PROCEEDINGS

TWENTY-NINTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

Durango, Colorado

March 7-9, 1978

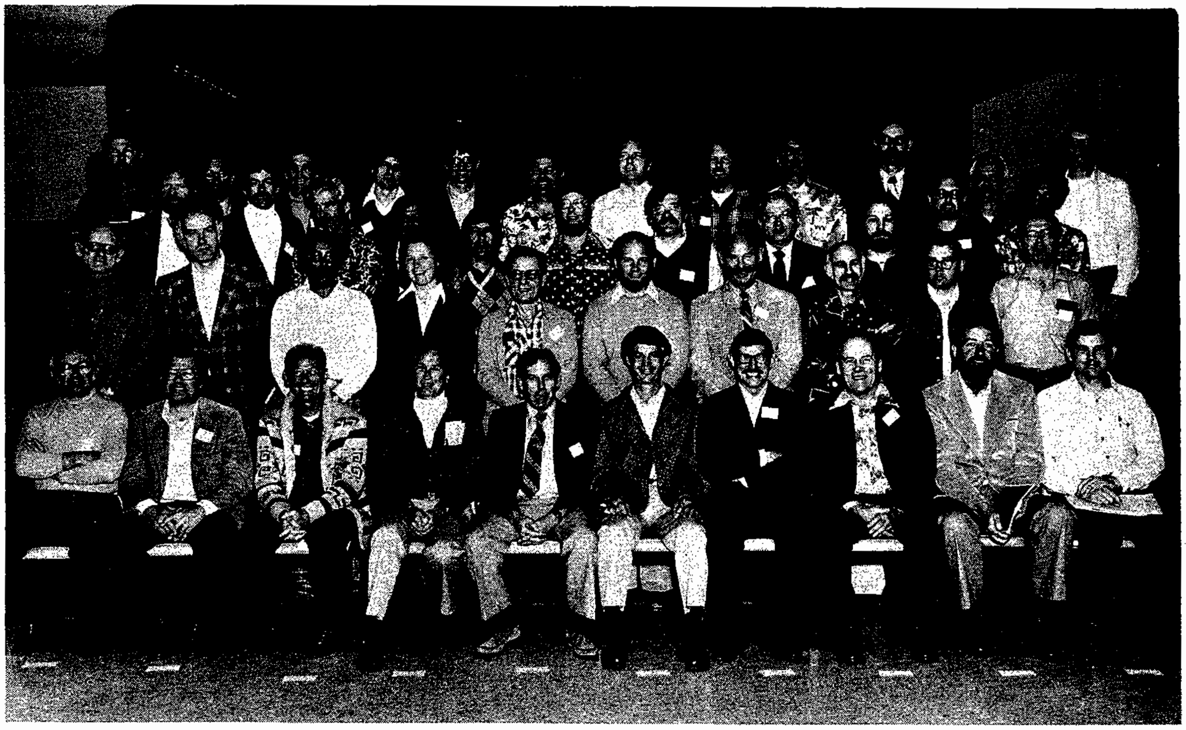
Not For Publication

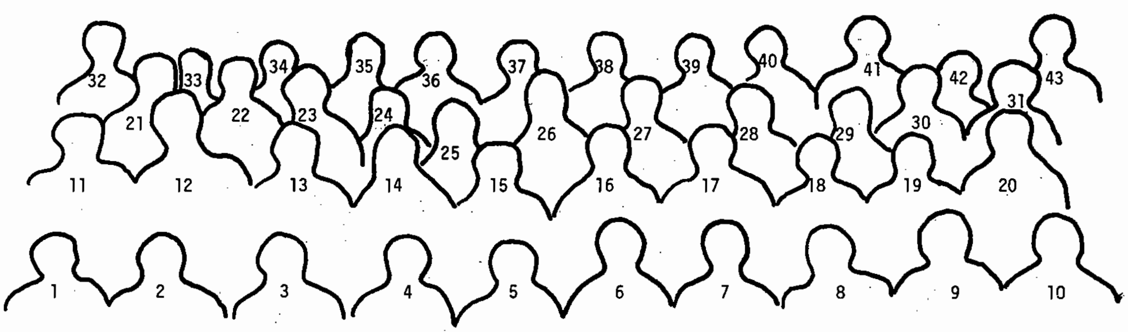
(For Information of Conference Members Only)

Prepared at

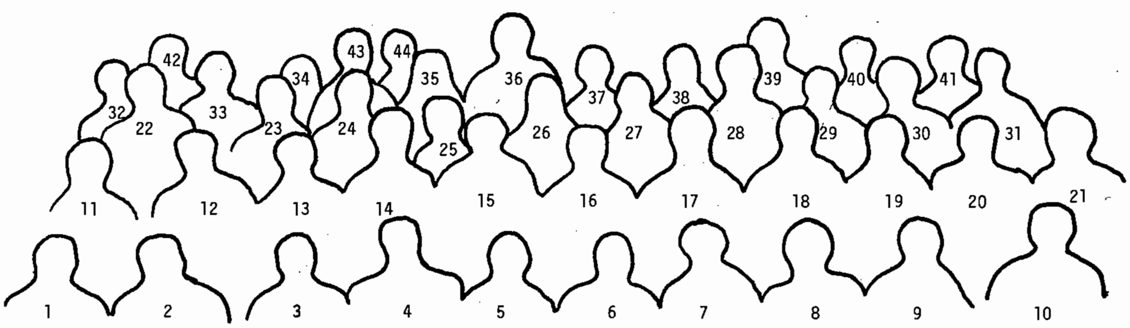
Oregon Department of Forestry

Salem, Oregon 97310

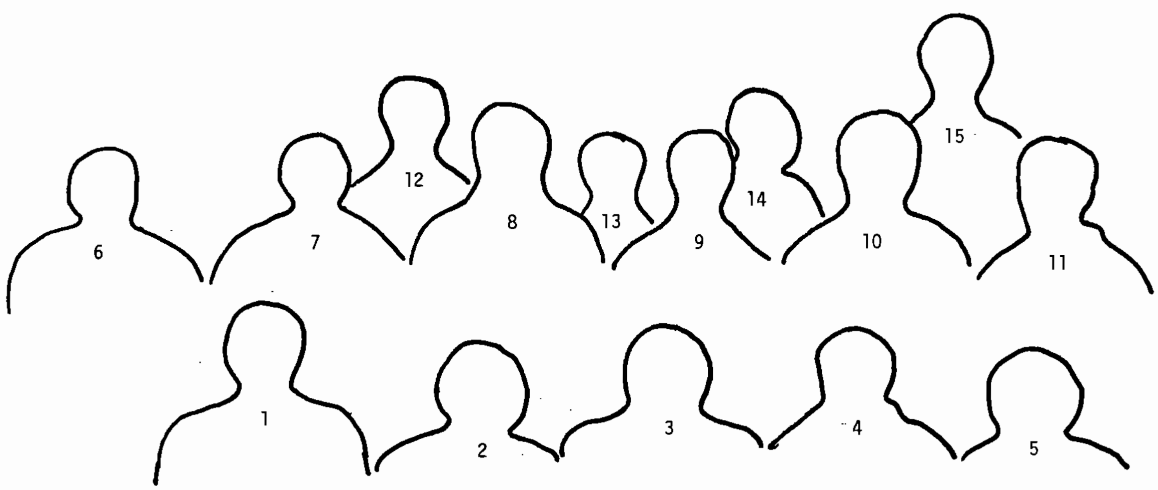




1. Bill McCambridge
2. Dave Wood
3. George Downing
4. Bill Bedard
5. John Laut
6. Doug Parker
7. John Foltz
8. Bill Ives
9. Bill Klein
10. Ladd Livingston
11. Ron Stark
12. Karel Stoszek
13. Mike Chavez
14. Pam Farrar
15. John A. Schenk
16. Dave Holland
17. Galen Trostle
18. Rick Johnsey
19. Larry Stipe
20. John W. Dale
21. Don Dahlsten
22. Fred Stephen
23. Bill Copper
24. Max Meadows
25. Robert Celaya
26. Tony Smith
27. Ralph Thier
28. William Metterhouse
29. Ken Gibson
30. Lee Ryker
31. Cliff Ohmart
32. Gary Pitman
33. Wes Yates
34. W. G. Evans
35. Bill Ostrofsky
36. Roy Cuthbert
37. John Peacock
38. Bill White
39. Henry Willcox
40. Jim Mitchell
41. Daniel R. Kucera
42. Bob Campbell
43. Gary Boutz



1. Jed Dewey
2. Patrick Shea
3. Wayne Bousfield
4. Al Rivas
5. Lynn Rasmussen
6. Donn Cahill
7. Paul Buffam
8. Carl W. Haywood
9. Don Pierce
10. Charles Minnemeyer
11. Emmett T. Wilson, Jr.
12. Kenneth R. Lewis
13. Gene Amman
14. Bob Acciavatti
15. Les Safranyik
16. Roy Shepherd
17. John McLean
18. Paul Tilden
19. Ed Holsten
20. Scott Cameron
21. Barry Hynum
22. Robert C. Thatcher
23. Larry C. Yarger
24. David Schultz
25. Jan Volney
26. Kathy Sheehan
27. Stan Meso
28. Mike Schomaker
29. Lawrence B. Helburg
30. José Cola Zanuncio
31. Steve Kohler
32. Hubert Meyer
33. Mark McGregor
34. Arland Valcarce
35. Sue Watts
36. Nick Crookston
37. Molly Stock
38. Roger Sandquist
39. Max Ollieu
40. Jerry Knopf
41. Ken Lister
42. Bill Ciesla
43. Dick Bacon
44. Gene Lessard



1. John D. Lattin	6. René Alfaro	12. Lonnie Sower
2. David Cibrian T.	7. Charles Tiernan	13. Fay Shon
3. Rodolfo Campos B.	8. Dave Voegtlin	14. Laura Merrill
4. Bob Stevens	9. T. Torgersen	15. Bill Bailey
5. Edgardo Hernandez V.	10. Bruce Hostetler	
	11. Mal Furniss	

PROCEEDINGS

TWENTY-NINTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

Durango, Colorado

March 7-9, 1978

Executive Committee (Twenty-ninth WFIWC)

R. L. Johnsey, Olympia	Chairman
G. C. Trostle, Portland	Immediate Past Chairman
L. N. Kline, Salem	Secretary-Treasurer
D. Parker	Councilor (1975)
S. Cade	Councilor (1976)
J. McLean	Councilor (1977)
C. Minnemeyer	Program Chairman
D. Cahill	Local Arrangement Chairman

