ostoyae*. Fortunately, in northern BC, *Armillaria* is not present. There was also a discussion of the hazard rating system that is being performed by Phero Tech Inc. and being ground truthed in several BC locations. The system is based on stand parameters described in Art Stock's PhD thesis.

John Borden summarised the ongoing status of pheromone research for WBBB. Currently the racemic exo-brevicomin bait is available commercially from Phero Tech Inc.; however, based on Stock's (1994) work, the true pheromone appears to be a 9:1 ratio of (+) exo: (+) endo-brevicomin. The commercial bait is a 9:2 ratio of (+) exo: racemic endo-brevicomin which "sort of works" but is sold in this formulation due to high costs of production. Borden suggests that if Phero Tech used the 9:1 bait, they could reduce the release rate six-fold and cost savings could be made. MSc candidate Nicole Jeans will be working with Borden at Simon Fraser University to further field test the baits and various formulations. Repellancy has been found with 100% endo-brevicomin but no one has worked on this. It may be a suitable tool for protecting ski hills.

Lorraine Maclauchlan, BC Ministry of Forests, Kamloops Forest Region, described her large-scale inventory of subalpine fir leading (50% or more SAF) stands in her region. Stands are stratified by biogeoclimatic zone and subzone. They are surveyed from helicopters, followed by a ground survey of 1-2 ha. First year results indicate difference in certain ecosystems related to age class and the different roles WBBB plays in stand succession.

Tim Ebata, BC Ministry of Forests, Forest Practice Branch, has observed over a 9 year permanent plot study that the average needle retention time for subalpine fir is 3 years with a maximum retention of 5 years, depending on the degree of crown exposure. This was judged subjectively from the ground as the maximum length of time the tree would be detected as a "red" during aerial surveys. In the first two years after attack, the crown is bright red; by the third year the tree has faded to brick red.

Natural enemies of WBBB have been listed in emergence studies from caged infested subalpine fir bolts by Art Stock during his MSc. thesis work. There are a huge number of species associated with the beetle but a lot remains unknown about them. *Pityokteines minutus* is one of the major bark beetle associates. Art Stock is presently the only one working on testing MSMA as a post-attack treatment. Blowdown is also a better attractant than baited trees.

What is the current management recommendation for stands under attack by the beetle? Things are dependent on economics and management constraints. If the stand can be clearcut, probably the most economical choice is to practice standard clearcut and plant forestry. If management constraints limit you from clearcutting, partial cutting in a way that mimics the beetle could theoretically manage the stand in a classical uneven age management regime. The key thing to remember is that this beetle does not "explode" in population like mountain pine beetle or spruce beetle. The bait and cut strategy could be applied IF the strategy is to remove all of the beetles that one can through harvesting while beetle populations are low. Beetles apparently can be moved 50 to 70 m through baiting; however, in most stand conditions where the beetle is a management issue, infestations are found throughout the stand and baiting would not be that efficacious.

The proactive, hazard-based approach is the only one valid over the long-term. Stands of high hazard but showing little beetle history (few reds or greys) should be the highest priority for harvest to maximize the potential sawlog volume. Stands with a long history of attack are mainly of pulp quality. They pose a management problem since they are of far lower value but may be important to convert them into more productive seral stands. Obviously, a better inventory of these stands is required to do long-term planning. The Bulkley Forest District in northwestern British Columbia, has the most experience managing forests infested heavily with WBBB. It is suggested that they be contacted for more "hands on" information.

The question of value of the standing snags is being examined by Tim Ebata, Bill Camenzind, Ken White and Gerrard Olivotto of the BC Ministry of Forests. The recent BC Timber Supply Review begged the answer to the question of value and salvage of pulp logs created by WBBB. Dendrochronology was used to date snags (similar results to Parish) and chip samples from each snag class were analysed for pulp quality and paper strength. Surprisingly, trees that have been dead for up to 30 years produced good quality pulp. Thus, in good pulp markets, the potential fibre volume is far higher than would be indicated by cruising of green and recently dead trees. This same study is ongoing and has an extensive inventory component that will address if the beetle caused mortality is caused by recent or old outbreak or is chronic. As with Harder's study, the fallen trees cannot be included in the analysis since they tend to "melt" away as soon as they make contact with the forest floor.

There was interest in having a symposium on WBBB and subalpine fir/ spruce ecosystems in BC, perhaps in the fall of 1997. Industry should attend this symposium.

Insect/Pathogen Interactions

Moderator: Staffan Lindgren, University of Northern British Columbia, Prince George, BC

Attendance: 30.

When teaching an integrated course in forest health (entomology and pathology), the intimate connection between fungi and insects becomes very evident. Insects and fungi (and other pathogens) interact in many ways, ranging from rather casual interactions to very close mutual dependency. Many of these interactions are quite obvious, while others may be less so. For example, we are fairly knowledgeable about the interactions between bark beetles and blue stain fungi, ambrosia beetles and their fungi, sawyer beetles and the pinewood nematode, and the fascinating relationship between *Sirex noctilio* (Hymenoptera: Siricidae) and *Amylostereum* sp. At the casual end of interaction, insects merely take advantage of situations where a fungus (or other pathogen) modifies the resource to render it available for utilisation. These relationships are more closely linked where fungi have evolved specialized, sticky spores to "hitch hike" on insects for dispersal. Further evolution has led to insects displaying varying levels of dependence on fungi for nutrition, culminating with the ambrosia beetles.

The intent of this workshop was to discuss some insect/pathogen interactions at these different levels. Several contributors challenged accepted paradigms within specific contexts, and this generated many questions.

Association between the spruce beetle and *tomentosus* root rot (Kathy J. Lewis, University of Northern British Columbia, Prince George, BC):

Root disease is often thought to contribute to population buildup and subsequent outbreaks of bark beetle populations. Diseased trees may be more susceptible to attack due to stress-related compounds, or may be unable to produce defence responses. The most prevalent root disease fungus in sub-boreal spruce forests is *Inonotus tomentosus*. A survey revealed that spruce beetles do not appear to favour tomentosus infected trees, and that they may in fact avoid them. This could be due to quantitative (decreased thickness) and qualitative (moisture, nutrition, chemicals) changes in the phloem tissue. *I. tomentosus* is a slow-growing fungus that can take decades to kill a mature spruce tree. Infected trees slowly lose vigour, unlike trees infected by faster acting fungi that can kill trees in only a few years. The result of this more prolonged period of decline may be reduced phloem suitability for the beetle. Planned research will investigate beetle attack and brood success in pheromone-baited healthy and infected trees.

Association between western pine moth and stalactiform blister rust (Lynn A. Rocchini, University of Northern British Columbia, Prince George, BC):

Western pine moth, *Dioryctria cambiicola*, attacks the stem or branches of trees. Stalactiform blister rust, *Cronartium coleosporioides*, forms large cankers on the bark of pine trees, creating fissures and pitch exudation along the periphery of the rust cankers. Both organisms are prevalent in a Provenance Trial at the Prince George Tree Improvement Station. This trial consists of more than 4000 trees representing 53 provenances from the range of lodgepole pine. The objectives of this study were to determine: (1) If there is an association between *D. cambiicola* and *C. coleosporioides* in the Provenance Trial, and if so: (2) What the nature of the association is? Analysis of a survey of 800 trees representing all 53 provenances showed that the presence or absence of pitch moth is not independent from the presence or absence of rust in the provenance trial (G-test of independence, $p<0.001$). These results show that there is an association, but not whether: (1) the rust stresses the tree which attracts the insect, (2) the attacked trees are more susceptible to attack by both organisms due to genetic factors or offsite planting, or (3) there is a physical association, where the rust creates a suitable micro-habitat on the tree for the insects. Since the insect attacks seem to be concentrated on the active portion of the rust cankers, the latter may be true, but further analysis is required before more conclusions can be drawn.

***Leptographium*/root beetle interactions** (Kier Klepzig, USDA Forest Service, Pineville, LA):

We have previously studied a syndrome in red pine characterized by circular areas of decline and mortality. Also associated with these areas of decline were weevils, *Hylobius pales*, *H. radicis*, and *Pachylobius picivorus*, and lower stem and root infesting bark beetles, *Dendroctonus valens* and *Hylastes porculus*. Two saprogenic fungi, *Leptographium procerum* and *L. terebrantis* were frequently associated with the weevils and bark beetles, respectively. We hypothesized that these fungi are introduced into the root systems of trees and grow across root grafts to infect other trees, which leads to the circular pattern of decline, and predisposes trees to mortality by *Ips pili*. We are currently studying the interactions of these insect-fungal complexes and their hosts in thinned and unthinned stands of *Pinus taeda*, and burned and unburned stands of *Pinus palustris*. We hope to determine in what way, if any, these management strategies impact the levels of root infesting insects and/or alter the susceptibility of trees to the saprogenic fungi they carry. Future research needs to focus on the taxonomy, life cycles, and host range of these insects and their associated fungi.

Interactions among bark beetles and associated fungi (Tim Paine, University of California Riverside, Riverside, CA.):

In addressing questions regarding the ecological and evolutionary interactions among associations of bark beetles and fungi, it is critical to distinguish between fungi that are carried by beetles within mycangia and fungi that are carried on the body surface as external contaminants. Both mycangial and non-mycangial fungi may stain infected wood, but the associations may be a very different type. The benefits accruing to the vectoring beetles may be very different. Among the mycangial fungi that have been carefully examined, most can be characterized as relatively non-pathogenic, they may or may not be important in killing the host tree, and are probably important for larval or adult maturation feeding. Among the non-mycangial fungi, the most highly pathogenic fungi are frequently associated with beetles that either do not kill trees, or that normally colonize dead or dying trees when populations are at non-outbreak levels. Although pathogenic fungi can be introduced into the tree, and this has been hypothesized to be an important cause of tree mortality, a comparison of the rate of fungal penetration into the host with the rate of beetle attack and/or beetle development suggests that trees are killed much faster than can be accounted for merely by fungal growth. There has been a great deal of information generated over the last 30 years on describing beetle/ fungal associations and characterizing the response of trees to invasion by beetles and their fungal associates. Additional work is required to understand the interactions at the point of infection during the attack process, to examine the interactions at the cellular level, and to frame the results in the appropriate ecological and evolutionary contexts.

Dispersal of *Scolytus multistriatus* in the absence of Dutch elm disease (Brad White, University of Washington, Seattle, WA.):

The lesser European elm bark beetle, *Scolytus multistriatus*, is the primary North American vector of the pathogenic fungus, *Ophiostoma novo-ulmi*, the causal agent of Dutch elm disease. The bark beetle is not dependent on the fungus to complete a successful life cycle, whereas the fungus is dependent on an insect vector for long range dispersal.

Endemic *S. multistriatus* populations were studied in the Puget Sound region in the absence of *O. novo-ulmi*. Laboratory studies demonstrated that *S. multistriatus* requires sexual maturation feeding on a diet containing protein before undergoing oogenesis. Furthermore, field studies demonstrated that female *S. multistriatus* respond to the aggregation pheromone only after completing oogenesis.

Maturation feeding on elm twigs has been reported as a facultative behavior in other *S. multistriatus* populations. Puget Sound endemic *S. multistriatus* populations disperse under conditions that include scattered brood material and pheromone plumes, whereas outbreak populations disperse under conditions with abundant brood material and pheromone plumes. Separate genotypes and physiological states (for example, high vs. low-lipid content) are likely favoured by the different dispersal environments encountered by endemic and outbreak beetle populations. As Dutch elm disease activity alters the dispersal environment, a genotype within a *S. multistriatus* population may be amplified in relation to other genotypes. Endemic conditions could favour long dispersal flights coupled with twig-feeding behavior, while outbreak conditions could favour short dispersal flights associated with an immediate response to the aggregation pheromone.

Taxonomy and Identification

Moderator: Robb Bennett, BC Ministry of Forests, Victoria, BC

Seventeen researchers, field personnel, instructors, and graduate students attended this session, including Chris Buddle, Kamal Ghandi, Jim Hammond, Trevor Hindmarch (all from the University of Alberta); Leslie Chong, Dave Holden, and Jorge Macias (from Simon Fraser University); Roger Burnside and Mark Schultz (USDA Forest Service, Alaska); Tiffany Andrews and Sheri Moraes (BC Ministry of Forests); Rob Higgins (University College of the Cariboo); Wen Jer Wu (Oregon State University); Jeff Lemieux (University of Northern British Columbia); Jeff Moore (Washington State Forest Service); and Robert Stronach (Albertal Forest Service). The format was a seminar presentation (outlining the role of taxonomists, appropriate usage of their expertise by other entomologists, and common pitfalls/misconceptions encountered by those needing identification services) by Bennett with questions, comments, and other discussion from the participants. The input of Lee Humble (Canadian Forest Service) and Jean-Francois Landry (Agriculture and Agri-Food Canada) to the development of this workshop is gratefully acknowledged.

There is a general lack of understanding in the entomological community about the role of taxonomists in entomology, the services they can provide to entomologists, and what can reasonably be expected from them in terms of service. Professional taxonomists have increasingly become a rare and endangered species over the last 30 years. Many have retired, there is not much incentive for new taxonomists to join the ranks, and many of the remaining taxonomists no longer work as professionals but provide identification and other services at an amateur level (i.e., ancillary to or outside of their described job function). Individuals within the dwindling coterie of amateur and professional taxonomists are still usually very happy to provide accurate determinations of your material (by and large taxonomists WANT to look at new specimens) but be aware that there is considerable time involved in specimen preparation, determination, and curation. Professional courtesy suggests that you make an effort to determine beforehand what the dollar value is of the service you need. A good rule is to make an allowance within your project budget of $65-75 for every hour required of a taxonomist's services (there are creative ways around direct dollar inputs that often can be worked out (e.g., co-authorship) prior to delivery of requested services). The majority of taxonomists are primarily interested in describing biological diversity (i.e., naming and classifying organisms); providing taxonomic/identification services is often a minor or non-existent component of their job function performed on their own time.

There is a very real need for accurate, professional identifications and subsequent long-term curation of insect material derived from research in diversity/ecology, ethology, physiology, pest management, or any other entomological field. Your research is only as good as the lowest common denominator -- the identity of your material. Although some non-taxonomists are reasonably able to determine the material they work with, most of these people are not up-to-date with the on-going changes in many groups and lack the day-to-day familiarity with taxonomic theory and techniques. It is always worthwhile to have your determinations checked for accuracy.