CONTENTS

*Summary not submitted

TECHNICAL PROGRAM

Twenty-ninth Annual Western Forest Insect Work Conference

Ramada Inn, Durango, Colorado

March 7-9, 1978

Monday, March 6

7:00 - 9:00 p.m.	Registration
8:00 p.m.	Meeting of the Executive Committee

Tuesday, March 7

8:30 - 9:00 a.m.	Registration
9:00 - 9:30 a.m.	Welcome and Initial Business Meeting
9:30 a.m.	PANEL: Concept and Implementation of Expanded Forest Insect Research and Development Programs, With Some Pros and Cons Moderator: P. Buffam Panelists: D. Ketcham, T. McIntyre, B. Wickman, G. Hertel, B. Campbell
10:00 a.m.	Break
10:30 - 12:00 p.m.	Panel Continued
12:00 - 1:30 p.m.	Lunch
1:30 - 3:00 p.m.	PANEL: Joint U.S. - Canadian Expanded Spruce Budworm Research and Development Program Moderator: M. McFadden Panelists: C. Buckner, M. McKnight
3:00 p.m.	Break

3:30 - 5:00 p.m.		CONCURRENT WORKSHOPS:	
	A.	The Status of Preventive Sprays	B. McCambridge
	B.	Forest Insect Population Quality	L. Safranyik
	C.	The Mechanics of Benefit-Cost Analysis, and Its Use	D. Sonnen
	D.	Problems and Benefits of Large Scale Projects	T. Flavell
8:00 p.m.		Mixer	

Wednesday, March 8

8:30 - 10:00 a.m.		CONCURRENT WORKSHOPS:	
	A.	The Biological Evaluation Process	D. Parker
	B.	How Will RPAR Affect Forest Entomology	D. Graham
	C.	Avian Predation of Forest Insects	D. Dahlsten
	D.	Trends in Forest Insect Research	B. Wickman
10:00 a.m.		Break	
10:30 - 12:00 p.m.		CONCURRENT WORKSHOPS:	
	A.	Insects of the Pinyon-Juniper Complex	W. Brewer
	B.	Discussion of the Side Effects of Direct Control	Pat Shea
	C.	Impact Assessment and How to Measure It	B. Klein
	D.	Response of Mountain Pine Beetle to Host and Environment	G. Amman

12:00 p.m. — Bus Tour to Mesa Verde National Park With a Look at Some Pinyon-Juniper Insects and a Tour of the Indian Ruins

Thursday, March 9

8:30 - 9:00 a.m. — Final Business Meeting

9:00 a.m. — PANEL: Dealing with and Informing the Public During Large Forest Insect Epidemics or Control Projects

Moderator: D. Graham
Panelists: J. Laut
S. Robinson
B. Metthouse
T. Harlan
C. Haywood

10:00 a.m. — Break

10:30 - 12:00 p.m. — Panel Continued

12:00 - 1:30 p.m. — Lunch

1:30 - 3:00 p.m. — CONCURRENT WORKSHOPS:

A. Problems Associated with Aerial Spraying of Insecticides — J. Dewey

B. Drought, and the Effect on Forest Insects — K. Stoszek

C. Vegetative Management in the Colorado Front Range — R. Gosnell

D. Status of Behiavor Modifying Chemicals in Forest Insect Management — D. Wood

3:00 p.m. — Break

3:30 - 5:00 p.m. — CONCURRENT WORKSHOPS:

A. Forest Insect Pests at Low Numbers — W. Cole

B. The Methods Application Group - Its Purpose and Accomplishments — B. Ciesla

C. Reducing Duplication of Effort in Writing Environmental Impact Statements on the Same Insect — M. Ollieu

D. Douglas - fir Tussock Moth Pheromone Trapping Program — L. Sower

MODERATORS AND PANELISTS - AFFILIATIONS

Gene Amman, U. S. Forest Service, INT Experiment Station
Wayne Brewer, Colorado State University
Charles Buckner, Forestry Directorate, Ottawa, Canada
Paul Buffam, U. S. Forest Service, Region 6
Bob Campbell, U. S. Forest Service, PNW Experiment Station
Bill Ciesla, U. S. Forest Service, Methods Application Group
Walt Cole, U. S. Forest Service, INT Experiment Station
Don Dahlsten, University of California at Berkeley
Jed Dewey, U. S. Forest Service, Region 1
Tom Flavell, U. S. Forest Service, PNW Experiment Station
Ron Gosnell, Colorado State Forest Service
Dave Graham, U. S. Forest Service, Washington, D. C.
Tom Harlan, U. S. Forest Service, Region 1
Carl Haywood, Potlach Corporation, Lewiston, Idaho
Gerry Hertel, U. S. Forest Service, Southeastern Area, S&PF
Dave Ketcham, U. S. Department of Agriculture, Washington, D. C.
Bill Klein, U. S. Forest Service, Methods Application Group
John Laut, Colorado State Forest Service
Bill McCambridge, U. S. Forest Service, RM Experiment Station
Max McFadden, U. S. Forest Service, PNW Experiment Station
Tom McIntyre, U. S. Department of Agriculture, Hyattsville, MD
Mel McKnight, U. S. Forest Service, Washington, D. C.
Bill Metterhouse, New Jersey Department of Agriculture
Max Ollieu, U. S. Forest Service, Region 4
Doug Parker, U. S. Forest Service, Region 3
Steve Robinson, Washington State Dept. of Natural Resources
Les Safranyik, Canadian Forestry Service, Pacific Forest Res. Centre
Pat Shea, U. S. Forest Service, PSW Experiment Station
Dave Sonnen, Colorado State Forest Service
Lonne Sower, U. S. Forest Service, PNW Experiment Station
Karel Stoszek, University of Idaho
Boyd Wickman, U. S. Forest Service, PNW Experiment Station
Dave Wood, University of California at Berkeley

WESTERN FOREST INSECT WORK CONFERENCE
Minutes of Executive Committee Meeting

March 6, 1978

Chairman Rick Johnsey called the meeting to order 25 minutes late (8:25 p.m.). Those present were:

Rick Johnsey
LeRoy Kline
Galen Trostle
Roy Shephard
Charles Minnemeyer
Donn Cahill

Minutes of the 1977 Executive Committee meeting were read.

The Nominating Committee needed to be organized with the duty of recommending replacements for Doug Parker as Councilor, Rick Johnsey as Chairman, and LeRoy Kline as Secretary-Treasurer.

The meeting sites for 1979 and 1980 were discussed. It was decided that a decision be made, if possible, at the initial business meeting for the 1979 site. An invitation for 1980 site should be made at the initial meeting with a decision at the final meeting.

Contents of the Proceedings of the Conference were discussed. It was agreed to keep everything as is with perhaps telephone numbers to be added along with addresses of the members.

The Ethical Practice Committee was discussed as to lack of interest and problems of keeping things alive. Motion was made and approved that Rick Johnsey appoint a task force to work on this "problem" during the conference.

The 1979 registration fees and expenses were discussed and approved.

Some members were concerned about the number of people attending the Work Conference and how this was reducing the effectiveness of the Workshops. There appeared to be no solution to the problem, except to perhaps have more workshops.

The meeting was adjourned at 9:30 p.m.

Minutes of the Initial Business Meeting

March 7, 1978

Chairman Rick Johnsey called the meeting to order at 9:00 a.m. He welcomed the members to Durango and asked for introductions of new members. Special recognition was made to the Mexican delegation. Many members of the Southern and Eastern Forest Insect Work Conference were present. An invitation was made for members of the Western Conference to attend the Southern Conference.

Minutes of the 1977 Final Business Meeting, the 1978 Executive Committee Meeting, and the Treasurer's Report were read. The Treasurer reported a balance of $ 447.21 at the beginning of the 1978 meeting.

Discussion took place concerning the offers in 1977 to hold the 1979 meeting at either Boise, Idaho or Missoula, Montana. A motion failed to pass that the second choice be the 1980 site. Members accepted the offer and voted in favor of the motion to hold the 1979 meeting in Boise, Idaho. Doug Parker offered the Southwest and Bill Ives offered Alberta, Canada for the 1980 site. Action concerning the 1980 site was tabled until 1979.

Rick Johnsey asked for announcements of standing committees or special meetings.

Program Chairman, Charles Minnemeyer, reviewed this year's program and arrangements.

The meeting was adjourned at 9:35 a.m.

WESTERN FOREST INSECT WORK CONFERENCE

Treasurer's Report

March 1, 1978

Balance on hand, February 28, 1977		$ 135.04
Received from registration, Victoria meeting	$2,909.66 (+)	$3,044.70
Sell of extra proceedings	$ 3.50 (+)	$3,048.20
Expenses of Victoria meeting	$1,675.99 (-)	$1,372.21
Preparation of 1977 proceedings	$ 925.00 (-)	$ 447.21
Balance on hand, March 1, 1978		$ 447.21

PANEL: CONCEPT AND IMPLEMENTATION OF EXPANDED FOREST INSECT RESEARCH AND DEVELOPMENT PROGRAMS WITH SOME PROS AND CONS

Moderator: Paul E. Buffam

Panelists: David Ketcham, Tom McIntyre, Boyd Wickman, Gerry Hertel, Bob Campbell

Introduction: Paul E. Buffam, USDA Forest Service, Pacific Northwest Region, Portland, Oregon.

In the early 70's, the southern pine beetle, gypsy moth, and Douglas-fir tussock moth were prevalent in the Southeast, Northeast, and West, respectively. People were becoming concerned about the approaches being taken at that time to protect valuable resources. These methods were basically only partially effective and of short-term consequence. People were also concerned that, with the possible exception of the gypsy moth, present research efforts were not aimed at determining alternative prevention or suppression techniques. Therefore, wherever researchers, insect managers, forest managers, and other concerned citizens met--be it a bar in La Grande, Oregon; a nightclub in New Orleans, Louisiana; or a pool room in Stroudsburg, Pennsylvania--they discussed possible solutions to this dilemma.

About this time, I feel that a few astute individuals realized the political significance of tying these three insects into one package. That would tie together the politicians from the urban areas of the East, where 60 percent of the Nation's population resides, with the influential Southern politicians with their heavily agricultural-oriented constituents and the Western politicians with their timber-oriented and recreation-oriented constituents.

After no doubt much behind-the-scenes work by the aforementioned astute individuals, the Assistant Secretary for Conservation, Research, and Education of USDA in August 1973 asked ARS, APHIS, the Cooperative State Research Service, and the Forest Service to develop a coordinated program for "suppressing these three pests within a short period of time." This plan was completed in March 1974 and funded beginning in Fiscal Year 1975.

The plan stipulated an outline for the Combined Forest Pest Research and Development Program that we know today as the Three Big Bug Program. All three Programs had common objectives. They were: "(1) To implement available technology for reducing impacts of the insect, and (2) to develop short-term and long-term technology needed to prevent or suppress damaging outbreaks."

This was a new way of doing business for most people--a short-term research and applications program with a heavy emphasis on the applied results.

The Gypsy Moth and Douglas-fir Tussock Moth Programs end on September 30 of this year. The Southern Pine Beetle Program will terminate on September 30, 1980. About 24 million dollars of extra appropriations have been spent on these three Programs to date. Are these types of endeavors worthwhile?

It is our purpose today to discuss the pros and cons of the concept and implementation of these Programs. Perhaps our comments will be beneficial to Charlie Buckner, Mel McKnight, and Max McFadden who are embarking on the Spruce Budworms Program, albeit in a little different way as you will hear later today. It is not our purpose to judge the success or failure of the Programs because most of us on the panel are too close to the issue, and also the USDA is paying good money to have the Programs evaluated by an independent source.

We will begin this panel with a slide/tape program that summarizes the activities of the Three Big Bug Programs. We will then break for coffee. Following the break, Dave Ketcham will give us his comments from a key administrator's viewpoint, Tom McIntyre from a program manager's viewpoint, Boyd Wickman from a researcher's viewpoint, and Gerry Hertel from a user's viewpoint. Bob Campbell will then give us his opinion on what we can realistically expect from such programs.

An Administrator's View: David Ketcham, USDA, Washington, D.C.

As my part of this discussion this morning, I will give you a brief overview of the total process involved in expanded research and development programs from the selection through the implementation of the technology developed. Because of the limited time, I will only hit the high points.

Concept

First, let's talk about what an expanded research and development program is and how it should be used. Conceptually, an expanded program is a means for concentrating resources on a serious problem where impact is severe and solutions are needed immediately. The southern pine beetle, gypsy moth, and Douglas-fir tussock moth--the three insects involved in the USDA Combined Forest Pest R&D Program--are excellent examples of problems meeting these criteria. The eastern and western spruce budworms and the mountain pine beetle are also good candidates.

Expanded programs are inherently short-term, usually lasting from 3 to 6 years; and they should only be used when sufficient technology on which to build is already available.

Of course, a primary objective of any expanded program must be to implement technology as soon as it is available. This includes current information which is available at the beginning of a program but is not being utilized as well as the technology that is developed during the program.

Expanded research and development programs can be a good way to solve serious problems in a short period of time. They also place real emphasis on the implementation of technology, an emphasis that is frequently lacking in "regular" research and development programs. However, they cannot be used for everything and they tend to neglect basic research.

Commitment

A key ingredient to all programs but one that is essential in these that are accelerated is commitment, both at the top and throughout the organization. You must have commitment at the top if you are to have the support and the resources needed to do the job throughout the life of the program.

Equally important, you must also have commitment throughout the remainder of the organization, including the scientific and user communities. This can be done by explaining to people about what the program is and what you are planning to do and by involving them to the maximum degree possible in the management of the program. Again, I want to emphasize that I am including here both scientists and users. My boss once told me that "sooner or later, you'll do what the boss wants done." Now, I am sure that my boss was not referring to me personally when he said that. I am also equally certain that he is correct: Sooner or later, you will do what your boss wants done. However, in an accelerated program you have no time for "sooner or later." You must have it "sooner," and it is worth making the extra effort to get it.

So, even though the gaining of commitment--both at the top and throughout the organization--takes time and the people involved frequently do not have the necessary skills, you must have it if you are to have a successful accelerated program.

Planning

As is the case for most anything else that we do, good planning is essential for success. This is especially so in the case of expanded research and development programs. The establishment of realistic goals and objectives, clearly stated, is essential. Because, remember, you won't have forever to accomplish them. The more detailed plans designed to meet these goals and objectives should also be realistic, clear, and concise. Both researchers and users representing a broad range of disciplines should be fully involved in this process.

Recognizing that all of this takes time, it is critical for program accomplishment.

Organization--Program Management

The establishment of an effective program management organization is essential. To do this, you must secure the services of the best people available. This is especially important since the people you do involve in the program must be placed when the program ends. If you have ever been involved in this kind of a situation, you have learned that it is much easier to place the people that everybody wants rather than somebody else's "duds" or rejects. As a matter of fact, you won't get the best people in the first place if they do not think that their participation will either enhance their careers or give them real job satisfaction.

If program managers are to function effectively, they must have the authority and the resources necessary to do their job. They must also have the flexibility to do what specific situations demand. They should also be held accountable for getting the job done.

Again, let me emphasize the importance of getting good people. This is difficult because top people are in demand and must be enticed. They are also sometimes hard to place back in their organizations even when they have been "top hands" because they have sometimes made enemies when they have had to make hard decisions. They are also sometimes regarded as having been "out of touch" and no longer fit the organizational mold. However, top people are a "must" for program success, and top level administrators must be depended on occasionally to make forced placements when the situation requires it.

Implementation

All expanded research and development programs should be designed to utilize the expertise available, regardless of organizational ties. This should include the entire scientific and user community in all phases of the program.

Program managers must be willing to make hard decisions when necessary to accomplish program goals and objectives. These might include the termination of someone's "pet" research project if it is no longer contributing significantly to these goals and objectives.

Program managers must also create and maintain that sense of urgency that is essential in an accelerated program to insure that work gets done on time.

These steps are essential in the implementation of expanded programs, and the benefits are great. However, you sometimes have the opportunity to test the commitment and support of top management when you step on the toes of someone who is important and influential.

Technology Transfer

Technology transfer is something that should be planned for from the beginning and not simply added on at the end. It is also a job for professionals, and I mean information specialists. These people should be brought in at the beginning and utilized throughout.

Program publications should be targeted to specific audiences, and they should be imaginative. The science or art of communication is so difficult that is deserves the best that you can give it.

The effective transfer of technology is a "must" for program success. New tools are not worth anything until they are used.

Evaluation

All programs, accelerated or not, should be evaluated periodically. In addition to these "ongoing" evaluations, accelerated programs should also be evaluated when they end. Although these are time-consuming and frequently require special expertise, they do permit "fine tuning" and provide you with the information needed to do things better next time.

Summary

In summary, expanded research and development programs should only be used when they meet the prescribed criteria that I mentioned at the beginning. They should focus on a serious problem where the impact is severe and solutions are needed immediately. A sufficient base of technology is necessary to meet program goals and objectives in a short period of time, usually 3 to 6 years.

The key ingredients for success are to:

--Select the proper program at the beginning,

--get commitment at the top as well as throughout the organization,

--set clear and achievable goals and objectives,

--provide the needed funds and other resources,

--use the best talents and skills available, and

--maintain a sense of urgency.

As I have said before and will say again, user involvement in the beginning is the key to implementation in the end.

A Program Manager's View: Thomas McIntyre, USDA, Hyattsville, MD

My comments today will be applicable in many instances to those of us in the three "Big Bug Programs" but I assume responsibility for all thoughts expressed since there has been no prior consultation with either Ken Wright or Bob Thatcher, Program Managers, West and South.

As Program Managers during the early phases of our assignment, we had general guidelines with which to operate since there were no precedents for programs of this nature. We were operating under the short time frame with several uncertainties. Paramount was the question of whether there were sufficient scientists, particularly within the university structure, to do the job under the short-term funding arrangements which were being proposed. It is now obvious, toward the conclusion of at least two of the Programs, that this was not the case. The understanding and cooperation of university administrators and participating scientists has been outstanding.

Initially, the Department of Agriculture told us that we were assured the resources of funding, personnel, and facilities to get the job done. Somewhat complicating the effort was our charge to deal with agencies where we had little prior experience. In my case, I inherited an ongoing research effort within four agencies where there had been gypsy moth research under way since 1972. There was an obvious need to direct and, in some cases, redirect ongoing research into a coordinated effort. All three program managers had little prior experience in dealing with the Cooperative State Research Service. We recognized, in the early planning stages, that this agency would play a major role since it provided our support source for much of the extramural funding to universities and colleges.

The Programs, I believe, were strengthened from the start since we essentially had assurance of continuing funding. This, no doubt, contributed to enthusiasm by the many scientists who became participants in the research effort.

Whenever necessary, the Program Managers received Department support in the form of delegated authority to carry out their assignments. We were reassured continuously by the Office of the Secretary on numerous occasions that there would be no change whatsoever in the strength of support. We feel the visibility of the three insect programs was strengthened by our position as members of the Office of the Secretary. Early in the game, it became obvious that this delegation of authority enabled us to move quickly on critical matters involving personnel, funding of research proposals, and cooperative task planning. The use of advisory counselors, working groups, and consultants was simplified under the concept of move quickly but efficiently and get the job done.

In all three programs, we maintained a close liaison with EPA. This was most reassuring since, essentially, we had their support from the beginning of much of our critical research where we were concerned eventually with registration of control compounds.

In dealing with personnel, the Program Managers had great flexibility in helping to recruit and select their program support staff including the research and applications coordinators. Each of us dealt differently with the matter but the flexibility of the Interdepartmental Personnel Act became obvious since several university scientists were assigned to these positions.

Many of you in the audience who were funded in the Tussock Moth Program realize the strength of the program manager concept when dealing with funding research proposals. I recognize the pros and cons of short-term funding but also recognize the responsibility of the Program Manager's staff in initiating new research and sometimes promptly terminating research which is considered unproductive toward meeting Program goals and objectives. In the three insect programs, we have tried in different ways to keep participating scientists informed of significant developments and accomplishments. I believe this is unique and is a major improvement in the way we do day-to-day business in the scientific community.

It is difficult to summarize what might be considered the negative aspects of the program manager's concept. Many items will no doubt surface as we now prepare for a comprehensive post-program evaluation of the tussock moth and gypsy moth programs. Many of you here will have a chance to express your ideas about our special short-term research and development programs. We look forward to these candid expressions since we firmly believe that these initial starts will possibly lead to similar R&D programs in the future.

From a Researcher's View: Boyd Wickman, USDA Forest Service, PNW Station, Corvallis, Oregon.

Rather than present a list of my personal pros and cons with their attendant bias, I have solicited comments from my research colleagues at the Corvallis Forestry Sciences Laboratory, other FS labs, and several universities. It is admittedly a small sample (about 12 people), but it does represent a cross section of disciplines. Many of the comments had a common ring to them. I do not know if that is because researchers only talk to each other and we have reinforced our prejudices or because the expressions are real. Since this sample has no statistical significance, we will not really know if they are a consensus viewpoint. It may provide some food for thought and perhaps help the direction of future programs.

First the Pros

1. In my sample there was an almost unanimous agreement that large "bug" programs provided a level of funding and support services rarely, if ever, experienced before. As a research project leader, I can say that instead of my usual worry about where I was going to get enough money to let someone travel 200 miles, I was spending an inordinate amount of time making certain that project scientists were spending their money. They were so used to doing without, doing their own technician work, scrimping on supplies, that it took constant encouragement to spend the money and get the job done. This viewpoint was absolutely necessary because of the tight time constraints of program studies.

2. Another near unanimous pro was the encouragement by the program team approach to problem solving. A multidisciplinary attack on a broad ecological problem like the DFTM for instance is probably the only way we can gain a meaningful understanding of the problem, the only way we can come up with management alternatives in a short time period. There are other benefits to this team approach. Most scientists, by the nature of science today, are narrow, highly trained specialists. What they see up to the end of their noses at least is probably very accurate, precise, and meaningful, unfortunately, most of us believe that our research discipline is the only one that can come up with these precise, meaningful answers. Suddenly we learn, Hey, there is a whole melange of scientists and specialists out there that may not see things the way we do but they sure can contribute a deeper understanding to one or two pieces of the jigsaw puzzle. And there are methods now of making the puzzle into a picture. One of our most satisfying experiences has been working with mathematicians and systems analysts to produce a DFTM model. Within my project we worked as a team to provide data to the modeling team which interacted with us constantly so that we were actually one team in the end. I think most of us found this professionally satisfying and productive to the program.