Furthermore, many entomologists tend to identify insects on the basis of habitat characteristics or host associations as opposed to true specimen diagnostic features. This approach is normally valid for standard pest management work but definitely should not be used as the basis for research conclusions or relied upon when important recommendations are being made. Finally, there needs to be a long term record of your research data: a representative, expertly identified, and properly labelled collection ("voucher specimens") of material resulting from your research should be placed in an established insect collection in a recognized institution. In British Columbia, this would usually mean the Royal BC Museum, the National Collection of Insects and Arachnids (Agriculture and Agri-Food Canada, Ottawa), the Pacific Forestry Centre, or the University of British Columbia. Again, this detail should be worked out with the target institution beforehand and an appropriate value for long term care of the vouchers attached to this in project plans.

A common complaint of taxonomists is the poor attention paid to proper preparation of material prior to submission for identification. Specimens should be prepared in a manner appropriate to the taxon in question (i.e., spiders, caterpillars, soft-bodied adult insects are usually preserved in 75% ethanol in glass, rubber-stoppered vials; moths, beetles, and other hard-bodied insects are normally pinned). Good references for methods are J. E. H. Martin, 1977 ("Collecting, Preparing, and Preserving Insects, Mites, and Spiders", Publ. 1643, Agriculture Canada) or the most recent edition of D. J. Borror, D. M. DeLong, and C. A. Triplehorn ("An Introduction to the Study of Insects", Holt, Rinehart, and Winston). Ensure that the method you use is acceptable to the taxonomist providing the determinations of your material. All material must be sufficiently labelled: this means that not only should there be good collection data for each specimen (see below) but that there should be enough data labels provided for all specimens in a bulk sample. One of the most tedious aspects of a taxonomist's job is having to prepare collection data labels for a large number of specimens included in one vial with one label. The taxonomist will take care of providing appropriate identification labels. The minimum necessary collection data include geographical information (country, province/state, nearest town or other identifiable feature, topographic reference if feasible, date of collection, name of collector). Other helpful data include host/habitat/behavioural information and references to additional information too extensive for inclusion on a label.

It is often difficult for researchers and field personnel to find someone who is proficient with the taxa you need identified or for interested students to find a taxonomic mentor and training. Training of new taxonomists is a very real problem. Today, few schools offer comprehensive training in the methods and theory of taxonomy and there is little incentive for students to pursue taxonomy as a career. Rarely are new taxonomy positions offered and extant taxonomy jobs are routinely axed these days upon the retirement of an incumbent. Electronic bulletin boards can help researchers to locate persons familiar with their research taxa and students to locate schools and mentors able to provide training programs at the technical or research level. A note sent to ENTOMOL-L (entomo-l@uoguelph.ca) or FORENT (forent@nature.snr.uvm.edu) outlining your needs will often bring speedy and helpful responses. For researchers, identification services often may only be found internationally; for the dedicated student of taxonomy, training may require leaving the country. Be prepared to look abroad.

Quarantine Issues

Moderator: Tom Hoffacker, USDA Forest Service

Seed, Cone, and Nursery Pest Issues

Moderator: Robb Bennett, BC Ministry of Forests, Victoria, BC

Fourteen researchers, orchard managers, contractors, professors, and graduate students including Herb Cerezke (cone and seed pest management contractor, Alberta), Carole Fleetham (seed orchard manager, BC Ministry of Forests), Dave Holden (graduate student, Simon Fraser University), Sandy Kegley (cone and seed insect research, Idaho), Jeff Lemieux and Lynn Rocchini (graduate students, University of Northern British Columbia), John McLean (professor, University of British Columbia), David Overhulser (seed orchard pest research and extension, Oregon), John Revel (a local silviculturist and cone/seed dealer), Tim Schowalter and Julia Smith (professor and graduate student, Oregon State University), Dave Schultz (USDA Forest Service, California), and Ward Strong (cone and seed pest management biologist, BC Ministry of Forests) participated in this session. Bennett currently is the cone and seed pest management officer for British Columbia. Using his cone and seed insect research program (funded primarily on a project-by project annual basis by Forest Renewal British Columbia at the time of this workshop and subsequently collapsed due to vagaries in FRBC project ranking process and funding levels) as a starting point, Bennett led an informal discussion of the recent history and future of cone and seed insect research funding, extension activities, and specific projects. No forest nursery personnel were present and nursery related issues were not discussed.

In Canada for some years, there has been a loosely knit but well established national cone and seed pest management research network. Originally drawn together under the now defunct federal Green Plan funded "Integrated Pest Management in Seed Orchards" program, the group has managed to continue working together with funding from Forest Renewal British Columbia. During the Green Plan era the program had an official leader (Peter de Groot and Jon Sweeney during the early to mid 1990's); Bennett has become the unofficial leader in his capacity as titular leader on most FRBC-funded cone and seed pest management projects. Members of the network have managed to meet on an annual basis (usually in conjunction with meetings of the Entomological Society of Canada) to discuss developments, priorities, and strategies. Contact is maintained with researchers in Europe, the United States, and elsewhere.

With the change of funding source from federal to provincial, the future of the network is cloudy; within a month of this workshop, FRBC support of virtually all cone and seed pest management research was halted. First projects to be dropped were those with all or some of the components of the research being conducted outside of the province regardless of the relevance to British

Columbia cone and seed pest management priorities or the competence of the researchers involved. Stalled or terminated projects include research on adelgids (distribution and abundance, feeding physiology, gall initiation, taxonomy, and molecular biology), *Dioryctria* coneworms (molecular taxonomy), control of a range of insects with "neem" (azadirachtin), *Aphrophora* spittle bugs (effects on lodgepole pine seed production), *Strobilomyia* spruce cone maggot (cone marking pheromones), *Cydia* seedworm (dispersal and chemical ecology), and *Synanthedon* pitch moths (mass trapping and chemical ecology). Other projects based in British Columbia, including (among others) adelgid and *Leptoglossus* seed bug impact and damage assessment, *Contarinia* cone gall midge chemical ecology, *Megastigmus* monitoring and biocontrol, *Strobilomyia* spruce cone maggot control, *Synanthedon* and *Dioryctria* pitch moth distribution and abundance, and *Cydia* seedworm survival during commercial seed extraction, are currently unaffected.

Highlights of some of these projects were outlined. Anne Savoie's X-ray and SEM work with John Borden of *Leptoglossus occidentalis* has demonstrated very significant differences between feeding damage caused by nymphs, adult females and adult males. In lab bioassays 4th instar nymphs cause the greatest amount of damage to individual seeds (destroying much of the endosperm tissue but not the cell walls) followed by 3rd and 2nd instars and adult females. Other nymphal instars and adult males cause little or no damage. Current work on this project is seeking to modify X-ray diagnosis techniques to assess accurately the actual impact of seed bugs and develop workable impact assessment techniques (present assessment and diagnosis techniques are neither reliable nor accurate).

Gerhard Gries' work with Bennett has successfully characterized and field tested the sex pheromone of *Contarinia oregonensis*. This is a major step forward in management of the main insect problem in Douglas-fir seed production. Current work is relating trap catches to damage levels in the development of a new midge monitoring program. Next spring will see the field testing of the monitoring technique and a mass trapping trial.

Stressing the great need for reliable assessment tools, Strong discussed the adelgid monitoring and damage assessment protocols developed by him for use in BC seed orchards. Adelgids are the major perennial problem in spruce and other conifer seed orchards in the interior of BC but a statistically sound monitoring technique has never been developed nor is there a damage prediction protocol. Strong's technique produces a reliable and accurate estimate of size of overwintering populations of adelgids on spruce but, unfortunately, this has little bearing on subsequent galling during the growing season. Use of the monitoring protocol to predict damage levels awaits research into mortality agents and factors necessary for gall initiation.

A web page and an electronic "expert identification" system for cone and seed insects are in the planning stages. The latter is tied to FRBC funding so its future is a bit iffy at present. The web page has received BC Ministry of Forests approval and should go ahead in Fall, 1997. The page will compile all relevant and available biological and management data (including images) on BC (primarily) and other North American cone and seed insects and will be tied to existing BC Ministry of Forests and University of British Columbia pages. The expert identification system is designed to be a trial for development of larger packages to be used as diagnostic tools by agricultural and forest entomology field workers.

Tree Response to Invasion

Moderator: Elizabeth S. Tomlin, Simon Fraser University, Burnaby, BC

Constitutive or preformed resin is considered to be the first line of defence in conifers against pathogens and stem-invading insects, acting as wound cleansing or toxic agents. The second line of defence following wounding is the traumatic or induced response, which is characterized by formation of a necrotic area in the immediate vicinity of the injury. The necrotic tissue becomes impregnated with resins and phenolic material produced by dying parenchyma cells. An understanding of what elicits this response and what factors affect its intensity and expression is important from a forest health or pest management point of view.

Tim Paine, Dept. of Entomology, University of California at Riverside, discussed the **Effects of Bark Beetles and Associated Fungi on Hosts**.

1) Effects of Fungi on Host. Mycangial fungi are associated with many species of bark beetles. Females of the western pine beetle and southern pine beetle have thoracic mycangia. At least four other species also have this type of mycangium which is typically lined with cells, possibly encouraging fungal growth. The mountain pine beetle and Jeffrey pine beetle possess maxillary mycangia which may or may not be lined with cells. The effect of mycangial fungi on the host has not been well explored, but may affect water relations; drying out the tissue to make it a more favourable environment for beetles. Mycangial fungi of the western pine beetle do not produce a strong wound response, and mycangial fungi in general, probably do not grow well in healthy tissue.

Bluestain fungi are vectored on the surface of bark beetles in pits or on mites, and are probably not obligate associates. These fungi dry out the sapwood of the host and can cause death of the host in inoculation studies. Southern pine beetles can kill their host in the absence of bluestain fungi, and in Ponderosa pine, occlusion of the sapwood occurs in advance of the fungus, with fungal growth lagging behind insect development.

2) Effects of Host on Fungus. Reaction resins are generally inhibitory to bluestain fungi. Inhibitory compounds include phenolics as well as terpenoids. Lesion development in response to fungal invasion increases rapidly in the first 200hrs after inoculation and then declines. Time of year and physiological state of the tree when attack occurs are critical variables affecting tree survival.

Kier Klepzig, USDA Forest Service, Pineville,LA, discussed **Tree Responses to Invasion by Saprogenic Fungi and a Fungal Cell Wall Component.** Conifers typically respond to bark beetle vectored fungi by forming a resinous lesion, which may vary in length as a reflection of how far the fungus is able to grow before the host stops it. We hypothesized that if the host is under some sort of stress that renders it incapable of mounting an effective defence against the fungus, the fungus grows farther and does more damage to the tree before it is stopped. This may be especially true in the case of saprogenic fungi which are incapable of causing disease in healthy hosts, but capable of accelerating the death of stressed hosts. In research with *Leptographium terebrantis* and *L. procerum* in *Pinus resinosa*, we found that abiotic and biotic stresses (reduced light and root disease respectively), led to decreased host defensive response and increased success by these fungi. In the wound response of healthy trees, large amounts of alpha-pinene were produced which reduced spore germination. Shading decreased amounts of alpha-pinene in wound lesions. We are currently studying the success of these saprogenic fungi in trees in thinned and unthinned stands of *P. taeda* and in burned and unburned stands of *P. palustris*. We have also found that *P. taeda* responds to inoculation with chitossan, a fungal cell wall component by producing a defensive response qualitatively similar to its response to bark beetles vectored fungi. As such, this compound may be useful as a relatively predictable elicitor of localized host defences.

Kimberly Wallin, Dept. of Entomology, University of Wisconsin-Madison, discussed **Host Plant Mediation of Feeding Guild Interactions: Influence of Jack Pine Budworm Defoliation on Bark Beetles and Associated Fungi**. Defoliation by jack pine budworm influenced parameters of resistance against subcortical insects, including resin flow, fungal confinement rates, and monoterpene composition. The extent and direction of these changes varied with defoliation intensity, seasonal phenology and time since defoliation. These altered resistance parameters corresponded with incidence of attack by *Ips grandicollis* and *Monochamus carolensis*.

Elizabeth Tomlin (with Rene Alfaro (C. F. S.) and John Borden (Simon Fraser University)) discussed **Comparison of Wound Response Between White Spruce Resistant or Susceptible to the White Pine Weevil**. The traumatic wound response of families of white spruce, *Picea glauca* (Moench) Voss, resistant or susceptible to the white pine weevil, *Pissodes strobi* (Peck), were compared after simulated weevil damage. Leaders from 331 trees were wounded in the spring just below the apical bud using a portable 1mm diam. drill, coinciding with the natural time of weevil oviposition. Leaders were removed in the fall and examined for evidence of traumatic resin canal formation. Drilled trees had a traumatic wound response 8 times greater than that of undrilled trees, which had some traumatic resin canals formed due to unknown causes. The traumatic wound response extended into the lower part of the leader, where it could possibly affect older larvae. Trees from resistant families responded with a greater intensity than susceptible trees, producing multiple rings of traumatic resin canals. Trees from resistant families also responded more rapidly than those from susceptible families based on number of cells to the first ring of traumatic resin canals. There was a reduction in diameter growth after drilling, and drilled trees suffered a reduction in constitutive resin canals in the bark in the year of drilling suggesting some energetic cost of traumatic resin production. Screening trees based on their capacity to produce traumatic resin canals may be useful in selecting genotypes resistant to the white pine weevil.

Spruce Beetle Management Issues

Moderator: Stuart Taylor, BC Ministry of Forests

Two current research projects were presented and spruce beetle management was discussed in three different areas in the United States. The management discussions represented different themes: management in riparian areas, management in a remote setting, and management with an emphasis on thinning stands.

Robert Hodgkinson, British Columbia Forest Service, discussed a study regarding **Spruce Beetle Emergence for Hibernation in BC and its Implications to Operational Sanitation Harvesting** which he is carrying out in co-operation with Staffan Lindgren and Art Stock.

The objectives of this 4-year research project are: 1) to assess if spruce beetle emergence for hibernation behaviour can be predicted by climatic factors; and, 2) to assess if such emergence can be prevented by felling infested trees at an optimal time.

Three spruce beetle infested sites were selected in the Mackenzie and Prince George Forest Districts in two biogeoclimatic zones. At each location, 30 1995-attacked spruce were selected and a meteorological station was installed in early May 1996. Ten random spruce at each location were felled in late May - early June and an additional 10 were felled in mid-August. Beetle emergence traps were installed on all trees in mid-August and subsequently removed along with associated phloem in early-to mid-October.

There was a highly significant difference between the percentage of immature adults that emerged for hibernation from standing trees (39.8% - 60.2%) compared to the 7.0% - 18.5% that emerged from felled trees. There was no significant difference in emergence for hibernation between the early or late felled trees. Statistical analysis was not possible at the Kerry Lake site because a grizzly bear vandalized 73% of the emergence traps.