3. There were some other comments on benefits of the approach like "Got to go to more meetings," "Met some interesting people and got to know my peers better and they me," "Felt I really contributed something to a forestry problem for the first time in my career," and "Enjoyed being able to identify with a big, well-known program since my work was usually very obscure." These are mostly ego things, but believe me researchers have big

egos and they need constant nourishment. The positive effects on egos are bound to have some positive effects for the program.

4. There are, undoubtedly, many more pros some of you in the audience are itching to express. One final personal observation--I think the DFTM Program is a success. At least as measured by obtaining some new methods for managing the pest, a better understanding of the population dynamics, a recognition of the multitude and complexity of ecological process involved in the DFTM-Forest System, and hopefully some way to put it all together for the manager and decision maker. But my sample wanted me to point out the groundwork for the "Success" was laid prior to the Program.

The recognition of the ecological processes. That is the one thing that may be most important in terms of ultimately managing or living with the DFTM. There has been a joint recognition by several disciplines that the DFTM is not just a pest and the forest a tree farm, but that they are interacting systems with both positive and negative effects on each other. Man tinkers with the system like a child playing with blocks but the Program effort has at least made it respectable to talk in terms of the DFTM also being an important component of the forest ecosystem, not just a villainous pest.

In summary, new information on the DFTM has not just increased it has accelerated in quantum leaps.

Now For Some Cons

1. There was a strong expression, in my sample, against the convergence technique and the planning process. I was very deeply involved in the planning process for both the DFTM and SBW Programs but rather then being defensive, I admit I share some of these views. The main concern was that the scientists had little or no input into the type of studies needed, or their priorities sometimes even research approaches were dictated to them. There was little opportunity for original or "far-out" studies; the type that are inherent in research and quite often have tremendous payoff. There was too much emphasis on a finished "product" rather than building blocks of knowledge, which is the usual scientific method. This tends to put sideboards on a scientist thus preventing valuable research on times that may be more important than the original research proposal, and does not provide for long-term research beyond the life of the program. Knowledge is a dynamic process--some may feel we know all we need to know about the DFTM right now. My response--wait until the next DFTM outbreak baby!

2. The second most highly criticized element was that of reporting. There were too many, too often, and too rigid. There was a feeling that the report writing detracted from the ability

to prepare scientific publications, which in the end are a more valuable product. And then there is a compendium. Perhaps the less said the better because much of the language I heard is not repeatable here.

3. The program concept implies that any problem can be solved in X number of years given Y amount of money. This is simply not so. Most programs would fail to meet their objectives without the work that has gone on, often by an underfunded few, prior to the program. There was a feeling that programs tend to swallow up the past, and take credit for what went before.

We also know that payoffs in areas like biological control population dynamics, host-site relations, and stand damage come only after decades of study, not 3-5 years. The lack of long-term commitment was a concern of most.

4. The program concept implies payment for favorable results and continued support only for success. There is perhaps tendency to "force" results, to hypothesize beyond the limits of experimental data, to claim "Here is the answer." "Good" science is usually slow science. By that I mean it is painstaking and the researcher tests and retests his hypothesis before he shouts "Eureka" to the world. Programs tend to short-circuit this process because they want a finished product. Programs encourage the release and use of partial results, promising results, untested results and that is not good science. I worry that perhaps we are creating a whole generation of young scientists with the "short-term," "make it a success" attitude so that they can go on to the next 5-year program and be a success all over again. It is heady stuff to be told that "your study results are just what we wanted," but who are the "we"? Researchers have a first commitment to scientific ethics and secondly to some administrator dangling dollar bills on fish hooks. Premature conclusions are becoming increasingly easy to publish and then if they are wrong take an inordinate amount of time and effort to refute or correct further down the road.

5. A few quotes from my sample: "Tends to involve political expediency rather than scientific method," "Could easily overload a crowded job market by encouraging universities to solicit grad students to work on program money--students they would not ordinarily take," another quote "I felt like one of the cows out in the corral waiting for my hay, making sure I gave my share of milk so I wouldn't be sent to the slaughter house." "The research is disjointed." "It is too political--money goes to organizations to spread the wealth, it is spent on some studies contrary to study reviewers recommendations that it not be spent."

6. A comment on my role as a research project leader and it may be unique to the Forest Service. But programs have created a whole new organizational structure that the Forest Service does

not seem to want to cope with. It has made my job a lot harder in terms of managing scientists. I have the responsibility for their performance and productivity, but the money comes from another manager who wants accountability also. Research coordinators probably work with project leaders like myself in a reasonable way, but the tendency for increasing accountability to the program rather than the parent organization is bound to cause increasing friction.

To Sum Up

Short-term R&D programs are a fact of life. One high-level FS administrator told me when I complained about one aspect of them, that we better get used to programs because 75 percent of FS research would be in that format within 5 years. I do not know how accurate his prediction will be. I do know that to survive, our project is now looking to the next 5-year program. So he is basically right, we researchers better learn to live with R&D programs right now. And there are some positive aspects that make living with them worthwhile. But as a scientist I make this plea: Just because of real or apparent successes let's not set the program approach to doing research in concrete. There are some things wrong with programs too!

In conclusion: Few of the researchers are enamoured with 5-year programs--but we have our price.

The Users View: G. D. Hertel, USDA Forest Service, Southeastern Area, Pineville, LA.

My task is to assume the awesome role of speaking for the "USER" in terms of what he or she thinks about the concept and implementation of the Expanded Programs. My comments will focus on the view of the USER as related to the Southern Pine Beetle (SPB) Program. Hopefully, some of the points will be relevant to the other Programs.

I am sure it is premature to get a good picture of the "USERS" thoughts about the big program concept. Their ultimate feelings will depend on the program's contribution to the way they do business. A postprogram evaluation is planned to determine the effectiveness with which the programs have been carried out. That evaluation will address several questions: Were real world problems solved? What could have been achieved if all work were completed? Could we have reached the same level of knowledge without an accelerated effort? One might imagine that consideration of future programs will rest heavily on the success of current programs--with, of course, the success determined by the USER.

Just who is the USER? The USER could be a scientist, a Forest Service State and Private Forestry (S&PF) specialist, a State pest control employee, a forester-biologist, or a nonprofessional owner of wooded property. We usually do not look at the USER group as including this broad a spectrum of people.

THE SOUTH'S LANDOWNERS

In the South, the government owns 8 percent of the commercial forests, industry owns 19 percent, and the nonindustrial landowner owns 73 percent. Each group has quite different management objectives and we must relate to each of these groups in whatever technology we develop and attempt to sell.

Foresters on the National Forest, for instance, must consider silvicultural needs, wild or scenic areas, fire management needs, forest insects and diseases, public involvement, visual aesthetics, range management needs, and air and water quality. This management reflects long-term programs, responsiveness to public needs, and a balance of resource uses as directed by Congressional mandate. Public lands are a public trust, and therefore do not carry the tax burdens, investment, and carrying costs that a private owner must pay. These dynamic forests must be managed in the best economic interest of the country.

The industrial forest can generally be expected to continue to exist over time. Forest lands are acquired to assure availability of raw materials to operate the firm's manufacturing facilities. To provide this portion of the Nation's timber requirements requires large capital investments, intensive management, shorter rotations, and maximum utilization of site potential consistent with environmental considerations.

Nonindustrial landowners form a very heterogeneous group of individuals. They value morals and ethics, but when it comes time to pay the bills and educate the children, profit is the most important factor. Most do not own land for the purpose of growing timber. Major deterrents to their applying more intensive forest management practices include the long-term, low return, high risk nature of the investment, lack of motivation and dollars for capital improvements, and the specialized equipment and personnel to get the job done.

The scientific community, another USER group, is responsible for obtaining the necessary information for detection, evaluation, prevention, and suppression of forest pests for specialists (S&PF, State, and Extension) who work with the land manager/owner. This is usually provided to satisfy their needs for most effectively dealing with forest pests.

As you can see, we have a very diverse "USER GROUP." The package (or packages) we attempt to sell must keep this in mind.

HOW USERS RELATE TO THE PROGRAM

Following are some specific aspects of the expanded bug programs (i.e., planning, organization, management process, accomplishments, and technology transfer). This review is limited to aspects that may be familiar to the USER.

Planning

In one southern State, all State District Foresters polled (14) consider the southern pine beetle (SPB) to be a problem. Only four of these same State District Foresters had heard of the Expanded Southern Pine Beetle Research and Applications Program (ESPBRAP) despite the fact that program management representatives have met with the Southern State Foresters twice and the Southern States Management Chiefs twice during the Program's life. None said they were involved in the planning stage.

ESPBRAP feels that nearly all potential USERS probably had input through the Southern Pine Beetle Action Councils, the Southern Forest Insect Work Conference, the S-99 Regional Project, and S&PF to the initial planning for the Program. However, very few forest pest control specialists of State agencies had an opportunity to review the Program prior to its initiation. Evidently a few people spoke for the majority of the USERS. We have to hope that they were fully aware of the problems at hand. The question which always arises is, "Did this input significantly alter the Program's direction?" I can obtain as many yeas as nays when asking that question. Initially, the cry was, "the Program is all research with no applications in sight." However, this may have failed to recognize the "state-of-the-art" at the beginning of the Program.

Two of the foresters in our State survey who had heard of ESPBRAP said they were involved since the Program began. Their involvement was providing investigators with location of possible study locations.

The original 5-year objectives were probably necessary to organize the conceptual flow of timed activities and to sell the Program to regional supporters, USDA, and Congress. However, the planned accomplishments may have been unrealistic when one considers what can be understood biologically over a 5-year period. Will economic conditions and insect, forest, and climatic conditions be such that the information developed now will be useful in the future? Crash, short-term programs are considered by many as a poor way to spend dollars because of the limited time for standardized planning.

Initially, some did not especially object to, or care about, specific inputs because none of their dollars (if one ignores their tax dollars) were going into support of the Program. If some usable tools came from the Program, so be it--they would be put into use.

<u>Organization</u>

The primary staff for ESPBRAP consists of:

Bob Thatcher, Program Manager
Tom Payne, Research Coordinator
Jack Coster, Applications Coordinator

A few of the primary staff members are directly funded by ESPBRAP to do research. This arrangement should not have been made because it is human nature for other investigators to believe that primary staff would get preferential treatment! However, the Program Manager does see to it that these projects are treated exactly the same as all others.

The Technical Review Panel (TRP) and Administrative Advisory Subcommittee (AAS) provided support to the primary staff. These two ad hoc groups were made up of highly qualified individuals who represented all USER groups. Some of the AAS questioned their own role, as their Committee was formed 1 year after the TRP was formed and the Program was underway. They felt that the AAS needed more clout!

Whether or not the "USER" fully understands, or is happy with, the Program organization is not really important as long as any benefits (benefits should not be defined as information prevented) derived from the Program reach the USER.