The weather station data is presently being analyzed and correlated to the percent emergence at each site. It is not expected that any meaningful correlations between weather and emergence will be possible until at least two more years of research. For this reason, it is hoped that the weather in 1997 - 1999 is appropriately different from that which occurred in 1996.

Therese M. Poland, Simon Fraser University, discussed her study on **Competitive Exclusion of the Spruce Beetle.** The feasibility of competitive exclusion as a potential management tactic for the spruce beetle was investigated using pre-attack baiting with pheromones of two secondary species, *Ips tridens* Mannerheim and *Dryocoetes affaber* Mannerheim. Spruce beetle attack densities, gallery lengths per m^2, and progeny densities were significantly reduced in individual felled trees baited with *I. tridens* pheromones, (±)- ipsdionol and (-)- *cis*-verbenol, *D. affaber* pheromones (±)-*exo*- and (±)-*endo*-brevicomin, or pheromones of both secondary species. A simplified *D. affaber* bait consisting of only (±)-*endo*-brevicomin also significantly reduced spruce beetle attacks, resource exploitation, and progeny production. Baiting with *I. tridens* pheromones also reduced spruce beetle attack and success in simulated patches of windthrown trees.

Resource exploitation and indirect interference by synomonal inhibition of spruce beetle attack are the most likely competitive mechanisms invoked. Competitive exclusion of the spruce beetle may provide an alternative management tactic where traditional methods based on tree removal, widespread harvesting, and the use of insecticides are not feasible.

Ken Gibson, USDA Forest Service, described **Management of Spruce Beetle in Western Montana with Emphasis on Riparian Issues.** A potential spruce beetle outbreak developed from a wildfire on the Kootenai and flathead National Forests in August, 1994. The fire (referred to as the Little Wolf Fire) ultimately burned over 14,000 acres, most of which was on the Tally Lake Ranger District, Flathead National Forest. Fire intensity was quite variable; some areas experienced fairly light ground fires, while others were of "stand replacing" intensity. Tree species affected were also quite variable--lodgepole pine and Douglas-fir were most common. Stream courses were comprised primarily of old-growth Engelmann spruce while subalpine fir was found at higher elevations. I was asked to help assess bark beetle potential, particularly in the less-severely burned stands, shortly after the fire.

Ground examinations revealed that many of the seemingly little-affected spruce stands had actually experienced ground fires of sufficient intensity to girdle many of the large-diameter, older spruce. We noted that beetle potential was high in those areas, as well as, some Douglas-fir stands which were only partially burned.

During winter 1994-95, severe wind storms blew down many fire-weakened trees, particularly spruce in riparian zones. Later, in summer 1995, surveys in those stands showed most of the downed spruce were heavily infested by spruce beetles. Subsequent, more-extensive surveys throughout the burned area found about 2,000 acres with significant amounts of downed spruce. Most were infested by beetles. Further analysis of district records showed nearly 5 000 acres, within 5 miles of the fire perimeter, contained high amounts of spruce. Approximately 3,700 acres were designated as "old growth" or potential old growth.

The need to salvage as much of the infested spruce, prior to adult beetle emergence in spring 1997, was emphasized. Ultimately, salvage efforts were proposed for about 1,200 acres of down and beetle-infested spruce within the area of the fire. Nearly 33 miles of streams coursed through the area, and most of the salvage was scheduled within these riparian zones. Because of the sensitive nature of these areas, and existing "streamside management zone" restrictions, almost one-fourth of the salvage was scheduled to be done with helicopters.

Salvage began in summer 1996, continued through much of the winter of 1996-97, and will be completed during summer 1997. Unfortunately, not all beetle-infested trees will be removed before beetle flight. In some areas, 250 trap trees will be dropped and removed by fall 1997. In still others, where no salvage logging will be done, about 200 Lindgren funnel traps will be used to try to contain emerging beetles.

In all, we are hopeful this integrated approach of cultural, chemical and mechanical means of dealing with a potentially devastating outbreak will help protect the integrity of these old-growth, and biologically important, riparian zones.

Dr. Edward Holsten, USDA Forest Service, gave a presentation on **Spruce Beetle Management Issues in Alaska-in a Remote Setting.** The spruce beetle (*Dendroctonus rufipennis)* outbreak(s) is the largest recognized forest health issue in Alaska. The infestations have been on-going for over a decade, but have substantially increased in the last five years. In 1996 aerial detection surveys noted more than 1.1 million acres of on-going and new infestations.

Past efforts at managing spruce beetle were "easier": (1) outbreaks were smaller and more accessible, and (2) "publics" were more accepting/trusting of professionals and land management decisions. There was less concern/awareness for spruce beetle caused-impacts to non-timber resources. Past management practices were small scale: salvage logging, some sanitation cutting, and lethal trap tree projects.

Current "management climate" has changed due to: (1) size of outbreaks, more than 25 million trees/year are being killed; (2) increased "public" concern with ecosystem management; (3) decrease in trust of forestry professionals, (4) "publics" questioning whether dead trees are a "problem", (5) harvesting on Native Corporation lands has increased; more than 100 000 acres "treated" on the Kenai Peninsula in the last decade with increased concerns over possible fragmentation of wildlife habitat; and (4) little "effective" management on public lands; management decisions are being handled via lengthy NEPA processes; management decisions then decided in the courts or through the State Legislature.

Julie Weatherby, USDA Forest Service, discussed **Spruce Beetle in Southern Utah.** Spruce beetle populations have increased significantly in Utah since 1992. Outbreaks are now occurring on the Monti and Difie National Forests. Recent stand disturbances; windthrow, avalanches, and landslides within moderate-high risk spruce stands have resulted in increased populations of this insect.

Treatment strategies include salvage only, sanitation/salvage, single tree and group tree selections, baited trap trees, felled trap trees and trap-out techniques using funnel traps. Single tree selection strategies have been designed to reduce basal areas to no more than 120 ft^2 and to increase spacing between residual trees. Frequently baited trap trees are used in conjunction with selection harvests. Group selection strategies have similar target based areas but clumpiness results in pockets of timber exceeding 160 ft^2 BA. Visual and wildlife objectives in addition to timber objectives frequently drive the choice of group selection strategies. In most selection cuts, susceptible large diameter trees are removed but the maintenance of size diversity in the leave stand is often prescribed for other resource objectives.

Biodiversity and Ecosystem Management

Moderator: Winifred Kessler, University of Northern British Columbia, Prince George, BC

Biodiversity has emerged as a key issue in all aspects of forest management including policy, practices, and the scientific and professional literature. The need to conserve biological diversity is a basic, underlying theme of new forest management strategies known as "ecosystem management" and "sustainable forest management." Today, it seems that no discussion of forest management is complete or relevant without consideration of the biodiversity implications.

Once restricted to the lexicon of ecologists, the term "biodiversity" commonly appears today in the popular media, the schools, the courtroom, the bush, around the family table--anywhere that issues of natural resources development and conservation are being discussed. Invariably, the images and examples that accompany these discussions are of the "charismatic" kinds of species: birds, mammals, fish, and the occasional reptile or flowering plant. Aside from a few charismatic butterflies, insects rarely enter into mainstream discussions of biodiversity and its conservation--despite the fact that insects outnumber the other taxa by far. Similarly, in discussions of ecosystem management and sustainable forest management, rarely is forest insect management identified as a significant element in the biodiversity picture.

What are the existing and potential roles of forest entomologists and forest pest managers in the new forest management strategies aimed at maintaining ecological integrity, including the full diversity of species and biological processes? Judging from the number of participants (100-120) in the April 16 workshop, this is a hot topic indeed among those involved in the study and management of forest insects. The workshop consisted of three 30-minute sessions, each focusing on a central theme. A panel consisting of **John Spence** (University of Alberta), **Jan Volney** (CFS Northern Forestry Centre), and **Tim Schowalter** (Oregon State University) provided opening comments on each theme, followed by general discussion among all participants.

Insects as Components of Forest Biodiversity

Are insects critical and significant components of forest biodiversity? If so, how does management of forest insects relate to broader goals and strategies for the conservation of biological diversity? John Spence, rubber ducky in hand for effect, gave the initial response. "We've grown up to view animals as good or bad, which has kept us from appreciating the importance of them all." Following that opening, John made the case that all species components in an ecosystem, even the least glamorous, have significant roles in the structure and function of the whole. He used the "cog and wheel" metaphor of Aldo Leopold to argue for keeping ecosystems intact. Although the ecological roles of species may not be obvious, we must assume that each contributes in some way to the operation of the whole.

In strategies for ecosystem management, it is understood that the objective to "conserve biodiversity" is a shorthand expression for maintaining the ecological integrity, resilience, and evolutionary potential of ecological systems over the long term. Given the myriad of functional roles served by insects, shouldn't these organisms be considered as possible linchpins in any strategy for sustainable ecosystem management? A loud "yes" was evident in John's response. The other panellists concurred with this basic premise, although Jan took a pragmatic stance, asking to see the practical aspects of John's ideas. Tim cautioned the group about sampling methods and interpretations of the results; i.e., varying sampling methods can produce different results. He also reminded the group that "maximizing biodiversity" (i.e. species richness) is not the aim; rather, the task is conservation of native species as components of the system to which they belong.

How did the group respond to these ideas? Judging from the open discussions that followed, these ideas have more supporters than detractors. There appears to be general concurrence that insects deserve more respect and study as integral and vital components of forest biodiversity. However, it was pointed out that the people who should be discussing these needs (the conservation biologists and related specialists) were not in the room. Their absence reflects generally poor linkages of the forest insect disciplines with the conservation biology community, and a perception by the latter that the Western Forest Insect Work Conference is about controlling insect pests.

New Roles for Professionals

The careers of many forest entomologists developed under the "kill and control" paradigm of forest pest management. How can this be reconciled with today's ecosystem management paradigm, which strives to maintain the full diversity of species, interrelationships, and processes in forest ecosystems? Do forest entomologists need to re-think their fundamental views, values, and roles in order to meet today's expectations and management goals for healthy forest ecosystems? The opening response was offered by Jan Volney, who pointed out that forest entomologists need to be ecologists first and foremost. The study of entomology must encourage thinking about insects in terms of processes and functions within an ecosystem context. However, in recent decades the emphasis on maximizing fiber as the "be all, end all" of forest management has been a major distraction. The jobs occupied by many forest entomologists, as well as their funding sources, have reduced the breadth of perspective to a narrow focus on forest pest management.

Tim agreed, referencing the broader public sentiment that "if it isn't a butterfly, it's a pest." John emphasized the need to switch from the kill and control mode to a broader mandate for risk avoidance.

The participants seemed split on this issue. Some agreed that a paradigm shift, including new roles, was needed. Others argued that forest entomologists, as ecologists, are already "broad enough to include biodiversity conservation in strategies for management of specific pests".

Threats to Biodiversity

Do the programs and practices of forest entomology impose significant threats to biodiversity and, by implication, to sustainable ecosystem management? Does focusing on a single management objective--the control of insects that cause timber losses--place other elements of biodiversity at risk?

Tim Schowalter had the first crack at these controversial questions. Using data from the Loquillo forest in Puerto Rico, he showed the enormous contribution of insect taxa to overall forest biodiversity. "You can't count or monitor them all," he emphasized, and recommended approaches that address functional groupings of insects (e.g., pollinators, detritivores). Building on that approach, he cautioned against painting entire group (e.g., sap suckers) with the same brush just because individual species are considered pests. "Because one species causes damage," he explained, "the whole suite gets a bad reputation."

Tim then discussed how management practices, designed to control one pest, can eliminate entire functional groups and cause secondary pest problems as a result. Without active management to retain coarse woody debris, suites of detritivores may be lost from forest stands. What are the implications for long-term productivity?

John agreed that we need to do much more research on non-target species. How often do the consequences of pest management practices outweigh the benefits? Again, the issue is one of risk management.

Participant reaction was vigorous but inconclusive. Clearly, there needs to be continuing dialogue on the basic question of whether conventional pest management can exist as a valid and acceptable component of sustainable forest ecosystem management.

Defoliator Management Issues

Moderator: John Wenz, USDA Forest Service

Participants: Approximately 35 attendees participated in discussions centred around presentations by four speakers.

Over the past several years, there has been a general change in forest resource management philosophy that can loosely be characterized as an increased interest in ecosystem sustainability and diversity and a reduced emphasis on timber production. Changing and increasingly diverse resource management objectives have spurred renewed interest in understanding the roles played by insects and diseases in ecosystem dynamics. Such interest has raised questions concerning native forest defoliator management and the relevance of monitoring and defoliator research - the topics for this workshop.

Julie Weatherby (Forest Service, Boise, ID) described the largest Douglas-fir tussock moth (DFTM) outbreak recorded in southern Idaho. It was detected in 1990 by aerial survey and by 1992 had defoliated more than 400,000 ac (162,000 ha). Eighty-eight percent of the Douglas-fir and 95% of the grand fir with >89% defoliation died between 1991-95. Douglas-fir beetle activity increased within the outbreak boundary following defoliation. The outbreak coincided with a significant drought period which likely contributed to the mortality.

Julie summarized results of an informal poll on defoliator issues of Idaho forest/district silviculturists who experienced the recent outbreak. The results were variable perhaps due to minimal experience with past outbreaks, especially western budworms. Respondees generally felt they would not likely consider direct suppression with the possible exception of the use of biologicals on a limited scale (developed recreation sites). Some felt that much of the habitat is outside the "historic range of variability" and that thus outbreaks may also be outside the historic range but could have a positive effect on forest health. Others noted that the recent DFTM outbreak caused enough mortality to interfere with prescriptions for visuals, wildlife hiding cover, goshawk habitat canopy closure, water temperature, timber production, regeneration, and recreation to render the project analysis invalid.

Peter Hall (British Columbia Ministry of Forests, Victoria, BC) discussed the implementation of a co-ordinated pest management program in response to the 1990-94, 8,900 ac (3,600 ha), DFTM outbreak in the Kamloops Forest Region. Based on research conducted during the 1981-84 64,200 ac (26,000 ha) outbreak, also in the Kamloops Region, the BC Ministry of Forests put in place a DFTM management program that includes the following elements: 1) a pheromone-based early detection system in high hazard areas; 2) increased pheromone trapping following initial population increases; 3) egg mass surveys to identify specific areas of population increase and predict defoliation; 4) use of the DFTM nuclear polyhedrosis virus (NPV) to suppress populations prior to visible defoliation. This program was in place in 1990; pheromone trap data and subsequent egg mass surveys indicated an impending outbreak and areas predicted to incur moderate to heavy defoliation identified. About 1,500 ac (600 ha) were treated with NPV during the outbreak, effectively preventing populations from increasing to damaging levels.

Institutional response to the recent DFTM outbreak near Kamloops is an example of effective implementation of a co-ordinated pest management program that was developed through close co-operation between management and research. Annual or regular monitoring of forest resource conditions and trends (e.g., DFTM population changes) is imperative, regardless of management objectives, in order to allow for both long and short-term informed decision making. In the case of DFTM, timely intervention may be necessary to preserve or maintain specific resource values.

Bruce Hostetler, Forest Service, Sandy, OR discussed management issues associated with the western spruce budworm (WSB) in eastern Oregon. Indications are that large-scale application of insecticides to control defoliators is becoming less acceptable to land managers and society as a whole. Evidence suggests that large suppression projects in Oregon during the 1980's and 1990's had little effect on populations as a whole and that to reduce effects significantly, treatments must be applied every 2 to 3 years during the outbreak. Thus, some feel there is little justification to allocate resources for defoliator research. The following two examples involving WSB in eastern

Oregon suggest a need to support continued research on the ecology and resource impacts of defoliators.

Stand 1. Almost all large, old, overstory ponderosa pine and Douglas-fir were harvested about seven years prior to the beginning of a WSB outbreak. The residual stand was almost pure Douglas-fir with an average DBH of 8.2 in (20.8 cm). The WSB outbreak resulted in almost 80% mortality in the residual stand reducing visual quality (a key issue for that stand) and increasing the risk of fire. An initial prescription that included consideration of WSB ecology (removal of many understory Douglas-fir and retention of many large, overstory pines and firs) would likely have resulted in minimal negative effects from the WSB outbreak.

Stand 2. This stand, of prime importance as elk habitat, consisted primarily of grand fir, with lesser amounts of ponderosa pine, western larch, Douglas-fir and lodgepole pine. A recent WSB outbreak resulted in 100% mortality to the grand fir, compromising the stand's value as elk habitat and increasing the risk of catastrophic fire. If the vulnerability of such stands to WSB could be predicted, management action could largely prevent negative effects.

These examples illustrate the need to better predict stand vulnerability to WSB and estimate the extent and severity WSB impacts for incorporation into silvicultural prescriptions. It is imperative to conduct long-term monitoring of innovative stand management strategies and to employ adaptive management techniques.

Bill Schaupp, Forest Service, Lakewood, CO reported on the 1993-95 DFTM outbreak in the South Platte River drainage on the Pike NF in Colorado. The general infestation covered about 20,000 ac (8,000 ha); heavy defoliation peaked at 6,000 ac (2,400 ha) in 1994 and declined to about 1,500 ac (600 ha) in 1995. Increased Douglas-fir beetle activity was evident in heavily defoliated stands. This is the largest recorded DFTM outbreak in Colorado and while the causes are unclear, it is thought that fire exclusion and changes in species composition to DFTM susceptible species (Douglas-fir) may be significant. The outbreak provided the opportunity for interaction involving the Forest Service, State of Colorado and the public. Management issues of concern included: 1) presence of a threatened species of Lepidoptera (Pawnee skipper); 2) fuels and fire potential; 3) granitic soils and erosion potential; 4) high recreation use; 5) a premier fly fishing stream and 6) intermingled ownerships and residential interface.

Considerable discussion punctuated these presentations. At some risk, the following is an attempt to summarize key issues: 1) While large-scale insecticide suppression efforts against native defoliators is decreasingly likely/appropriate, there is a continued need for suppression using biological insecticides (e.g., NPV) in high-value areas/stands for the efficient attainment of diverse, specific, resource management objectives; 2) It was not clear that DFTM predictive capabilities are sufficient in some geographical areas to allow the effective use of NPV prior to the onset of visible defoliation (as was the case in British Columbia during the 1990-1994 outbreak); 3) There remains the need to monitor defoliator populations and predict potential resource impacts to allow for informed resource management decision-making regardless of whether the decision involves direct suppression; 4) There is a continuing need to evaluate defoliator impacts and develop predictive capabilities to help develop and implement management strategies to prevent/reduce unacceptable impacts.

Decision Support Systems - The Needs vs Ongoing Projects

Workshop Moderator: David MacLean, Canadian Forest Service, Fredericton, NB

What are the needs for decision support, from the standpoint of forest managers? How do these relate to ongoing insect management decision support system (DSS) studies? What are the unfulfilled needs and opportunities? These were the questions addressed by 7 speakers, a mix of 3 forest/pest managers and 4 scientists involved in DSS development. Each gave a brief 5-min. overview, which was followed by lots of discussion. Participants included the following:

Insect	Needs	Existing/Ongoing Studies
Bark beetles	S. P. Taylor, BCMoF	T. L. Shore, CFS
Spruce budworms	H. Ono, AFS	D. McLean, CFS
Defoliators/weevils	L. E. Maclauchlan, BCMoF	R. Alfaro, CFS
Jack pine budworm		J. Volney, CFS

Stuart Taylor described 3 types of decisions required for bark beetle management in British Columbia:

1. assignment of treatment priorities;
2. allowable cut decisions, in which unsalvaged loss estimates are used in timber supply analysis calculations; and,
3. monitoring or auditing of different tenures for quality control, as in assessment of spruce beetle infestation levels and treatment results.

Stuart indicated that one of the needs for Annual Allowable Cut (AAC) decisions was a Natural Disturbance Tracking System, in which survey information on the location and severity of natural disturbances is transferred to a Geographic Information System (GIS) and interpreted in terms of stand response. The attributes needed for beetle decision support include:

- administrative tenure holder,
- beetle incidence/ intensity,
- treatment results (area & year logged); and,
- the geographic base information.

Some potential problems are the need for good attribute definitions (i.e. must be readily understandable) and changing beetle probe and mapping standards.

Discussion: Stuart Taylor thinks a flaw of the current system is an over-emphasis on treatment priorities at the expense of the other types of decisions. Discussion regarding impacts to allowable cut: David Gray thinks this type of stuff is only an administrative audit, not DSS. Provides information, not decision support. Discussion ensued regarding different needs for different decisions (treatment priorities and need for greater allowable cut). Lorraine Maclauchlan explained a need to provide information and projections on periodicity and cycles. Stuart et al. see need to project shortfalls in timber supplies. Ann Lynch raised FVS+Bud-Lite work on incorporating dendrochronologically reconstructed insect periodicity information into forest projections, which shows promise for projecting over outbreak cycles, even multiple outbreaks.

Hideji Ono explained that 97% of timber in Alberta is allocated to AAC now, so the previous decision of "going elsewhere" to harvest when faced with pest problems is no longer possible. Alberta is currently in the midst of a 220,000 ha spruce budworm outbreak. What we know includes:

- spruce budworm (SBW) affects growth and yield and limits timber supply;
- harvest allocation is based on growth and yield projections for healthy stands; and,
- SBW outbreaks cannot be predicted, we don't know why outbreaks are in certain areas.

What we can do is: adjust the harvest schedule, but cannot schedule additional road-building (by companies) for budworm management; use insecticide treatments (*Bt*); begin to use GIS for spatial evaluations; adjust growth and yield tables to account for insect effects (the companies see this as important); and do short-term hazard rating. The needs include: cost/benefit analyses for treatment options (need data on best time to treat); estimating effects of multiple outbreaks in stands; improved basis for decisions to preserve timber in older stands by spraying insecticides; computer technology that can do better, faster, and more work (than humans) to support decisions.

Lorraine Maclauchlan described the need for a landscape-level planning tool that tells us the following: what to expect (defoliators, pathogens, bark beetles, fire); when to expect the event; longevity of event, per ecosystem and geographic zone; and the impact of the event at the tree/stand/landscape level, for determination of objectives and treatments. Lorraine also described the need for a silviculture & pre-stand tending prescription DSS tool for areas affected by insects and disease. This would, for each biogeoclimatic zone and species, provide objectives of area and final product and a range of treatment regimes. The DSS tool should be sensitive to pest complexes, impacts, timing of treatments, and stand/landscape objectives.

Discussion: Dave MacLean: who would use the first tool? Lorraine: Region, industry, district managers, Land & Resource Planners use it now. Stuart Taylor: now we have a shift in harvest philosophy to larger patches, up to 800+ ha, or several times larger than the past norm, based on past fire disturbance & caribou needs. Rene Alfaro: what is required at the landscape level isn't insect & disease DSS, but integrated resource management DSS? Yes, all agreed. K. Burke: more detail on the prescription DSS? Lorraine: being developed by ESSA, using a model from USFS Region 6 Forest Health Management (Sheehan) to make projections. Will overlay constraints and cutting regimes, look at outputs; system is in early development/use stage.

Terry Shore described development of the Mountain pine beetle (MPB) DSS. His group has been working on the DSS for 5-6 years, even longer on hazard modelling, and now is looking at expanding the MPB system for Douglas-fir beetle and spruce beetle. The MPB DSS addresses data and map integration, predictive modelling (risk and impact), and a rule base for selection of management options. Recent progress has been on incorporating risk models in rule bases. The DSS approach is from an entomological perspective, and is not yet into resource objective layers. They have a prototype of management option selection program, version 2 of a risk rating system, a prototype impact model, a literature database, and a spread model. Future plans include WWW application of the risk rating system, management expert system, and literature database.

Dave MacLean described the eastern spruce budworm (SBW) DSS developed since 1992 by he and Kevin Porter. The DSS is based on strong impact information, a PSP database of defoliation vs. growth and mortality information used to calibrated the STAMAN growth and yield model to predict defoliation effects. Studies have also determined effects of hardwood content, drainage, and species on defoliation and impact. SBW DSS usage is in three areas: 1) estimating budworm effects on forest planning for timber supply, AAC, harvest scheduling; 2) protection (insecticide) planning; and 3) landscape planning to reduce forest-level damage (planning stand type combinations that reduce aggregate damage). Dave described two DSS tools. The first was an ArcView-based Inventory Projection System, that projects spatial forest inventory up to 30 years in the future, under user-specified budworm outbreak timing/severity and protection scenarios. The 2nd was the Protection Planning DSS, a system for planning SBW protection based on a marginal timber supply benefits map. The user can digitize potential spray blocks and get information on timber supply (m^3) saved per spray block. Dave's thoughts on future directions in DSS research included the need for preventative DSS tools that assist in use of management to restructure forest landscapes to reduce risk and reliance on pesticides; tools to help incorporate effects of insect-caused damage into management planning; DSS to evaluate cost/benefits and improve visualization of insect outbreaks and management strategies; and the output of a suite of forest performance indicators (environmental, economic, social) from DSS.

Discussion: Rene Alfaro: likes the idea of expanding pest DSS to other resource values. Dave: that point is now becoming clear from many directions.

Jan Volney presented work on impact of jack pine budworm (JPBW), as part of the JPBW DSS. Over 10 years he followed cohorts of JP trees under different conditions, and evaluated factors that influence mortality. The analysis was approached similarly to studies of human demography. Results showed that a small number of variables affect the likelihood of JP mortality: 1) amount of 2nd year defoliation (an indicator of cumulative effects), 2) amount of topkill, 3) relative crown position, and 4) tree diameter. These were found to be good predictors of which trees die in a stand during JPBW outbreaks. Can also make projections of vol/ha, non-timber values (via tree population dynamics), and stand dynamics. Jan indicated that he is also working with economists to evaluate effects on timber and non-timber values.

Rene Alfaro presented work on a DSS for white pine weevil (also called spruce weevil) in BC. This work developed modifiers for weevil damage for incorporation into the TASS growth and yield model developed by Ken Mitchell, BCFS. The system is applicable to young plantations and regeneration pests. TASS is a tree distance-dependent model that includes crown competition. It is used to produce managed stand growth and yield tables. The following factors were needed to develop the SWAT subroutine that modifies crowns of trees in response to weevil attack: weevil biology, epidemiology, spatial information, crown recovery, and defect formation. No. leaders produced in response to weevil attack is calculated; this is passed to the weevil model, which returns information on effects, defects. This is used to modify volume/age curves, which have been used in some timber supply analyses. The system allows simulation of different levels of weevil attack, silvicultural options, host resistance, insecticide injections, and effects of site preparation by burning (which has been found to increase weevil damage).

Discussion: Is the system applicable to mixed species? Rene: yes, but different species don't compete. Effectively, the model is growing different species as different stand. Work is proceeding on a mixed species model.

Semiochemical Research and Applications

Moderator: Pat Shea, USDA Forest Service

Participants: Darrell Ross, Ron Billings, Richard Werner, Rodger Burnside, Don Dahlsten, Lynn Rasmussen, John Borden, Ian Wilson, Brian Strom, Steve Burke, and 25 other individuals.

Darrell Ross, Oregon State University, discussed his ongoing research in co-operation with the USDA Forest Service, Pacific Northwest Research Station, to develop pheromone-based methods for managing the Douglas-fir beetle (DFB). They have developed an operational treatment using the anti-aggregation pheromone, MCH, to protect high-risk, high-value stands from infestation by DFB. Application of MCH in plastic pouches at rates of 25g/ha can significantly reduce the probability of infestations occurring. The treatment does not appear to have any negative effects on natural enemies associated with the DFB. The only obstacle to operational use of this treatment is registration by the Environmental Protection Agency. They have also been studying the possibility of using pheromone-baited traps to control the amount or distribution of tree mortality caused by DFB during outbreaks. The most attractive lure tested for the DFB was a combination of frontalin, seudenol, and ethanol. Many questions pertaining to the most effective use of baited traps are still under study. Once these treatments are fully developed they can be combined with silvicultural treatments in programs designed to meet a variety of resource management objectives across the landscape.

Ron Billings, Texas Forest Service, reported on a co-operative project involving Scott Salom, Wayne Berisford, and Steve Clarke whereby the efficacy of verbenone has been demonstrated in several southern states for suppressing southern pine beetle (SPB) infestations. Two tactics have proven effective: (1) application of verbenone to standing uninfested and freshly-attacked trees in pulpwood stands with < 80 infested trees; and, (2) application of verbenone to uninfested trees around the leading edge of infestations with < 120 trees, in combination with felling all currently-infested trees. A website on SPB and a description of these verbenone tactics has been established on the Internet:

http://viner.ento.vt.edu/~salom/jspbinfodirect/spbinfordirect.html

Plans for 1997 are to field test improved dispensers and various application techniques and develop materials for eventual technology transfer of these semiochemical baits to potential users.

Richard Werner, USDA Forest Service (retired), reviewed field studies conducted during 1995 on the Kenai Peninsula in Alaska to determine the efficacy of MCH for protecting stands of spruce from spruce beetle (SB) attack. One-half acre circular and square plots were treated with MCH bubble caps spaced at 25ft intervals in the square plots and at 25ft intervals around the circumference of the circular plots and along an inner circumference located 40ft within the plot. Both treatment configurations had significantly lower successful beetle attacks than the untreated control plots. A field study was also completed in 1996 to verify that MCH was the major semiochemical that deterred spruce beetle attack. The efficacy of MCH was compared to 4-allyanisole (4-aa) and (L)- limonene in spruce stands with low and medium level beetle populations. The deterrents were tested in 12 funnel Lindgren traps with spruce beetle binary pheromone frontalin and alpha pinene. MCH caught significantly fewer beetles than 4-aa and (L)-limonene in medium level SB populations; trap catches in low populations were not significantly different between MCH and 4-aa. Combinations of the tree deterrents did not increase efficacy.