<u>Program Management Process</u>

After the Program got underway, some "USERS" became more critical of the Program <u>direction</u> and <u>expenditures</u>. The main criticism seems to be that there is an excessive amount of emphasis on population dynamics. The cry is "We care about dead trees, not beetles." Some critics suspected a preallocation of funds.

Some commented that the Program replowed old ground. With its makeup, only a refinement and elaboration on what is already known is all that could be expected. The Program answered that quantitative studies were needed to establish old relationships and to dispel some of the mythology. Within the time framework of the Program, there was not time to get deeply involved in long-term, high risk, or more fundamental studies.

People with SPB experience should have used intuition, knowledge, and common sense to start and guide initial field tests. Many times, careful scrutiny of the rationale for a specific study in light of current understanding of bark beetle ecology and forest management tactics might have eliminated some efforts from consideration.

Many people who were on the ESPBRAP mailing list (opinion makers) did not circulate copies of the Newsletter and Progress Reports within their respective organizations. S&PF should have worked with the Program staff to reach the USERS rather than caring about how much money they received from ESPBRAP.

Program Accomplishments

In general, the USERS do not believe that the materials provided them have been satisfactory to date. Many hoped for faster results useful to the field. I do not know of anything being used now by the Southeastern Area, State pest control organizations, or National Forests as a result of Program accomplishments. I am aware, however, that some results will be available soon. They include:

1. Utilization criteria and an economic decision model for beetle-killed timber;
2. a registered insecticide for preventative and remedial control;
3. a stand hazard rating system that relates to site/stand conditions (age, growth, stand density), to probability of attack, and subsequent damage (= severity);
4. techniques for predicting spot growth or decline spanning a few months on an area-wide basis (it must be simple); and
5. guides for managing stands to reduce probability of attack (If I do it, what if my neighbors don't?).

Technology Transfer

It is difficult to relate to the TT process before we have a package or packages to sell. The Program cannot rely solely on mailing lists to get information out. FIDM is helping to expand the contacts by identifying key people in each State. The Southeastern Area has the responsibility to get the information to all Federal land managers (NFA, NPS, Corps of Engineers, and Military) and to our primary contacts with the State forestry organizations. Of course, other organizations are also interested; e.g., Extension Service, Soil Conservation Service, State forestry associations, Forest Farmer Association, Southern Forest Institute, and various forest product associations.

Much of the information obtained is, or will be, captured in "How To" USER handbooks aimed at specific audiences. In view of some of the proposed titles, we should consider a label on the front of each identifying the audience (homeowner, forester, scientist, etc.).

Another major problem is the willingness of the investigator to provide technical vs. nontechnical material. The system may be such that he gets his recognition only from articles published in refereed scientific journals. Also, journals will not publish material that has already appeared in another outlet. In future Programs, it may be necessary to contract with investigators to insure that information can move out as soon as it is ready for dissemination to particular USERS. Additional outlets or new mechanisms for information dissemination may be needed.

SUMMARY

The USDA Combined Forest Pest Research and Development Program is a new approach to quantify, predict, and solve our major regional forest insect problems. The success of this approach will be measured by the results that are produced and get into the hands of USERS. The USERS are a heterogeneous group with diversified objectives. Technology developed by the "Big Bug Programs" will have to keep the heterogenicity of USERS in mind.

When Programs are planned, good objectives are needed with good working hypotheses. With limited time, could we really have hoped to accomplish as much as we anticipated? Understanding of a dynamic, variable biological system is probably not achieved in a short time frame. With this in mind, a vehicle must be established to take full advantage of existing or readily attainable technology in selecting and implementing work.

Even though most considered SPB a region-wide problem, many field people were unaware of ESPBRAP. Obviously, many supervisory and staff people did not pass along such information in their respective organizations. The Southeastern Area should work directly with the Programs to assume a more effective flow of information to the USER.

Please, leave the Program management staff in place for the duration of the effort! Changes are just not good for establishing and maintaining relationships with USERS during a short-term Program.

Many of us are conducive to dark and perhaps unfounded suspicions about scientists. We must interact more to alleviate such feelings by working together--within and between disciplines and within and between organizations--from initial planning to use. A number of Federal and State organizations do not have a good track record for doing this, so why should we have expected this to happen in the Program?

All of us, not only Program managers, have an obligation to produce as many useful results as possible. Program effectiveness depends on all of us for involvement and support. Many opinion leaders went to bat to obtain funding for these Programs. I would not want to embarrass these opinion makers and, at the same time, let down our USERS.

What Can We Realistically Expect from a Short-Term RD&A Program: R. W. Campbell, USDA Forest Service, PNW Station, Corvallis, Oregon.

Modern-day R&D programs are truly big business. We have an obligation to insure that the public, which is paying the bills, is getting its "money's worth." As the first of these programs begin to wind-down, it is fair to ask what we can realistically expect these short-range, concentrated efforts to produce.

First off, we can expect both the programs and their end products to differ widely. Factors that will influence the evolution of each "big bug" program include:

1. The state of knowledge at program onset regarding both the biology and ecology of the forest-pest system, abilities to manage this system, and socioeconomic factors. An important part of this knowledge is the degree of certainty or uncertainty that accompanies this knowledge.

2. Each "big bug" program must be tailored to a particular socioeconomic environment. For example, the program must identify current values of both the threatened resource and the threat posed to that resource by the pest in question. It must also identify and understand both relevant current management practices and the complexity of the overall management situation.

3. State of information synthesis at the start of the program may be critical. Also, program related results have to be placed in perspective before they can be used efficiently as part of overall resource planning and management. Hopefully, an adequate overall planning structure will be available. If not, the program must be prepared to develop such a structure on its own.

4. Managerial "style" is critical. Specific, reachable objectives must be defined and efforts must be directed toward reaching them. In short, short-range R&D programs are programs of strongly directed research.

Despite their differences, I think all well-designed and well-managed programs can and should be expected to accelerate both research and the translation of that research into practice. They can and should serve to blur and soften the artifical and destructive barriers that sometimes develop between research and management-related activities. They can and should provide a synthesis of prior work and a focus for ongoing studies. They can and should leave an expanded knowledge base and a group of trained people to continue working long after the formal program ends.

Short-term R&D programs are now and will remain of pivotal significance in many of our professional lives. Let's learn how to produce the most useful short-range and long-range products from the resources provided by these programs. At the same time, though, let's recognize the short-range, high-intensity R&D programs are not the way to fight all our research and dvelopment battles. We must design our whole research and development effort so that each new short-range accelerated program is built on solid underpinnings.

Panel: THE CANADA/U.S. SPRUCE BUDWORMS PROGRAM

Moderator: Max McFadden

Panelists: Charles Buckner and Mel McKnight

The Canada/U.S. Spruce Budworms Program, as the name implies, is a cooperative, international effort to accelerate and expand research, development and application efforts against spruce budworms. I had asked Charley Buckner and Mel McKnight, the program leaders for Canada and the U.S. respectively, to describe the Program as it has developed in each country. Unfortunately, Charley could not be with us in Durango, but Mel has agreed to cover the Canadian effort at least from the viewpoint of organization. Following Mel's presentation I will discuss implementation and status of the western component of the U.S. part of the Program.

The Canada/U.S. Spruce Budworms Program:
Melvin McKnight, Program Leader,
Forest Service, USDA, Washington, D.C.

The Department of Environment, Canada, and the U.S. Department of Agriculture have agreed to cooperate in a 6-year joint effort aimed at the spruce budworm (*Choristoneura fumiferana*) and the western spruce budworm (*C. occidentalis*).

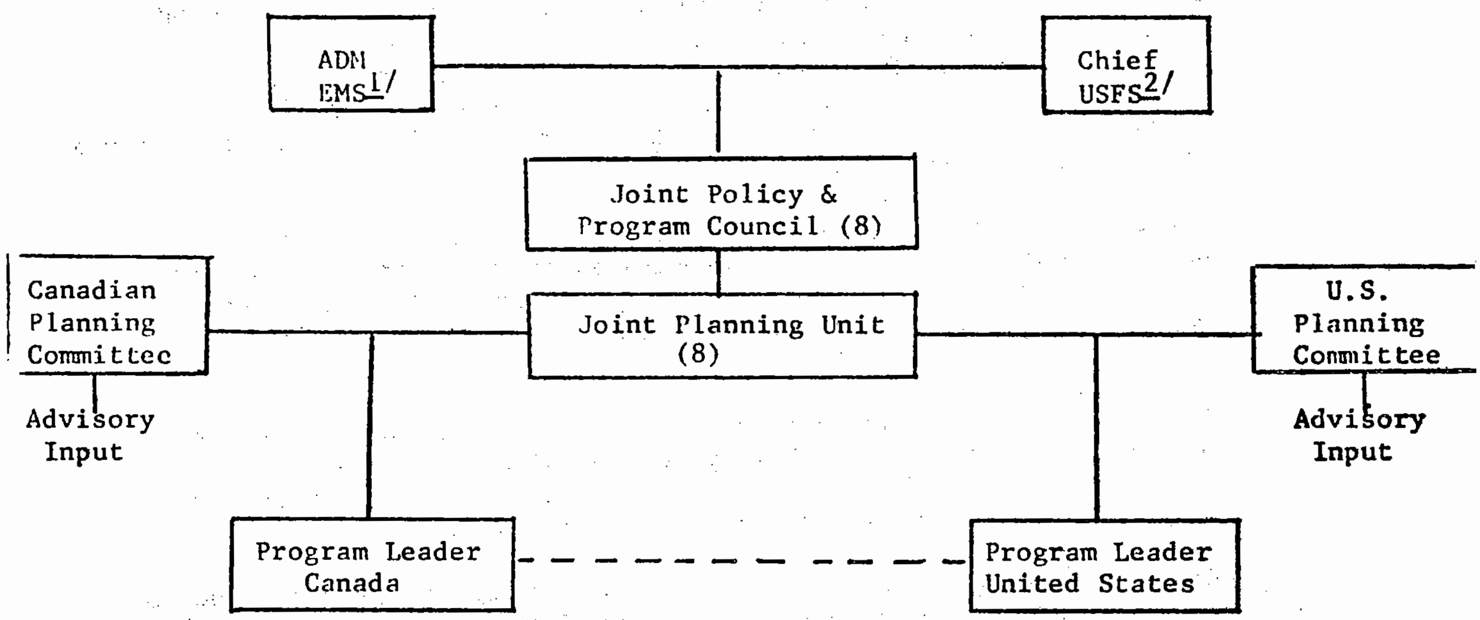
ORGANIZATION

The organization of the Canada/U.S. Spruce Budworms Program features joint leadership at several management levels (fig. 1). The Chief, U.S. Forest Service, and the Assistant Deputy Minister, Environmental Management Service, are the top line officers. The Joint Policy and Program Council (JPPC) has four members from each country to assure maximum cooperation and coordination between Canada and the U.S., and to provide guidelines for the Joint Planning Unit.