Roger Burnside, State of Alaska, reported on a project initiated in early 1996 to assist with the trapout of emergent engraver beetles near 300+ white spruce log decks that were left within cut blocks harvested during the winter of 1994/1995. A decision was made to look at the response of dispersing beetles in the clear-cut openings and adjacent residual stands. The purpose was to gather additional information which might be useful for development of operational guidelines for "time of harvest" and slash treatment measures to minimize future stand losses from *Ips perturbatus*. Traps were baited with 40mg of racemic ipsdienol bubblecaps (110 micrograms/24 hr release rate). The results from the 1996 ipsdienol trapping indicate relatively high *Ips* populations in the recent cut over blocks (harvested winter '95/'96) compared to *Ips* populations in residual stands that had experienced recent heavy *Ips* and budworm/coneworm infestations.

Don Dahlsten, University of California, reported on a continuing project to investigate the response of different geographical populations of *Ips pini* and their predators to different enantiomers of its pheromone. Parallel experiments in California and Wisconsin will be conducted to assess such geographic differences in response and therefore provide a more comprehensive approach for pest management. Information on differences and similarities among predator and prey responses to bark beetle pheromones should increase our ability to incorporate biological control into management programs developed for *I. pini*, in particular, and bark beetles in general.

This summer studies will test whether predator to prey ratios can be affected, yet minimize the response of predators such *Thanasimus*, *Enoclerus*, and *Platysoma*. Further studies will determine which of these selected pheromones most closely attracts actual ratios of predators to pests arriving at host trees.

Lynn Rasmussen, USDA Forest Service, discussed his research on *Dendroctonus adjunctus* (RHPB) and *D. brevicomis* (WPB). Lindgren funnel traps baited with exo-brevicomin and frontalin, were placed in a 1/4 mile grid spacing in the Pine Valley campground, Dixie N.F. Utah. These traps were used to ascertain the flight periodicity of RHPB and WPB, infesting ponderosa pine, while at the same time reducing populations of these bark beetles. Traps were collected weekly. The number of beetles caught revealed a small April/May and large October flight of RHPB. Most WPB were caught in September. In mid-November of each year all infested trees in the campground were marked and later removed during the winter. These actions have reduced tree killing in the campground from a pre-treatment average of about 30 to 13 in 1996. Trapping is continuing in 1997.

John Borden and Ian Wilson, Simon Fraser University, presented data showing that four volatiles from the bark of quaking aspen stimulated the antennae of mountain pine beetles (MPB) in coupled gas chromatographic-electroantennagraphic analyses. When tested individually as potential disruptants to trap baits composed of trans-verbenol, exo-brevicomin and myrcene, only 1-hexanol caused a significant decline in responses to beetles to Lindgren funnel traps. However, in binary, ternary, or quartenary combinations the other tree volatiles, benzaldehyde, benzyl alcohol and nonanal, all contributed in an additive manner to the disruptive effect. In binary and ternary mixtures compounds were replaceable, indicating redundancy. The quarternary blend in mixture with verbenone caused a significant increase in disruption of the response to traps over that caused by verbenone alone. The same blend increased the efficacy of verbenone in protecting attractant-baited lodgepole pines from attack. These results suggest that non-host bark volatiles may have practical utility when used in combinations with antiaggregation pheromones to protect trees from attack by bark beetles.

Brian Strom, USDA Forest Service, reported on field studies with *Dendroctonus frontalis* (SPB) that show treatments which alter visual silhouettes hold promise for disrupting the host selection process of this species and may lead to improved tree protectants. A factorial experiment with various combinations of aggregation pheromones and white and black funnel traps was conducted to determine the effect of semiochemicals and visual disruptants on SPB and its primary predator, *Thanasimus dubius*. The number of SPB and its predator caught in Lindgren funnel traps was reduced more by visual than semiochemical treatments. However, the combination of semiochemical and visual disruptants, 4 allylanisole and white paint in this study, reduced SPB catch by about 90%, the greatest reduction of any treatment combination. In another study, trees were painted in front of an actively growing SPB infestation and those trees painted white had about 79% fewer SPB landing on sticky traps and about 95% fewer attacks than black trees. This research effort will continue to investigate the relationship between aggressiveness and visual disruptability in bark beetles.

Riparian Zones and Forest Health

Workshop Moderator: Ken Gibson, USDA Forest Service, Missoula, MT

Participants: Approximately 40 attendees participated in discussions relative to the importance of riparian areas, their unique management concerns, how insects and diseases may affect them, and the need to safeguard the health of these critical areas.

Ken Gibson began with an overview of riparian areas, characteristics by which they are distinguished, and the Forest Service's role in protecting these sensitive and critical habitats. Specifically, the position of the USDA Forest Service on riparian areas is:

> We are committed to giving special attention to riparian areas. Often these are the most productive, sensitive, diverse, and geographically limited ecosystems in the National Forest System. Many important resources (fish, some wildlife, and certain vegetative communities) totally depend on riparian areas. Forest Service policy focuses on managing for "riparian dependent resources"; natural and beneficial resources include groundwater recharge, moderating of flood peaks, sediment reduction, visual and recreational enjoyment, timber production, forage production, wildlife habitat, and cultural resources.
>
> A doctrine of "wise use" involves managing riparian areas under the principles of multiple use and sustained yield - while emphasizing management and improvement of soil, water, vegetation, fish, and wildlife habitat. We accept the challenge to fully realize values and benefits and maintain the unique features of healthy riparian areas. Long-range plans, providing for maintenance and improvement of watershed conditions, have long-term objectives, guidelines and standards to maintain unique values of riparian areas.

Sandy Kegley (USDA Forest Service, Coeur d'Alene, ID) next described an approach, being developed in the Northern Region, USDA Forest Service, for assessing the impacts of insects and diseases on forested habitats. An abstract of that methodology follows:

> Insects and pathogens are important and somewhat predictable agents influencing forest succession. Past Forest Service planning efforts have not always reflected the full role of insects and pathogens in forest succession. Forest Health Protection staff in the Northern Region has developed methodologies to efficiently analyze these insect and pathogen successional roles. The methodology involves a combination of data management, spatial and non-spatial analysis, and modelling.
>
> This analysis is a practical application of current ecosystem management theory. The influences of pathogens and insects on forest succession are measured by relating successional transition rates and types to conditions where pathogen and insect activities are expected to lead to transitions.

> Results of this analysis provide means to better understand historic and current functions of insects and pathogens; and provide a basis for predictions of future trends of insects and pathogens with respect to specific ecological functions. This methodology should find wide application for planning activities relative to many forested ecosystems.

Sandy further related how that assessment could be used to detect affects in riparian areas, and how the model may be used to plan activities assuring the health of riparian zones.

Jill Wilson (USDA Forest Service, Flagstaff, AZ) detailed some of the unique characteristics and attendant problems of riparian areas in the arid habitats of the Southwestern United States. An abstract of her comments follow:

> Riparian areas are critical to ecosystem health in the southwestern United States. Though they comprise only two percent of the landscape, they are used by two-thirds of the animal species in the area at some point in their life cycle. Riparian areas represent the zone of interaction between aquatic and terrestrial environments. They are significant in many ways. They are home to many threatened, endangered, and sensitive species. They assist in slowing flood flows, reducing erosion, buffering soil chemistry, and protecting hydrologic systems from temperature extremes and evaporation loss.
>
> Herbivorous insects and pathogens are often symptoms of underlying decline in riparian ecosystems--as they are in terrestrial ones. Direct effects include defoliation, dieback and mortality. Indirectly, their activities can affect other processes and result in increased streamflows, reduced interception, and reduced evapotranspiration. Many of the pest species in riparian areas are ones we're more familiar with, such as bark beetles and dwarf mistletoes. Others, however, are sometimes unique to riparian zones, or ones about which less is known.
>
> The alder flea beetle, *Macrohaltica ambiens* LeConte, and a rust, *Melampsora* spp., are good examples of pests contributing to decline of two important riparian tree species, Arizona alder and Arizona willow, respectively. Both need to be studied further to understand more fully their biologies and long-term impacts in these sensitive environments. These and other insects and diseases found in riparian zones need more attention and study to help obtain a better understanding of their interactions and influences in these critical habitats.

David Beckman (IDL, Coeur d'Alene, ID) related an outbreak of an exotic pest, balsam woolly adelgid (*Adelges piceae* [Ratzburg]), in riparian areas in north-central Idaho. The adelgid, first discovered in Idaho in 1983, expanded its range to more than 24,500 acres in 1996. It is beginning to have considerable impact on subalpine fir stands in many riparian areas throughout its range in Idaho. Found not only in riparian areas, but low-elevation frost-pockets as well, adelgids are killing subalpine fir in high numbers and seriously affecting the growth of immature grand fir.

A general discussion, involving many workshop attendees, followed. Several shared experiences from various parts of the United States and Canada. All realize the special needs of riparian areas and the extent to which they must be protected for the benefit of other forested ecosystems, their inhabitants and visitors.

Terminal Weevil Management Issues

Moderator: Rene Alfaro, Canadian Forestry Service

Lorraine Maclauchlan, entomologist with the BC Ministry of Forests, Kamloops Forest Region, discussed current research in *Pissodes terminalis* research. *Pissodes terminalis* primarily attacks and kills the current years growth of young lodgepole pines resulting in some degree of stem defect. The growing space available to trees, or stem density, and the biogeoclimatic zone in which the damage occurs greatly influences the severity of stem defect resulting from weevil attack. Although multiple attacks per tree are seen, one attack resulting in a major defect such as a fork is enough to cause major value loss to the affected tree.

The heat sum required for development of *P. terminalis* is currently being determined through field recordings and controlled rearing studies. This degree day development will assist in developing a climatic hazard rating for the weevil. Daily observations are made in the field of weevils that have been marked and released into a screen cage. Their activities will then be coupled with the climate data. Extensive field assessments have been done throughout the range of biogeoclimatic zones in which *P. terminalis* is found. The attack rates and subsequent defects that are formed are being factored into the hazard and risk rating calculation.

Stand tending activities, such as spacing, greatly influence the percentage of annual attack in a stand, the defect formed following attack and the success rate of weevils developing within leaders. Therefore, the type of stand tending and timing is an important factor in the hazard and risk model.

Other areas of research include further work on an oviposition deterrent and other forms of semiochemical communication.

Michael Hulme, research scientist with the Canadian Forest Service, discussed a palearctic parasitoid that shows promise for the biological control of *Pissodes strobi*. While there are many native parasitoids that attack *P. strobi* broods, most appear to be polyphagous and thus unsuitable for manipulation in applied biological control. One, a native egg-larval parasitoid, *Allodorus* (= *Eubazus*) *crassigaster*, attacks only *Pissodes* species, all of which are considered pests. Given the varied habitats of these nearctic *Pissodes* species, different ecotypes of the parasitoid must exist. The parasitoid appears to have good searching ability, and has high fecundity. The egg laid in the host egg, hatches at the same time as the host egg but further parasitoid development is delayed until the host larva reaches maturity. At this stage the parasitoid larva completes its development, and pupation and adult eclosion follow directly.

Parasitism by *A. crassigaster* on *P. strobi* is generally low. However, parasitoid species in Europe which are closely related to *A. crassigaster* and occupying the same ecological niche on palearctic *Pissodes* species, show much higher parasitism of *Pissodes* broods. These European parasitoids should readily attack *P. strobi* since they are able to parasitize any chosen *Pissodes* species in European trials. Indications are promising from a variety of work that these European parasitoids will have a much greater impact on *P. strobi* broods than the native *A. crassigaster*.

Stuart Taylor, BC Ministry of Forests, Prince George Forest Region, described a study concerning predicting spruce weevil attacks on white spruce sites. A correlation study was conducted on 80 sites in 1995 to develop a model to rate stands of white spruce for their susceptibility to spruce weevil attack based on various site variables. In total, 32 site variables were assessed and the criteria to select the "best" regression models included: maximization of the coefficient of multiple determination; maximization of the F-ratio; minimization of the standard error of the estimate; and minimization of model complexity. The "best" multiple regression solution included the independent variables: stand age; stand density; and, elevation ($F(3,71) = 18.025$, $p= 0.001$).

Two variable ordering techniques both confirmed that stand density was the least important variable and that elevation and stand age were the most important. Further, the preliminary analyses also indicated that future experimental work may show that slope position, slope percent, humus content and, perhaps, one or two vegetation species may serve as useful predictors of weevil attack. Finally, the following "simple rules" were presented that would allow the practitioner to define a high weevil hazard in this subzone:

High weevil hazard exists where

Stand Density (sph)	and	Elevation (m)
>1600		<775
1200-1600		<800
<1200		<825

Rene I. Alfaro, Research Scientist with the Canadian Forest Service, discussed management of the white pine weevil, *Pissodes strobi*. An Integrated Pest Management System (IPM) has been proposed for *P. strobi*. This system relies on restoring ecosystem balance by reducing the conditions that lead to outbreak development. The system recommends tactics that diminish heat accumulation in the stand by encouraging growth of suitable non-host conifers as well as deciduous species such as aspen or alder. These trees render the stand cooler and shadier, reduce food supply, and probably create conditions which enhance natural enemy populations.

Reduction of damage by increasing plantation density is also recommended. Central to IPM is the continuous monitoring of weevil populations and forecasting of weevil impacts on forest productivity through a computerized Decision Support System, which helps to evaluate the need for, and the possible benefits of, any given tactic.

A salient feature of the IPM system for *P. strobi* is the combination of tactics involving silviculture and host genetic resistance. Host genetic resistance could be utilized to allow increasing the percentage of spruce per hectare in ecosystems prone to infestation. In low hazard areas, silviculture-driven tactics such as mixed-species planting and increased planting density may be sufficient to produce a successful spruce crop.

In high hazard areas, the silvicultural prescription should include the use of resistant stock. However, the deployment of resistant genotypes should take into consideration the need for avoiding the risk of insect selection leading to biotypes capable of overcoming the resistance mechanisms. For this, a component of susceptible stock should be planted along with the resistant material. Judicious use of genetic resistance, together with shade conservation, mixed-species planting, maintenance of biodiversity, and other measures for restoring ecosystem balance, will secure continued production of spruce timber in British Columbia.