The U.S. members of the JPPC are the Deputy Chief for Research (co-chairman with the Director General, Canadian Forestry Service), Deputy Chief for State and Private Forestry, Deputy Administrator of Cooperative Research, Science and Education Administration (SEA-CR), and a representative of the Association of State College and University Forestry Research Organization (ASCUFRO).

The Joint Planning Unit (JPU) also has four members from each country. The JPU provides a staff function to the JPPC by evaluating plans developed by the Program Leaders and the Planning Committees and recommending adjustments if needed. The U.S. members are the Director of Forest Insect and Disease Research (FIDR), Director of Forest Insect and Disease Management (FIDM), a representative of the National Association of State Foresters, and a representative of ASCUFRO.

Canada/U.S. Spruce Budworms Program



1/ Assistant Deputy Minister, Environmental Management Service

2/ Chief, Forest Service, USDA

Figure 1

The Program Leaders execute the Program and facilitate coordination within and between the Canadian and U.S. components.

The U.S. portion of the Canada/U.S. Spruce Budworms Program will be organized with eastern and western components (not separate eastern and western programs(fig. 2) . We intend to incorporate the most effective features of the USDA Combined Forest Pest Programs. However, this is an agency program with leadership assigned to the Forest Service, not a departmental program administered from the Secretary's Office.

The Deputy Chief for Research has overall responsibility for the Spruce Budworms Program with responsibility for coordination with the Deputy Chief for State and Private Forestry (S&PF) and the Deputy Chief for National Forest Systems (NFS), and with the Cooperative Research, SEA.

The Program Leader, assigned to the FIDR Staff in the Washington Office, will have responsibility for coordinating all aspects of the Program in the U.S. and for facilitating coordination and cooperation between the U.S. and Canadian programs.

Operational responsibilities for the eastern and western components of the RD&A Program are assigned to the Northeastern Station (NE) and Pacific Northwest Station (PNW), respectively. At both NE and PNW the Program Managers report to the Station Directors and are responsible for planning, organizing, implementing, monitoring, and reporting all aspects within the respective components of the R&DA Program. The Program Managers will generally work directly with the Program Leader to assure coordination of all activities in the U.S. and Canadian programs.

The Applications Coordinators and Research Coordinators will provide staff assistance to the Program Managers in coordinating all activities within each component. Specific responsibilities will include; (1) determining the needs of forest managers and of FIDM Staffs in the Regions, Area and State Agencies for operational methods, materials, and strategies to deal with the spruce budworms, (2) planning and coordinating program activities to meet these needs, and (3) providing technical leadership to assure that the new and improved information and technology are made available promptly for application by the Regions, Area and State Agencies.

The Spruce Budworms Program will start up in Fiscal Year 1978 with existing funds already planned for R&D activities on the spruce budworms, and with Program resources made available from phase-down of the USDA Douglas-fir Tussock Moth and Gypsy Moth R&D Programs. We expect full funding to be achieved in Fiscal Year 1978 and continue through Fiscal Year 1982, and to phase down in Fiscal Year 1983.

Spruce Budworms Research, Development, and Applications Program

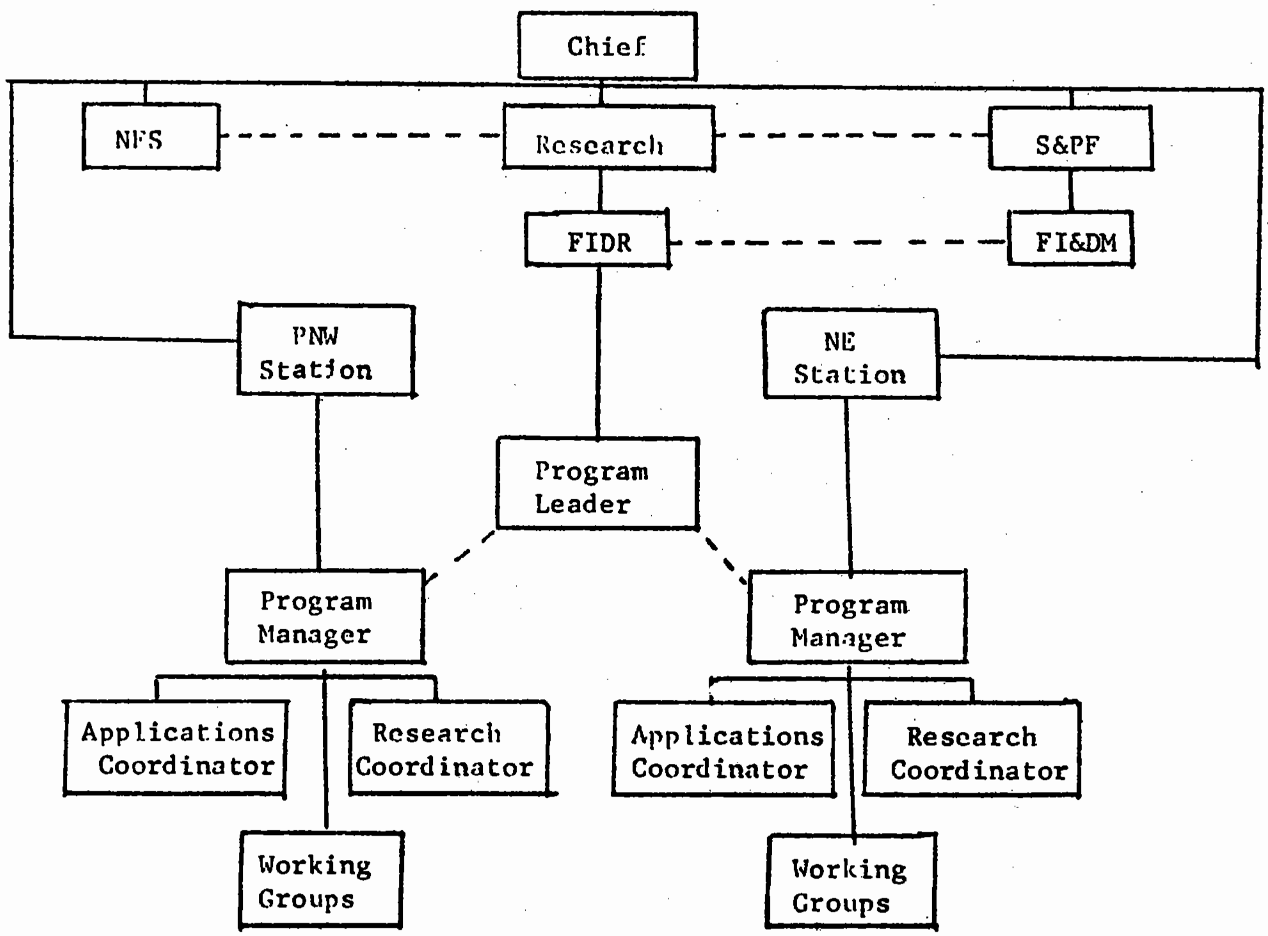


Figure 2

MISSION AND OBJECTIVES

The Joint Planning Unit has provided a mission to design and evaluate economically and environmentally acceptable management strategies for spruce budworms and budworm-susceptible forests to assist resource managers in attaining management objectives.

The objectives of the Program are to improve methods for evaluating and predicting population levels and forest responses; improve control technology and develop environmentally acceptable chemical, biological, and silvicultural treatments; develop methods for assessing and predicting economic impacts of budworms and management actions on resource uses and values; develop strategies for integrating pest and resource management systems; and evaluate each management strategy to assure that it is environmentally acceptable.

PLANNING

Resource managers, investigators, and Program Management participated in planning workshops in Portland, Oregon in December 1977, and in Montreal, Quebec, in January 1978. Both groups reviewed and revised existing plans for R&D activities to meet resource managers needs. The two revisions were combined to produce a composite plan that reflects the U.S. approach of accelerated R&D activities and incorporates the long-standing Canadian program of research on the spruce budworm.

EXPECTED ACCOMPLISHMENTS

Specific program outputs will include, (1) better methods for population and damage surveys, (2) improved control technology including chemical, biological, and silvicultural treatments, (3) improved methods for assessing and predicting short- and long-term impacts of budworms on forest resources, and (4) strategies for integrating pest and resource management systems. These Program outputs are considered collectively as "pest management systems for the spruce budworms". Attainment of Program objectives will provide forest managers with information needed for better pest management decisions.

The Western Component:
Max McFadden, Program Manager
U.S. Forest Service, PNW, Portland, OR

Perhaps the most significant event in the implementation of the western component was a planning workshop held in Portland during December 1977. About 90 scientists and administrators representing many different scientific disciplines and many user groups met to revise existing planning documents for the western component. The workshop was successful in providing revised expected accomplishments, a revised activity schedule and a list of activities that would receive funding priority in FY 1978.

Based on the above a request for proposals was mailed in late January and a Plan of Work and Budget was prepared and submitted for approval in March.

Sixty-three proposals were received and reviewed by program management and a Technical Review Panel on March 15 and 16, 1978. The Plan of Work and Budget was approved by the Joint Planning Unit on March 2, 1978 and by the Joint Policy and Program Council on March 16. All proposals have been evaluated and negotiations for funding are now in progress.

Working group meetings have been scheduled for the first week in May. Emphasis will be on coordination and cooperation between investigators and work planned for this coming field season.

Western component staff now includes secretary Linda Burbach and Applications Coordinator Tom Flavell in addition to myself.

WORKSHOP: STATUS OF PREVENTIVE SPRAYS
Moderator: W. F. McCambridge

Either 2% Sevimol suspension or 2% lindane emulsion appear, most of the time, to be effective bark beetle attack preventive sprays. Size of beetle attack population greatly affects prevention success.

Major bark beetle outbreaks have been rampant across much of the United States for several years. As the limitations of direct control are more fully realized, the protection of individual, high value trees has become a problem of great concern. For the past two years, four insecticides have been tested against a number of bark beetles to protect various pine tree species, and to obtain data with which to facilitate registration of effective compounds. Sprays were applied at about 1 gallon per 50 sq. ft. of bark = the point of run-off. Water was the carrier in all cases. Summary of results follows.

California. Ponderosa pine - western pine beetle. Data by DeMars, Smith, Page, Greene and Slaughter.

Table 1. Trees killed by western pine beetle (x), and those still living which might have been killed without the protective spray (*)[1/]

Plot #	Lindane 0.25	Lindane 0.5	Lindane 1.0	Reldan 0.5	Reldan 1.0	Reldan 2.0	Untreated	Trigger
6	*	*	*	-	*	*	-	X
7	-	-	-	*	*	-	-	X
10	*	*	-	*	-	*	-	X
13	-	-	*	*(5)	*	-	X	X
15	*(4)	-	-	-	*	-	-	X
16	*	-	*(15)	-	-	*	-	X
20	*	-	-	*(30)	*(2)	-	-	X
21	-	*(15)	*	*	*	-	-	X
22	-	-	-	-	-	-	X	X
23	-	*	*	-	*	-	X	X
Σ * + X	5	4	5	5	7	3	3	10
% killed	0	0	0	0	0	0	30	100

1/ - = < 200 beetles trapped

* = > 200 beetles trapped; tree expected to live

X = mass attacked; death of tree fairly certain

( ) = estimate of number of unsuccessful attacks as indicated by pitch tubes.

The treated trees were sprayed to a hight range of 28' to 35'.

"One over-all impression is that neither the introduced nor indigenous beetles were particularly "vigorous".

Table 2A. Number of adult predators caught in sticky traps and dead-fall cloth traps. Sum of 10 traps per each treatment.

	Lindane			Reldan			
Predator	0.25	0.5	1.0	0.5	1.0	2.0	Untreated
			Sticky Traps				
Temmochila	2	7	3	0	4	5	7
Enoclerus	82	91	93	73	93	67	191
			Deadfall				
Temmochila	1	0	5	0	0	0	1
Enoclerus	1	1	3	2	0	1	4

Bark residues of lindance and Reldan after 7 and 30 days were also determined.

Oregon. Lodgepole pine - mountain pine beetle. Data by Trostle and Smith. (Trees on 6 plots sprayed 20' to 25'; those on 4 plots sprayed to 12' to 15')

Table 1. (%) of trees protected by treatment; 10 trees per treatment. Final judgement of untreated mortality to be made in 1978.

	Concentration		No. Killed
Insecticide	High	Low	Untreated
Lindane	1% (100%)	.5% (67%)	6
Dursban	2% (75%)	1.0% (50%)	4
Sevimol	2% (100%)	1.0% (100%)	4

Note by moderator: The above data does not indicate the fate of trees sprayed to 12-15'. I suspect that these trees are at considerable risk when attacking beetle members are high.

California. Log Bioassays. Protective sprays on ponderosa pine from western and mountain pine beetles. Data by Smith.

Table 2. Ponderosa pine log bioassay in individual cages; trees sprayed in April 1977; all were aqueus emulsions, INCLUDING SEVIN [emphasis by moderator], at 1 gallon per 40-50 sq. ft. of bark surface.

Material	Conc. %	Residual period months	% Control MPB	WPB
Lindane	0.5	2	94	100
		3	73	98
Dursban	0.5	2	95	98
		3	78	-
Sevin	0.5	2	69	48
		3	36	-

Note by moderator: % control based on reduction of egg gallery length over controls.

Results and Discussion.

"With few exceptions, the chemicals were more effective against WPB than MPB. In earlier tests this was not so. There are at least 3 possible explanations: (1) the quality of WPB has decreased; (2) the quality of MPB has increased; (3) MPB is different in different hosts; all earlier tests used MPB from lodgepole but this year the brood was from sugar pine and in later tests from sugar pine cycled through ponderosa."

"For very short periods, low concentrations of lindane and Dursban are effective. Unfortunately Sevimol was not in tests."

In further lab testing Smith found,..."the higher the beetle density, the lower the effectiveness of the treatment."

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Idaho. Results of a 1977 pilot project to evaluate the effectiveness of Sevin insecticide in preventing attacks by the mountain pine beetle in lodgepole pine on the Targhee National Forest.

Trees were sprayed to 30'; 1 gallon per 50 sq. ft. of bark.

Table 5. Success ratios (lodgepole pine-MPB). Data by Gibson. Lindane as 1.3% emulsion, carbaryl as 2.0% Sevimol suspension. H_2O at pH 5.9.

Spray Block	Insecticide	Not Attacked[1/]	Attacked[2/]	% success
I	Lindane	19	3	86
	Sevimol	22	0	100
II	Lindane	3	16	16
	Sevimol	23	0	100
III	Lindane	5	10	33
	Sevimol	16	0	100
IV	Lindane	10	8	56
	Sevimol	17	0	100
V	Lindane	3	12	20
	Sevimol	21	0	100
VI	Lindane	2	2[3/]	50
	Sevimol	10	0[4/]	100
TOTAL	Lindane 1.3% a.i.	42	51	45
	Sevimol 2.0% a.i.	109	0	100

[1/] Not attacked = Not attacked + Pitchouts + Attacked only above 30'

[2/] Attacked = Attacked + Strip attacked

[3/] Nine plots logged prior to evaluation

[4/] Seven plots logged prior to evaluation

Colorado. Protecting ponderosa pine from mountain pine beetle attacks. Either 2% lindane emulsion or 2% Sevimol suspension, sprayed to the basal 30' will protect ponderosa pine from mountain pine beetle attacks. Spraying to 10', 15', or 20' did not protect trees. We are not sure if spraying to 30' will protect very large trees (d.b.h. > 20") nor the residual effectiveness of the sprays beyond 2 1/2 months.

All sprays were applied at approximately 1 gallon per 50 sq. ft. of bark.

Table 1. Protection of ponderosa pine from MPB when sprayed to 9.14 m. Water p.H 6.0 except as noted. Data by McCambridge.

Insecticide and % w/w	1976 Infested[1/] - number of trees -	1976 Protected - number of trees -	1976 Protected %	1977 Infested[1/] - number of trees -	1977 Protected - number of trees -	1977 Protected %
Lindane						
0.5	31	3	9			
1.0	13	24	65			
2.0	4(1)	30	88 (97)	7(1)	24	77 (97)
2.5				5(1)	22	82 (96)
Carbaryl						
0.5	30	8	21			
1.0	19	17	47			
2.0	7(3)	25	78 (91)	0	31	100
2.5				2(0)	25	93 (100)
3.0				0	33	100
3.0 unbuff.				0	26	100
Chlorpyrifos (Dursban)				Not tested in 1977		
0.5	33	2	6			
1.0	30	5	14			
2.0	28	11	28			
Chlorpyrifos-methyl (Reldan)						
0.5	33	5	13			
1.0	30	7	19			
2.0	15	18	55	12	18	60
4.0				4	28	87
4.0 unbuff.				3	28	90
Methyoxychlor., w.p.	Not tested in 1976 →					
2.0				28	9	24
Attractant	115	-	0	114	-	0
Check	Not available in 1976			84	-	0

[1/] Includes successfully infested and "not protected", i.e. those trees with many pitch tubes. Number in parenthesis is trees successfully infested only, and corresponding % protected.

Note: Total trees in each treatment not equal to 40 or 120 for check and attractant because beetles failed to reach some trees.

Colorado.

Table 4. Sum of fauna collected in three drop cloths per treatment, between July 8 and September 15, 1977.

Insecticide	Diptera	Hemiptera	Homoptera	Hymenoptera	Lepidoptera	Neuroptera	Arachnids	Coleoptera	TOTAL
2% Methoxychlor	155	32	2	20	46	18	22	1301	1626
2% Lindane	79	17	1	24	34	5	35	166	361
2.5% Lindane	60	16	2	18	51	7	38	324	516
2% Sevimol-4	73	24	2	21	32	12	40	723	927
2.5% Sevimol-4	118	34	0	30	57	11	75	447	772
3% Sevimol-4	81	40	3	40	64	11	48	493	780
3% Sevimol-4 unbuff.	89	23	5	34	26	8	49	291	525
2% Reldan 4E	185	32	5	50	97	24	67	1247	1707
4% Reldan 4E	159	41	1	37	65	24	60	829	1216
4% Reldan 4E unbuff.	176	34	7	48	60	18	65	337	745
Attractant	54	6	0	14	25	6	8	313	426
Check	36	8	2	20	19	3	3	201	292

Colorado.

Table 5. Coleoptera in drop cloths collected between July 8 and September 15, 1977.

Insecticide	% of tree infested	Mountain pine beetle	Cerambycids	Buprestids	Clerids	Ips	Ostomids	Turpentine beetle	Other	TOTAL
2% Methoxychlor	(100)	598	2	2	64	4	49	0	582*	1301
2% Lindane	(0)	111	9	2	12	0	0	0	32	166
2.5% Lindane	(0)	254	5	1	12	2	0	0	50	324
2% Sevimol-4	(0)	559	47	7	40	0	4	0	66	723
2.5% Sevimol-4	(0)	300	43	3	21	0	1	0	79	447
3% Sevimol-4	(0)	372	38	2	17	1	4	0	59	493
3% Sevimol-4 unbuff.	(0)	201	13	3	11	3	1	0	59	291
2% Reldan 4E	(33)	1119	12	6	14	0	1	0	95	1247
4% Reldan 4E	(0)	691	12	1	23	1	5	0	96	829
4% Reldan 4E unbuff.	(0)	236	2	1	12	0	2	0	84	337
Attractant tree	(100)	262	5	1	18	3	3	2	19	313
Check tree	(100)	175	5	0	5	0	0	0	16	201

* Of this total, 524 were tenebrionids.

Drop trays were placed under three trees in each treatment (all trees at each of 3 sites) to determine what insect fauna was being killed by the sprays. All insecticides are broad spectrum killers as can be seen in Tables 4 and 5. Insect fauna in the attractant and check tree drop trays are partly due to contamination; i. e., insects falling from nearby sprayed trees. But some of the catch is due to the inability of some Coleoptera (observed) to remain on the tree once they land. Why this occurs is not known.

<u>New Mexico</u>. Ponderosa pine - roundheaded pine beetle. Data by Kinzer.

<u>Southeast U.S.</u> Southern pines - southern pine beetle. Data by Felton Hastings.

WORKSHOP: FOREST INSECT POPULATION QUALITY
Moderator: Les Safranyik

Fifty-four persons attended this workshop. The moderator briefly reviewed the history of research efforts on this topic and, for the purpose of facilitating discussion, defined insect population quality simply as an expression of the relative ability of species populations to survive and multiply under a set of environmental conditions. Thus, quality is a composite expression of genetical and physiological changes in individuals or groups of individuals of populations in response to biotic and abiotic factors of their environment. Therefore, it is important to determine the proportions of physiologically or genetically different groups within generations or consider the possibility that these proportions might change in response to changes in environmental conditions, including population density. Qualitative differences are known in insects. Phase polymorphism, differences in viability, fecundity, longevity, vigour, fitness - all can result from qualitative change.

Dr. Molly Stock reviewed her current related works centered around the general applications of electrophoretic data. She stated that while major emphasis in coordinated pest management programs has been placed on study of environmental variables affecting insect numbers, there is an increasing awareness of the need for information on variation between individuals which make up the population, variations which, in turn, interact with the environment. We can no longer consider pest insect populations as homogeneous entities responding in a passive manner to environmental changes. This fact is obvious when we consider the frequency of observed "erratic" or non-uniform responses of different populations of single forest pest species to factors such as insecticides or silvicultural control practices.

Traditionally, the individual's phenotype (its outward expression of its genetic makeup -- commonly anatomical characteristics) has been used to infer the genetic structure of populations in an attempt to aid prediction of future population trends. Unfortunately, many phenotypic characters are difficult to quantify because they are a manifestation of an unknown number of interacting genes, the environmental component of the gene expression is unknown, and dominant characters often mask recessive characters.

Analysis of protein variation, using starch gel electrophoresis, has several advantages in genetic studies. Genetic expression at a very basic level is revealed, the method is simple to learn and use, the cost is low, and a great deal of information can be obtained on a population in a short period of time. Recent applications of this technique in our laborabory include investigation of genetic differentiation within the mountain pine beetle (systematic studies), analysis of differential insecticide response among populations of Douglas-fir tussock moth and spruce budworm, and development of a predictive scheme associated with population trends in the Douglas-fir tussock moth.