White pine weevil research projects by graduate students at the University of British Columbia were described by **John A. McLean**, University of British Columbia. These studies have been carried out in collaboration with Dave Spittlehouse, BC Ministry of Forests (Brian Sieben) and Rene Alfaro, Pacific Forestry Centre (Rory McIntosh and Ron Parker).

Heat sum accumulation data for British Columbia and for the MacKenzie Basin have been used by **Brian Sieben** to develop a province wide weevil hazard rating system for spruce plantations. The initial approach has been to determine air temperature degree day lapse rates to extrapolate heat sums over the landscape. Several sources of variance have been found that can affect this approach. Spruce leaders have temperature regimes that may be as much as 5 °C above ambient air temperature. Cold air drainages lead to katabatic cooling with depressed valley floor minimums that affect computation of daily averages the Atmospheric Environment Service (AES) calculates by using the average of daily maximum and minimum temperatures.

Brian has also demonstrated the temperature differences associated with slope, aspect, and overstory shading. Brian is utilizing digital terrain models to define these aspects of the landscape and will apply correction factors, as best as he is able to determine them, in order to produce the most reliable hazard rating map. This approach also allows Brian to game with climate warming scenarios.

One aspect of **Rory McIntosh's** research at the Kalamalka Research Station is that he has been able to monitor leader temperatures throughout the year. The impact of the elevated leader temperatures throughout the season is that the first weevils emerge at almost the predicted 785 degree days that was determined by Les McMullen in 1976. The air temperature AES computed heat sum at this time was 180 degree days low. Another way of viewing this is that the AES degree day accumulation predicted emergence on JD 206, 18 days after the first weevils had emerged! Management systems that rely on accurate prediction of weevil emergence will need to include an allowance for leader warming effects.

Rory has also carried out detailed dispersal studies with marked weevils over the last three years. Every weevil he has encountered in the Kalamalka plantation now has a unique number (more than 1400 now). Diurnal studies throughout the summer have shown how weevil behaviour varies with temperature. Most inter-tree movement was recorded in April and May.

How do forest management techniques affect weevil development in plantations? **Ron Parker** has been working with the McGregor Model Forest to assess weevil incidence in young stands in the SBSwk1 and the SBSvk. He was able to show that older stands had a higher attack rate but there is no consistent relationship of attack with site preparation (none vs burned vs mechanical) or stand management (none versus brushed). Only the class 2 stands (10 - 20 years old) were sufficiently well represented for sampling of each category.

Landscape Level Surveys

Moderator: Bill Schaupp, USDA Forest Service

Discussion among the approximately 19 attendees concerned the acquisition, accuracy, value, and use of landscape level survey data. Erik Smith and Jan Volney gave invited presentations to help stimulate discussion. Three issues which repeatedly emerged were appropriate new uses for aerial survey data, the potential to corroborate information by comparing results from different spatial scales, and matching the acceptable level of data accuracy to a given spatial scale and project.

Moderator Schaupp opened the session by observing that in the past 10-15 years, it has been increasingly possible to integrate and analyse information on spatial scales larger than individual forest stands. This has been facilitated by the development of computer technology to use spatially referenced data and by the availability of increasingly sophisticated satellite imagery. Landscape level surveys can be conducted from the ground, from aircraft, and from satellites. Issues of appropriate scale are a constant and important concern, especially when comparing information acquired at different spatial scales.

"Opportunities and problems often are the same," said Eric Smith as he began his presentation. The opportunity now exists to incorporate landscape level information from several sources, helping to address problems associated with adequate sample size and appropriate sampling design. The size of the area to be considered and the scale of data resolution are problems associated with this opportunity that are not well worked out yet. Data from ground and aerial surveys can be aggregated to provide a landscape perspective. Techniques are available to assess spatial and temporal relationships at the landscape scale. These new statistical techniques can be difficult to understand. Comprehending scale and grain size effects then becomes a new challenge. We do not understand the movements of insect populations over landscapes very well. It is difficult to quantify and to obtain repeated measures for comparison. As the field of landscape ecology emerges, new landscape level techniques will allow us to investigate this subject. One major area of application is landscape analysis and planning. Smith said that landscape ecology is an emerging and important field where there is a lot of action.

Jan Volney presented results of studies he and his co-operators conducted that integrated information spanning spatial scales from the stand to the boreal forest biome. The first set of studies he presented concerned the forest tent caterpillar. Results from stand-level investigations were matched with temperature and long-term population information from across the boreal forest. This revealed how spring temperatures contribute to long-term forest tent caterpillar population trends and defoliation cycles. The second set of studies concerned the jack pine budworm. Stand demography investigated over a 10 year period was matched with long-term defoliation records from across Canada, obtained by aerial survey. In this way, Volney illustrated how *Armillaria* root disease and fire modifies jack pine budworm population behaviour. By relating these influences to habitat type and fire history, jack pine budworm behaviour over large areas and long time scales can be better understood. Volney noted that age structure of our forests is important, yet generally not well known. Volney suggested that global changes may be affecting the rate of change and periodicity of jack pine budworm populations, yet it was a spatial scale he was not able to incorporate into his studies. He closed by describing the Canadian aerial surveyors who made annual surveys for so long as visionaries. One can never know what information will be useful in the future.

GIS Applications

Moderator: Kevin Porter, Canadian Forestry Service

This workshop brought together approximately 25 people interested in the application of geographic information systems (GIS) to forest insect problems. Three speakers gave short presentations that varied in scope from operational applications to research-oriented, analytical use of the technology. Abstracts of their presentations follow.

Forest health spatial and attribute data capture, display and analysis - Val Fletcher, British Columbia Forest Service, Victoria, BC A system for forest health information, being developed within the BC Forest Service, consists of two major subsystems: the Forest Health Attribute Database (FHAD) and the Silviculture Electronic Mapping System (SEMS). FHAD is implemented using Microsoft Access to capture aspatial data on pests (currently bark beetles in mature stands). It tracks the "lifetime" of each location surveyed through either aerial inspection or ground probe. Site, access, planning, survey and treatment data are entered as well as derived data such as risk index. A "gislink" attaches these attributes to spatial data. SEMS is a Microstation (Bently) application that contains a forest health module for tracking spatial information. Hazard/risk (high, medium, low) is recorded for each forest health factor.

The information in the two subsystems can be integrated through several display and analysis tools. Basic display capabilities can be accomplished with Mapview, ArcView (GIS), and Geomedia while complex spatial analysis and reporting is possible with a full function GIS such as ARC/INFO, Pamap, or MGE.

FHAD is now implemented in six pilot Districts with SEMS readied in eight pilot Districts. Wider implementation is expected in the current fiscal year and will include up to 12 additional districts. We are developing these systems to better facilitate the detection, quantification, and impact assessment of damage agents. It will also allow both short- and long-term planning of suppression/treatment activities, reallocation of resources and performance monitoring of these activities.

In the future, we plan to utilize field data loggers for data collection and also move to a pen based operating system with map display to capture aerial spatial information. In addition, FHAD will be expanded to capture defoliators and root diseases along with pest information on forest cover openings. We would also like to include data on young and disturbed stands from the mainframe-based Integrated Silviculture Information System (ISIS) and eventually move toward an Integrated Corporate Spatial and Attribute Database (INCOSADA) that facilitates simultaneous, integrated data capture.

Improving decision support systems through spatial analysis of historical data - David Gray, Canadian Forest Service, Ste-Foy, Quebec. The ESBW DSS under development by the CFS in Fredericton, NB estimates accumulated benefits accruing to a forest stand from a protection scenario applied until scheduled harvest. The DSS simulates and compares stand growth under budworm-protected and budworm-unprotected scenarios to estimate these benefits. A critical factor in the simulations and estimations is the forecasted budworm epidemic. The DSS currently applies the same 30 year budworm cycle pattern to all stands, regardless of their spatial location or eco-physiological condition. A spatial analysis of historical defoliation patterns may reveal spatial patterns in the defoliation and/or eco-physiological conditions associated with the defoliation patterns. The results from such an analysis could be used to provide improved, location-specific forecasts of budworm outbreaks to the DSS.

Our data are the 1965 - 1996 ESBW defoliation records for Quebec. A grid of 222 columns and 84 rows divides the province into 9,502 cells (approx. 58 km^2 each). Within each cell the defoliation category (none, light, moderate, heavy, low host mortality visible, high host mortality visible) has been recorded each year. Each cell has also been categorized according to its eco-physiographic characteristics (Robitaille and Saucier 1996).

We examined the data for very large scale trends in the first-year-of-defoliation in the episode. Such trends should be removed prior to any spatial analysis in order to satisfy requirements of stationarity (Isaaks and Srivastava 1989, Legendre 1993). A second-order polynomial was used to estimate the trend, and the defoliation pattern within each cell was rescaled from its original 1965 - 1996 time scale to a time scale relative to the predicted first-year-of-defoliation for the spatial co-ordinates of the cell.

We used disjoint clustering (SAS: PROC FASTCLUS) and an agglomerative clustering procedure (SAS: PROC CLUSTER) to group similar defoliation patterns while maintaining 80% of the total variability present in the patterns. The cells of each of the 32 clusters that emerged from the procedure were seen to have a high degree of spatial contiguity. Our analysis will next look at potential associations between clusters and the eco-physiographic characteristics of the member cells of the clusters.

Isaaks, E. H., and R. M. Srivastava. 1989. Introduction to applied geostatistics. Oxford Univ. Press. NY. 561 pp.
Legendre, P. 1993. Spatial autocorrelation: trouble or new paradigm. Ecology: 74(6):1659-1673.
Robitaille, A. and J-P. Saucier. 1996. Land district, ecophysiographic units and areas: The landscape mapping of the Minister Resources Naturelles du Quebec.

Evaluation of a stand susceptibility rating system for the spruce beetle in British Columbia - Allen Brackley (presenter), Industrial Forest Service Ltd., Prince George, BC, S. P. Taylor, British Columbia Forest Service, Prince George, BC, and T. L. Shore, Canadian Forest Service, Victoria, BC A recently developed rating system for assessing a host stand's susceptibility to spruce beetle, *Dendroctonus rufipennis* (Kirby), attack was modified to allow calculation of a susceptibility index using spatially referenced British Columbia Forest Service forest inventory files. A sample area of about 58,000 ha was rated. This area was then compared to an existing electronic database that contains attributes on spruce beetle attacks. The results showed that the higher classes from the derived susceptibility index had significantly more beetle attack. Further, most of the initial parameters used in the rating also showed significant differences between classes of susceptibility. The validity of the original model is confirmed and the resulting modified model can be used to rate spruce stands for potential damage by this insect. This system will enable future harvesting programs to be more proactive and directed to stands in the heavier susceptibility classes that have higher potential for damage. Improvements in this index will occur in the future as the accuracy and precision of the forest inventory files improve and as ground sampling is conducted to further test and refine the index.

Discussion

Much discussion followed the presentations and focused on the possibilities for using photographic imagery with a GIS. Some options for getting good photos of damage integrated into the GIS along with interpretation of the photos in a digital manner were considered. One workshop participant from the BC Ministry of Forests has been taking oblique photographs of every patch of damaged trees, from aircraft. He plans to begin using a digital camera and wants to automate the detection of damage on the photos. A pathologist from the same organization has been using high resolution imagery to identify diseased trees. He had some image samples with him that several participants studied at the conclusion of the workshop.

CONFERENCE BUSINESS MEETINGS

EXECUTIVE COMMITTEE MEETING
14 April 1997

Chair Lorraine Maclauchlan called the meeting to order at 3:25 pm.

Present were
Lorraine Maclauchlan, Chair
Don Dahlsten, Past Chair
Ladd Livingston, Treasurer
Ann Lynch, Secretary, Conference Guidelines & Proceedings Committee Chair
Mike Wagner, Counsellor
Steve Burke, Memorial Awards Committee
Don Heppner, 1997 Conference Committee
Bob Hodgkinson, 1997 Conference Committee
Stuart Taylor, 1997 Conference Committee

Secretary Ann Lynch distributed and read copies of the Minutes of the Executive Committee Meeting, held 8 April 1996 in San Antonio, Texas. Minor corrections were noted. Mike Wagner moved to accept the minutes, Don Dahlsten seconded, and motion passed.

Secretary Ann Lynch distributed and read copies of the Consolidated Business Meeting held on 9 April 1996 Minor corrections were noted. Ladd Livingston moved to accept the minutes, seconded by Don Dahlsten, motion passed.

Treasurer Ladd Livingston read the Treasurer's Report. Don Dahlsten and Lorraine Maclauchlan will meet with Ladd after the Executive meeting to audit the books. Ladd reports that all proceeds have been received from the Albuquerque meeting, approximately $840. All costs from the Rapid City meeting have been accounted for except printing and mailing of the Proceedings. Ladd will have Bill Schaupp send the $1,030.95 remaining in the Rapid City account to Ladd. Ann Lynch's Proceedings' costs will be covered by funds in Ladd's Work Conference account.

When copies of the Albuquerque proceedings were mailed to active but non-attending members, it was forgotten to include a request for those members to send funds to cover Proceedings costs, as was agreed at last year's meeting.

Additionally, Ladd talked to a tax accountant regarding obtaining non-exempt status for the Work Conference. The accountant recommended that the Memorial Fund pursue non-exempt status rather than the Work Conference. That way the revenue services will be interested in tracking only award funds, not the funds and business of the Work Conference. This should greatly simplify the issue.

Committee Reports and Related Business

Reports from the Common Names Committee, the Founders Award Committee, and the Memorial Awards Committee were deferred until the initial Business meeting.

Ann Lynch read the report for the Conference Guidelines and Proceedings Committee. This report is to be read at the initial Business Meeting.

Mal Furniss submitted a report for the History Committee to Ladd Livingston, and it will be read by Don Dahlsten at Tuesday's meeting. The report will be posted at the Memorial Awards table in the poster session.

Chair Lorraine Maclauchlan appointed a Nominating Committee comprised of Mike Wagner, Don Dahlsten, and Ladd Livingston, with Mike Wagner serving as Chair. This Committee is to submit nominations for a Secretary who serves two years and a Counsellor to serve three years, replacing Jan Volney.

Additional Old Business

Ann Lynch reported that Business from the 1996 Meeting, held jointly as the North American Forest Insect Work Conference, are to be copied and bound with the 1995 Rapid City Proceedings, with the '96 Business in its own section on paper of a different colour. This Proceedings is expected to be out in June.

New Business

The Prince George committee reported that all was well with the current meeting. Discussion ensued regarding covering the front desk. There was no reply to the proposal to FRBC for funding support. The Local Arrangements Committee decided not to seek funding from industry: Bug-Busters has contributed time and personnel resources. The BC Ministry of Forestry will probably contribute $2,000 after receiving a Bill for Collections for goods & services. A surplus is expected from this meeting, although so far the cost of the proceedings has not been factored into that cost basis. The registration desk will accept checks for $95 US or $135 Canadian for meeting registration. Cost of the final lunch is optional at $13.50 Canadian or $10 U.S. Sign-up forms for various field trips are at the registration desks. Only the trip to the Tree Improvement Centre at Red Rock is outside; the others are indoors. Commemorative beer mugs are also for sale. T-shirts are provided with registration. Extra T-shirts will be offered for sale later in the meeting.

It was reported by Ladd Livingston that Barbara Bentz has finalized hotel arrangements for the 1998 meeting. She has asked for $1,000 to cover the deposit. Ladd will provide this amount from the Prince George fund after registration fees have been collected.

Mike Wagner raised the question regarding the '99 joint meeting. This meeting is to be hosted by the pathologists, and they decide on time and place. Don Dahlsten indicated that the meeting is to be in Carson City NV in August 1999.

Ladd Livingston reported that David Beckman, with assistance from Mal Furniss, compiled a list of old meeting locations from the University of Idaho special collections, which is the official repository of the Work Conference. Ladd will provide the Secretary with a hard copy and an electronic copy.

New Business

The Secretary will submit a motion at tomorrow's meeting to amend the Constitution for politically correct language, and will raise for discussion the topic of creating a Web site for the Work Conference.

Don Dahlsten reported that John Schmid wrote him a letter with concern about the use of excess of funds, not about the funds per se, but to propose that one-half of any newly generated funds go to the Memorial Scholarship fund. In the past, this was deemed not appropriate because agencies fund employees to attend the meeting, not to support a Scholarship fund, and a potential conflict exists. Discussion ensued regarding wanting to keep a cushion of funds available. Mike Wagner recommended that an alternative would be to authorize the Executive Committee. to periodically transfer sums of money to the fund. Don Dahlsten said any such discussion must go to the membership.

The meeting was adjourned at 5:04 p.m.

INITIAL BUSINESS MEETING
8:00 a.m., 15 April 1997

Chair Lorraine Maclauchlan called the meeting to order at 8:15 am, and tendered greetings to lovely Prince George.

The Chair asked for information regarding status of the members. Lynne Rassmussen reported that long-term member Walt Cole passed away just over a year ago.

Secretary Ann Lynch read the minutes from the 1996 Combined Business Meeting. Steve Burke moved that the minutes be approved, Mike Wagner seconded, motion passed.

Secretary Ann Lynch read the minutes from Monday's Executive Committee meeting. Discussion ensued regarding confusion on the location and date of the joint Insect and Disease meeting in 1999. Bill Schaupp, at the request of the Executive Committee, had checked on this issue. He reported that the disease work conference endorsed the holding of a joint meeting in 1999, and that the meeting will be hosted by Dave Johnson and John Laut in mid-September in Colorado. Bill reported that Johnson & Laut had sent a letter to this effect to various members of both executive committees. No one reported actually receiving this letter.

A motion to accept the minutes was made by Bill Schaupp, seconded by Don Dahlsten, and passed.

Ladd Livingston read the Treasurers Report regarding five accounts, as tabulated. The balance in the checking account is low because funds were needed in advance for the Prince George meeting. The Memorial Scholarship Fund had an increase of $548 in the past year, mostly from the sale of photos and items of a similar nature at last year's meeting. John Wenz moved that the Treasurer's report be accepted. The motion was seconded by Mike Wagner, and passed. Lorraine Maclauchlan reported that she and Don Dahlsten had found the books to be in order.

COMMITTEE REPORTS (Submitted Committee Reports are included in these Proceedings - see Table of Contents)

There was no report from the Common Names Committee.

Ann Lynch read the report of the Conference Guidelines and Proceedings Committee, which included recommendations that the Secretary maintain an electronic compilation of Programs and business documents, and that the work conference establish a Web site.

The History Committee report sent by Mal Furniss and Boyd Wickman was summarized by Don Dahlsten. This report will be posted at the Memorial Awards table in the poster session.

Steve Burke gave the report for the Memorial Awards Committee. He indicated that the Terms of Reference for the Memorial Scholarship must be voted upon and approved by the membership in order to achieve tax-exempt status. Copies of the Terms are available in the poster room. This item will be raised for a vote at the Final Business Meeting. Steve indicated that these terms were unofficially approved by the Executive Committee at the 1996 meeting in San Antonio. As discussed earlier, the report includes the discussion of John Schmid's concerns regarding excess funds.

The Chair read a letter that she had drafted thanking John Schmid for his service to the Founder's Award Committee. She asked for approval to send the letter to John Schmid, which was given.

Staffan Lindgren reported for the Founders Award Committee. He recommended that future Program mailings include instructions for making nominations for the Founders Award. Staffan reported that John Borden asks to be released from the Committee. Staffan appointed a nominating committee for John's replacement, this committee to be composed of members of the Founders Award Committee present at this year's work conference in order to provide a nominee at the final business meeting.

The Secretary reiterated that it was agreed upon at the San Antonio meeting that the Founders Award Committee would send nomination instructions to the Program Committee in a timely fashion, so that they could be included in the first mailing. This information is also supposed be included in each Proceedings.

Regarding future meetings, the Chair indicated that the 2000 meeting was undecided. Don Dahlsten indicated that he thought Darrel Ross had issued an invitation for Oregon. Darrel confirmed this later in the session, and the issue is to be brought up for vote at the final business meeting.

OLD BUSINESS

The Chair asked if the tax exempt issue had been adequately addressed, with an affirmative response.

Regarding the next North American Forest Insect Work Conference, Jan Volney indicated that the Mexicans had also tendered an invitation, but that he would like the WFIWC to endorse the invitation from Edmonton.

NEW BUSINESS

Secretary Ann Lynch made a motion that "All occurrences in the Constitution of the terms "Chairman" and "he" be replaced with the terms "Chair" and "he or she", respectively." Motion was seconded by Staffan Lindgren, and passed.

Ann Lynch, Conference Secretary and Chair of the Conference Guidelines and Proceedings Committee brought up for discussion her recommendation that the Work Conference Secretary establish a Web page for the Conference. Discussion ensued, with enthusiastic support from the Founders Award Committee and various members, and some concern for cost and time commitments.

Treasurer Ladd Livingston asked that members verify the affiliation and contact information for themselves and their colleagues on his lists.

A motion to adjourn was made at 9:15 by Don Dahlsten, seconded by Jill Wilson, and passed.

After adjournment, Skeeter Werner informed the Secretary that he had missed the call for announcements on retirements and deaths, and he wanted to report that he retired last year and is now half dead.

FINAL BUSINESS MEETING
1:30 p.m., 17 April 1997

***** UNAPPROVED MINUTES *****

Chair Lorraine Maclauchlan called the meeting to order at 1:35 pm.

1) Minutes of the Initial Business Meeting were read and approved.

2) Nominating Committee Report.

Mike Wagner announced the following nominations:

Bob Hodgkinson for Counsellor 1998-2000
Ann Lynch Secretary

Nominations were moved, seconded, and approved as read.

OLD BUSINESS

3) NAFIWC PROPOSALS

Invitations for the next North American Forest Insect Work Conference have been tendered from Edmonton for a Conference in or near Calgary, and from Mexico. Much discussion ensued. a) Calgary offers good field trip opportunities, good access, several nearby National Parks, Eskimo Heritage cultural opportunities, and dinosaur and gopher museums. The Edmonton hosts are looking for people to serve on a Technical Committee: two people from each Work Conference plus the two Past Chairs of the NAFIWC. Jan Volney moved that the WFIWC endorse the Edmonton invitation, seconded by Ann Lynch. b) Mike Wagner, Ron Billings, and others recommended further contact with the Mexican contingent, with some disagreement voiced. Mike further commented on increasing interest and participation from Mexicans and Mexican students. Further discussion indicated that Mexican participation has been very low over the years, and Canadian participation has been substantial. Ladd Livingston recommended approving the Edmonton motion, and then allowing the Mexicans to make a counter proposal. Several members indicated that they were more comfortable with the Mexicans hosting the regular regional conference. Staffan Lindgren clarified that accepting a motion infers Western Conference responsibility for hosting the NAFIWC. The Chair called for a vote on the motion, which was accepted unanimously.

4) Terms of Reference for the memorial Scholarship.

A motion to approve the Terms was made, seconded, and passed.

5) Founders Award Committee nominations

Jill Wilson reported that the Founders Award Committee nominates Ken Gibson to replace John Borden. The Chair approved the nomination.

After discussion regarding ensuring active nominations for this Award, Staffan Lindgren indicated that nominations stand for three years without re-submission.

In order to ensure that candidates for the Founders Award are nominated each year, Mike Wagner moved that the charge of the Founder Award Committee be changed to permit the Committee to nominate candidates for the award in those cases where no nominations are received from the general membership by the end of the official nomination period. Motion was seconded and passed.

6) Surplus funds

Ladd summarized the history of this issue as follows: Surplus funds were first generated when the U.S. Forest Service covered the cost of a proceedings. Subsequently, more people attended Penticton than expected. Each year more funds are added, although usually not much. Ladd sees no point in holding a checking account of $6000. In his letter to Steve Burke, John Schmid recommended that at least 50% of the current surplus be transferred to the Memorial Scholarship fund, taking care to leave a balance available for securing hotel sites, etc. John suggested $2,000; Ladd recommends $3,000. Peter Hall indicated that a surplus was likely from the 1997 meeting. Discussion followed which generally supported moving some funds to the Scholarship Award fund, although the amount to be moved varied. Factors to be considered include a) circumstances can result in a particular meeting, such as NAFIWC, requiring higher-than-average pre-meeting or proceedings costs, b) it has been many years since we had a meeting that lost money, and c) that a World Wide Web site will add to our costs. Finally, a motion was made to strike a committee to make recommendations by the 1998 meeting. The Chair appointed a Surplus Funds Committee of Ladd Livingston, Peter Hall, and Jill Wilson.

7) Scholarship Award Plaque

Ladd communicated that scholarship funds are often made as memorials, and that there are places on the plaque for such recognition. Ladd requested direction on a minimum donation for entry on the plaque roll. After discussion, a motion was made, seconded, and passed to use a limit of $50, U.S.

8) World Wide Web

The Secretary moved that the Secretary evaluate options for a Conference Web site, and to establish such a site with oversight from the Executive Committee regarding content, cost, and member participation. Motion was seconded and passed.

NEW BUSINESS

9) Bob Hodgkinson read the following motion for John Borden:

> "Whereas, timber infested with spruce beetle is being harvested in Alaska, and
>
> Whereas, British Columbia is importing raw spruce logs from Alaska for sawmilling, and
>
> Whereas, the above practice presents a major risk of spreading spruce beetle infestations,
>
> Be it resolved that the Western Forest Insect Work Conference urges the State of Alaska and affected land management agencies to implement and intensify spruce beetle management programs within the boundaries of the State".

Heated discussion followed, and the motion died for lack of second.

10) A call for the Prince George attendance figures was answered with Bob Hodgkinson's estimate of about 150.

11) On behalf of program committee, Staffan Lindgren wants it noted in the minutes that although the 1997 Conference Committee is a committee, Bob Hodgkinson did 90% of the work, and he deserves credit for an excellent job. Bob denied credit, and recognized assistance from many, including Lorraine Maclauchlan, Robb Bennett, Don Heppner, Terry Shore, Stuart Taylor, Staffan Lindgren, BugBusters, Northwood Pulp & Timber Ltd., the hotel, and others.

12) Lynn Rassmussen indicated that the 1998 invitation is for the week of 2 March, with Barbara Bentz as Local Arrangements Chair.

A motion to adjourn was made, seconded, and passed at 2:15 p.m.

COMMITTEE REPORTS

Common Names Committee

Committee Members - As of this writing, the Committee membership includes Lee Humble, Iral Ragenovich, Larry Stipe, and Torolf Torgersen. Judith Pasek, Robert Lavigne, and John Stein have informed me that they will not be serving on the committee in CY 1997. Judy Pasek will be transferring to APHIS in Raleigh, NC; Jack Stein has transferred to State and Private Forestry in Morgantown, WV; and Bob Lavigne has retired from his post at the University of Wyoming---gone to Australia!

Thus, the Names Committee is three members short of its required seven. Perhaps new members can be solicited in the Annual Report of the WFIWC, or in the cover letter sent out with the Report.

There was one new application for a new common name in 1996. That proposal was from Mal Furniss for the name willow bark beetle for *Trypophloeus striatulus*. The full committee, as comprised before the recent losses of members, is now in the process of examining the submittal information for possible approval.

There are no residual applications or actions remaining from previous years.

Torolf R. Torgersen (Chair)

Committee on Common Names of Insects[1/]
Membership as of May 9, 1997.

Lawrence E. (Larry) Stipe (1979)
USFS, Forest Pest Management, R-1
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Iral Ragenovich (1980)
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(503) 326-6680;
DG: I.RAGENOVICH:R06C

Torolf R. Torgersen, Chair (1979)
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DG: TORGERSEN:S26L06A

L.M. (Lee) Humble (1990)
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(250) 363-0644;

[1/] Rules require that there be seven members.

Conference Guidelines and Proceedings Committee

Report of the Conference Guidelines and Proceedings Committee. 14 April 1997.

The Committee had little activity the past year, due to the relocation of the Chair, but expects significant accomplishments this year. The Committee has compiled conference and meeting guideline information from various sources.

The Chair of the Conference Guidelines and Proceedings Committee, who concurrently serves as Secretary, advises that the Secretary maintain an electronic copy of all available Final Programs, Minutes, and Committee Reports, beginning with the 1994 meeting, and adding past documents as time and resources permit. This will facilitate maintenance of information in a readily available transferable form. She notes that a complete body of Work Conference Proceedings are not available to many people.

The Chair also recommends that the Work Conference establish a Web site. This topic should be raised for discussion at the Business Meeting.

Ann M. Lynch, Chair

Founders Award Committee

The committee corresponded early in the year on several items. We had no nominations for the award in 1997. Roy Shepherd, award winner in 1996, will be presented with a plaque and will give an address to the conference banquet in Prince George, BC

We hope to see more nominations for the Founder's Award this coming year. We recommend that future program notices include a brief statement soliciting awards and the committee chairperson's name and address for obtaining nominating instructions. We would also like to have several copies of the instructions on the conference registration table.

The award plaques have been continuously produced in Ft. Collins through the collaboration of various chairpersons and John Schmid. John has done most of the work and deserves recognition for his efforts. Enclosed is a draft letter, for your consideration, thanking John. Perhaps it could be read at the business meeting and sent to John under your signature.

John Borden has asked to be relieved of his Founder's Award Committee assignment. John has been a member of the committee since its inception and has made many contributions. I want to thank him for his thoughtful analyses of nominations and other tasks. I respectfully request that a nominating committee, composed of the four committee members attending the Prince George conference, select a replacement for John, subject to your approval, at the final business meeting.

Boyd E. Wickman, Chair

History Committee

Boyd Wickman developed a history of Pandora moth outbreaks extending back several centuries in time, in co-operation with the University of Arizona Tree Ring Laboratory. Using historical records of the last reported outbreak in central Oregon during 1918-1925, he was able to locate sites from which cores were obtained from surviving trees to date past outbreaks.

A manuscript, entitled: "Photographic images of Forest Insect Investigations on the Pacific Slope, ca 1910-1953, Part 1, California", authored by Furniss and Wickman, was slated for "History Line", but that outlet apparently ceased with the death of Terry West, History Section, Forest Service Washington Office. It has been revised for the American Entomologist, which is establishing a new feature: "Heritage". Boyd plans to draft a companion manuscript (Part 2, Oregon and Washington) describing the historical photo file, now at LaGrande, OR, that dates to before the Portland Forest Insect Lab was established by F. P. Keen in 1930. Fourteen photos from these files were selected and enlarged, for sale at the San Antonio and subsequent meetings. Proceeds are to be used for the Scholarship Fund.

Wm. F. McCambridge, RM Station (retired), was contacted at 1909 Richards Lake Rd., Fort Collins, CO 80524, regarding his recollections during his assignment by the BE&PQ to Alaska in 1952-1956. He was the first forest entomologist stationed there. He provided 5 slides that were copied for the archives, and a tape-recording of his recollections. That information will be added to notes and numerous photos of R. L. Furniss, who made earlier field trips to coastal Alaska in 1946, 1948 and 1950, while stationed in Portland.

An article by M. Furniss on "depredations" by *Dendroctonus pondersoae* in the Black Hills Forest Reserve, ca 1897-1907, was published in the 1997 spring issue of the American Entomologist. It involved Andrew D. Hopkins and Jesse Webb, the first American trained forest entomologist, and ushered in the work of the Division of Forest Insect Investigations after its creation in 1902. Another manuscript, entitled: "Walter Julius Buckhorn (1899-1968): Legendary forest entomologist, not of the classroom kind," was submitted to the Oregon History Quarterly.

A list, by author, of several hundred unpublished reports of the former Coeur d'Alene and Missoula Forest Insect Labs was organized by Furniss, and their whereabouts was checked by Larry Stipe (Missoula) and Sandy Kegley (Coeur d'Alene). One of these, on *Ips pini*, by H. J. Rust, was loaned to A. M. Liebhold, Morgantown, WV where coincidentally, A. D. Hopkins began his career, and American forest entomology got its start, in 1890.

An obituary for Ralph C. Hall (1899-1996), an early member of the Western Forest Insect Work Conference, appeared in the American Entomologist, 1996 summer issue (p. 127, 18\28). His son, Jim, of Corvallis, OR, has been contacted regarding Ralph's memorabilia for the archives.

Material relating to Robert E. Denton was received from his son by Sandy Kegley and will be forwarded to the archives. LeRoy Kline announced his intention to deposit WFIWC-related records acquired during his stint as Secretary.

submitted by: M. M. Furniss and B. E. Wickman

Memorial Awards Committee

Mailouts: Due to the co-ordination and cost complications and the unresolved "non-profit" status of WFIWC it was felt that a mailout to all members to solicit funds in anticipation of WFIWC 1997 was not warranted.

Non-profit Status: Ladd Livingston has investigated the situation and has identified the path of likely least resistance. It would be best for WFIWC to administer memorial funds separately from general funds. We anticipate that this can be accomplished quickly thus enabling donations by WFIWC members, corporations and trust funds to gain the desired tax deduction. It is highly unlikely that Canadians will get this tax deduction.

Terms of Reference: The WFIWC membership or executive needs to officially vote on the "terms of reference" of the memorial award. A draft is attached for your approval. As you may recall these terms had been unofficially approved by the executive in 1996 at San Antonio.

Trust funds: Karen Ripely has tracked down a directory of trust funds that can be solicited for donations. The directory is even organized by subject category thus one can pinpoint those funds that are aligned to the interest and objectives of WFIWC (eg. Environmental trusts).

Presence at WFIWC 1997: The organizing committee has been very accommodating in providing space and tables to assist fund raising efforts. Volunteers have been gathered to man the table. Volunteers will be there to explain the objectives of the fund drive,, take in donations and sell a selection of six historical photos. In 1996 roughly $500 US was generated by a similar effort. It is anticipated that the memorial plaque will be on display including the first inscriptions of names of past members and significant sponsors.

John Schmidt letter: On Feb. 17, 1997, the Committee Chair received a letter requesting that WFIWC consider using some of the general revenue now sitting in a bank account be donated to the memorial awards fund. This letter has been forwarded to the WFIWC executive for their consideration. It should be noted that this issue has been reviewed before and has not gained membership approval. One of a number of concerns was that government employees had been funded to attend prior conferences without the knowledge that a portion of the funds would be used to support a memorial scholarship award.

Steve Burke, Chair

WESTERN FOREST INSECT WORK CONFERENCE LOCATION HISTORY

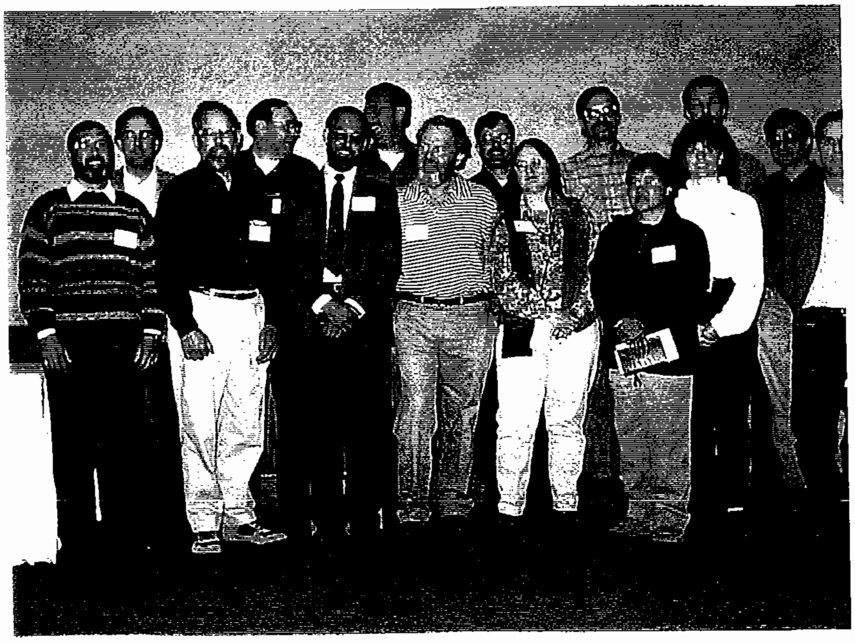
Year	Dates	Region/Country	State/Province	Location
1949	Dec	Region 6	Oregon	Portland
1950	Dec	Region 2	Colorado	Fort Collins
1951	Nov	Region 6	Oregon	Portland
1952	Dec	Canada	British Columbia	Victoria
1953	Nov	Region 1& 6	Idaho	Moscow/Pullman
1954	Dec	Region 5	California	Berkeley
1955	Dec	Region 6	Washington	Spokane
1956b				
1957	March	Canada	Alberta	Calgary
1958	Feb	Region 6	Oregon	Corvallis
1959	Feb	Canada	British Columbia	Vancouver
1960	March	Region 4	Utah	Ogden
1961	March 1-3	Region 5	California	Berkeley
1962	March 13-16	Region 3	Arizona	Tucson
1963	March 4-6	Region 6	Oregon	Portland
1964	March 9-11	Canada	Alberta	Banff
1965c	March 1-4	Region 2	Colorado	Denver
1966	Feb 14-17	Canada	British Columbia	Victoria
1967	Feb 28-Mar3	Region 4	Nevada	Las Vegas
1968	March 4-7	Region 5	California	Berkeley
1969	March 10-13	Region 1	Idaho	Coeur d'Alene
1970	March 2-5	Region 6	Washington	Seattle
1971	March 1-4	Region 2	Colorado	Glenwood Springs
1972	March 6-9	Canada	Alberta	Edmonton
1973	March 6-8	Region 3	Arizona	Tucson
1974	March 5-7	Region 4	Utah	Salt Lake City
1975d	Feb 23-28	Region 5	California	Monterey
1976	March 1-4	Region 6	Oregon	Wemme
1977	March 1-3	Canada	British Columbia	Victoria
1978	March 7-9	Region 2	Colorado	Durango
1979	March 6-8	Region 4	Idaho	Boise

b No meeting in 1956 - Meeting dates changed form December to March
c Joint meeting of western and central insect work conferences
d Joint meeting of insect and disease work conferences

Year	Dates	Region/Country	State/Province	Location
1980	March 2-6	Region 8	Texas	El Paso
1981	March 2-6	Canada	British Columbia	Victoria
1982	March 2-4	Region 1	Montana	Missoula
1983	March 1-3	Region 5	California	Santa Rosa
1984	March 5-8	Region 6	Oregon	Eugene
1985	March 4-7	Region 2	Colorado	Boulder
1986	March 3-6	Canada	British Columbia	Victoria
1987	March 2-5	Region 4	Utah	Park City
1988	March 7-10	Region 3	Arizona	Flagstaff
1989e	Sept 11-15	Region 6	Oregon	Bend
1990	March 5-9	Region 1	Idaho	Coeur d'Alene
1991f	March 25-29	Region 2	Colorado	Denver
1992	March 2-6	Canada	British Columbia	Penticton
1993	March 1-5	Region 5	California	Sacramento
1994g	March 7-11	Region 3	New Mexico	Albuquerque
1995	April 24-28	Region 2	South Dakota	Rapid City
1996h	April 8-12	Region 8	Texas	San Antonio
1997	April 14-18	Canada	British Columbia	Prince George
1998		Region 4	Wyoming	Jackson Hole
1999i	Sept	Region 2	Colorado	
2000				
2001j				

e Joint meeting of insect and disease work conferences
f North American Forest Insect Work Conference
g Joint meeting of insect and disease work conferences
h North American Forest Insect Work Conference
i Joint meeting of insect and disease work conferences
j North American Forest Insect Work Conference

PHOTOGRAPHS



Front Row: Larry Pedersen, Ron Billings Eric Smith, Don Dahlsten, Ann Lynch, Leslie Chong, Therese Poland, Stephen Burke
Back Row: Russ Cozens, Les Safranyik, Mark Schultz, Bob Cain, David Beckman, Darrell Ross, Emil Begin

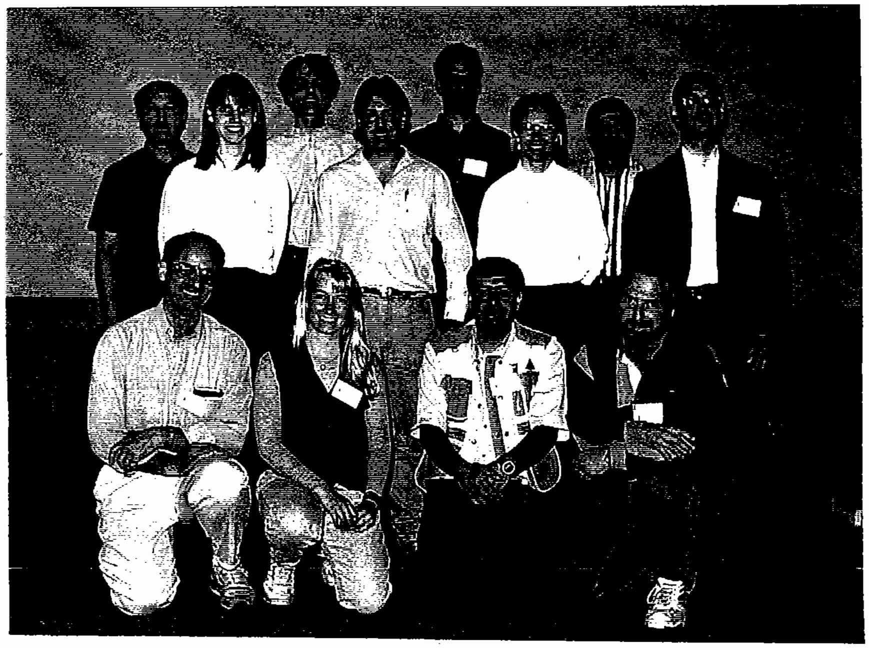
Front Row: Paul Wood, Roger Burnside, Bruce Thomson
Middle Row: Terry Shore, Ron Parker, Roy Shepherd, John Wenz, Sandy Kegley, Ken Gibson
Back Row: Stuart Taylor, Staffan Lindgren, Peter Hall, Lorraine Maclauchlan, Bob Hodgkinson, Dave Schultz

Front Row: Tim McConnell, Bruce Hostetler, Dave Overhulser, Andrew Lawson
Back Row: Dave Bridgewater, Andy Eglitis, Brad White, David Ganz

Front Row: Leroy Harder, Dave Holden, Dan Lux, Steve Kohler
Middle Row: Sherah VanLaerhoven, Robert Stronach, Imre Otvos, Ladd Livingston
Back Row: Darrell Devlin, Jed Dewey, Dave Piggin, Dan Miller, Matthew Greenwood

Front Row: Jeff Moore, Tiffaney Andrews, Dezene Huber
Middle Row: Tim Ebata, Kathy Bleiker, Sheri Smith, Trisha Rimmer
Back Row: Wayne Anselm, Astrid VanWondenberg, John McLean, Kevin Buxton, Ward Strong

Front Row: Kevin Porter, Bill Riel, Sheri Moraes, Nicole Jeans
Middle Row: Jill Wilson, Lynn Rasmussen, Elizabeth Tomlin, Julie Weatherby, Karen Johnson
Back Row: Jon Bell, David Gray, Pat Shea, Richard (Skeeter) Werner, Shane Collingridge



Front Row: John Borden, Marnie Duthie, Jorge Macias, Bob Setter
Middle Row: Naomi Delury, Todd Bresser, Ilze Rupners, Bill Schaupp
Back Row: Herb Cerezke, Ian Wilson, Dave Christie, Jess Rios

Front Row: Tim Work, Kimberly Wallin, Julia Smith, Richard Goyer
Back Row: Tim Schowalter, Mike Wagner, Brian Strom

Front Row: John Spence, Troy Kimoto, Jan Volney
Back Row: Ken White, John Henigman, Dave McLean, Rob Higgins

REGISTERED ATTENDANCE

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