Preliminary analysis of populations of mountain pine beetle in lodgepole pine and western white pine in both mixed and widely separated tree types suggest that considerable genetic divergence has occurred between mountain pine beetle populations infesting certain allopatric (non-overlapping) host tree types.

An apparent relationship was found between certain esterase genotypes in the Douglas-fir tussock moth with relative response to the insecticides acephate and carbaryl. Surveys of populations for gene frequences of this type might increase accuracy of prediction of response of regional populations to insecticide treatment.

Information on 20 populations of Douglas-fir tussock moth representing different stages in the outbreak cycle (for example, release, outbreak, decline, endemic) suggest that monitoring populations for genetic changes at two specific gene loci might contribute significantly to our ability to predict incipient population changes such as imminent outbreak or population collapse.

The ensuing discussion centered on the importance of sound sample survey design, and elucidation of cause-effect relationships, in interpreting population change in relation to changes in genetical and/or physiological characteristics of individuals or groups within a population.

Dr. Gene Amman briefly discussed changes in the size-sex ratio, and reproductive capacity of mountain pine beetle populations as functions of certain physical properties of lodgepole pine trees, such as phloem thickness and tree diameter. These results were discussed with reference to related work with other bark beetles. It was illustrated how during epidemics the characteristic changes in the diameter and phloem thickness distribution of lodgepole stands can cause increases in female/male ratio and attack density, and decreases in female size and fecundity; changes all of which contribute to the decline of epidemics.

Dr. Gery Pitman mentioned that apparent north-to-south difference in the response of mountain pine beetles to the synthetically produced pheromone system in lodgepole pine may be related to differences in the host tree component(s) of the pheromone system and/or geographical variation in beetle populations.

The moderator commented on the work of Dr. Tara Sahota, Pacific Forest Research Centre, Victoria, B.C., who is currently investigating the rate of yolk protein production in the spruce beetle in relation to developmental temperatures, broad density and the type of host material in which the beetles were reared.

WORKSHOP: Problems and benefits of large-scale pilot projects

Tom Flavell, Applications Coordinator
Western Component, Canada/U.S. Spruce Budworms Program

Doug Parker, Entomologist
Forest Insect and Disease Management Staff
U.S. Forest Service, Region 3

Pilot projects conducted by the U.S. Forest Service, Forest Insect and Disease Management staffs, are designed to evaluate the operational usefulness of pest management practices before they are recommended for general use. Although not restricted to evaluating insecticides most large-scale pilot projects in the West have focused on this method of pest management. Usually these are compounds which research has shown to be effective against a forest pest under laboratory and small-scale field tests. In many cases they are already registered against a variety of agricultural pests.

The U.S. Forest Service feels information from pilot projects is essential for meaningful registration of insecticides for forest insects. The Environmental Protection Agency, however, will register an insecticide for forest use on the basis of field tests alone. In essence then, the Forest Service has added an additional step in the registration process for insecticides aimed at forest pests. This step is considered important because it seeks answers to some basic and practical questions such as:

1. Will the insecticide perform satisfactorily when applied operationally?

2. What handling problems can be expected in the field when dealing with relatively large quantities of the insecticide under simulated operational conditions?

3. What problems occur with the spray system?

4. How much will it cost to apply the insecticide on an operational project?

5. What environmental impacts may be expected when the insecticide is applied to the forest ecosystem?

6. What effect does the insecticide have on parasites/predators of the target pest?

Answers to these questions do not come easily or cheaply. As technology in these areas has increased in sophistication, costs have risen dramatically. The result has been an effort to restrict the objectives of pilot projects; i.e., to reduce their sophistication.

On the other hand, pilot projects offer a unique opportunity to make observations on the behavior of a pesticide used under simulated operational conditions over a relatively large area. The more sophisticated, the more likely questions on efficacy and environmental impacts will be answered.

In view of these considerations, participants in the workshop discussed the question of whether or not large-scale pilot projects are really needed and the level of sophistication required. Although difficult to summarize, the general consensus was that pilot projects provide a very useful test of promising insecticides. The level of sophistication should be sufficient to answer pertinent questions on the pesticide's performance or environmental safety. Since the delivery system is a key element in determining the effectiveness of any material it should be adequately monitored. Environmental monitoring is of paramount importance and should receive careful attention. This is particularly important with regard to filling in gaps in knowledge because of the peculiarities of the forest habitat types in which the pesticide is likely to be used. In summary, it is essential that sufficient data be taken on all aspects of the insecticide application so that a full evaluation can be made of the success or failure of the test materials. To do less may result in an unfair bias for or against a material.

Specific administrative problems associated with pilot projects and possible solutions discussed were:

1. <u>Timing for approval of funds for pilot projects</u>:
   With all the paperwork that must be done before funding can be approved for a pilot project, funds often are not received by a unit conducting a pilot project until a very late date. The delay in getting funds causes many problems in such activities as: advertising and awarding contracts, hiring seasonal employees, and beginning field work. Ideally, full funding should be available as soon as the work plan is approved.

2. <u>Contracting problems</u>:
   More exact specifications should be included in contracts to insure that adequate equipment is obtained for a quality aerial application. Costs of contracts may increase, but should be offset by more efficient application.

   Requiring a pre-qualification of spraying equipment in contracts was recommended by some workshop participants.

3. <u>Personnel</u>:
   It is extremely difficult to obtain qualified personnel for conducting pilot projects in some Forest Service Regions. The pros and cons of establishing a trained cadre of people, such as has been done for fire suppression, were discussed.

4. <u>Communications</u>:
   Some Forest Service Regions have had difficulties concerning ground to air communication systems used on pilot projects. Region 6 is purchasing two complete systems that include portable repeater units. The system has proven to be very satisfactory. These systems may be available for use by other Regions.

WORKSHOP THE BIOLOGICAL EVALUATION PROCESS
Moderator: Douglas L. Parker

I. INSTRUCTIONS

The purpose of this workshop is to acquaint you with the steps in the biological evaluation process and give you an appreciation of the difficulties of developing alternatives and recommendations for coping with an insect outbreak.

Put yourself in the role of a pest management specialist who must provide information to a resource manager. Keep in mind that the resource manager makes the decision about what to do, not the entomologist.

We will divide into several work groups. You will have 45 minutes to complete the following:

A. Select a group leader. This person will record your group's thoughts and present the results to the entire group.

B. Read the attached background information.

C. Discuss the adequacy of the survey techniques and entomological information. List other survey techniques or information that would be useful.

D. Develop alternatives and recommendations to be presented to the land manager. Record your group's results.

II. DESCRIPTION OF TAOS ENTOMOLOGICAL UNIT

A. General Location

The Taos Entomological Unit is in the Sangre de Cristo Mountains of north-central New Mexico (see maps). This mountain range is deeply dissected with canyons, elevations vary from about 7,300 feet to 10,400 feet at the highest peak, and slopes are moderately steep (15 to 40 percent).

B. Infestation History

The budworm infestation in the Taos Entomological Unit is on the Carson National Forest, Rio Fernando de Taos drainage, and the Taos Pueblo Indian Reservation, Pueblo de Taos drainage. The first visible defoliation was detected in this entomological unit in 1975. The infestation increased several fold in 1976 and 1977 (see maps).

C. Vegetation

1. Trees

Mixed conifer forests with Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco, and white fir, *Abies concolor* (Gord. & Glend.) Lindl., and occasionally blue spruce, *Picea pungens* Engelm., Engelmann spruce, *Picea engelmannii* Parry, subalpine fir, *Abies lasiocarpa* (Hook.) Nutt., ponderosa pine, *Pinus ponderosa* var. *scopulorum* Engelm., or limber pine, *Pinus flexilis* James, as climax dominants or codominants, occupy most of the area between 8,000 and 9,600 feet. This forest can be divided into two habitat types. The first type, *Abies concolor-Pseudotsuga/Acer glabrum/Berberis repens*, is found on cooler, wetter sites on canyon side slopes and on gentle north-facing mesas. Aspen is an important seral tree species, often occupying large burned areas within this type. Engelmann and blue spruces and subalpine fir are minor components on the coolest, wettest sites. Ponderosa and limber pines are infrequently encountered. The second habitat type, *Abies concolor-Pseudotsuga/Quercus gambelii*, is found on warmer, drier sites, often on opposite canyon slopes from the first type. Ponderosa and limber pines are the common seral tree species, whereas other conifer species are absent.

2. Shrubs

The following woody shrubs occur in the area: cliff rose, hairy mountain mahogany, New Mexico locust, Gambel oak, bitter cherry, common chokecherry, American plum, and Utah serviceberry.

3. Grasses and Forbs

The climax vegetation in meadows is the Arizona fescue-mountain muhly bunchgrass type. Grazing has reduced this type so that Kentucky bluegrass is dominant in most areas. The commonest forbs are *Potentilla* spp.

D. Wildlife

A variety of wildlife species occur in these mountains. Major big-game animals known to exist in the area, or suspected to occur there, are elk, mule deer, black bear, Merriam turkey, and mountain lion. Small game animals are rabbit, squirrel, dove, blue grouse, scaled and Gambel's quail, geese, and band-tailed pigeon. Non-game animals are too numerous to list.

The streams in Rio Fernando de Taos and Pueblo de Taos are fisheries.

E. Transportation

There is a paved highway in the Rio Fernando de Taos drainage with an adequate secondary road system in most side canyons.

There are a few roads in the lower portions of the Pueblo de Taos drainage, but the Indian tribe will not allow any travel on these roads.

F. Influence Zones

There is a Water and Travel Influence Zone in the Rio Fernando de Taos drainage. Aerial application of any chemical is prohibited in these zones.

G. Recreation

There is an average of about 25,000 visit or use days in the Rio Fernando de Taos drainage for camping, picnicking, fishing, hunting, and dispersed use. Also, the highway in this drainage has an average use rate of 500,000 vehicles per year.

H. Timber

On the Forest, mixed conifer stands are classified in the Standard Component, i.e., areas where timber management programs are conducted. There are active timber sales in this drainage and others are planned for the future.

No timber harvesting is done on the Indian Reservation.

III. METHODS

Region 3 has been divided into entomological units based on geographical location of contiguous host type and past history of budworm infestations (Fig. 1). Aerial detection survey data from 1976 and 1977, on the extent and severity of defoliation, were used to determine which units should be included in the biological evaluation (Fig. 2 and 3).

Sampling was done during August 1977. Each plot consisted of 3 trees within a 1-acre (.40 hectare) area. Sampled trees met the following criteria: Douglas-fir, dominant or codominant; 30 to 50 feet (9.1 to 15.2 meters) in height; relatively open-grown with a full crown; some feeding evident, but not severely defoliated or with top-kill. Two 27.5-inch (70 cm) midcrown branches were cut from opposite sides of each sample tree with a pole pruner. Each

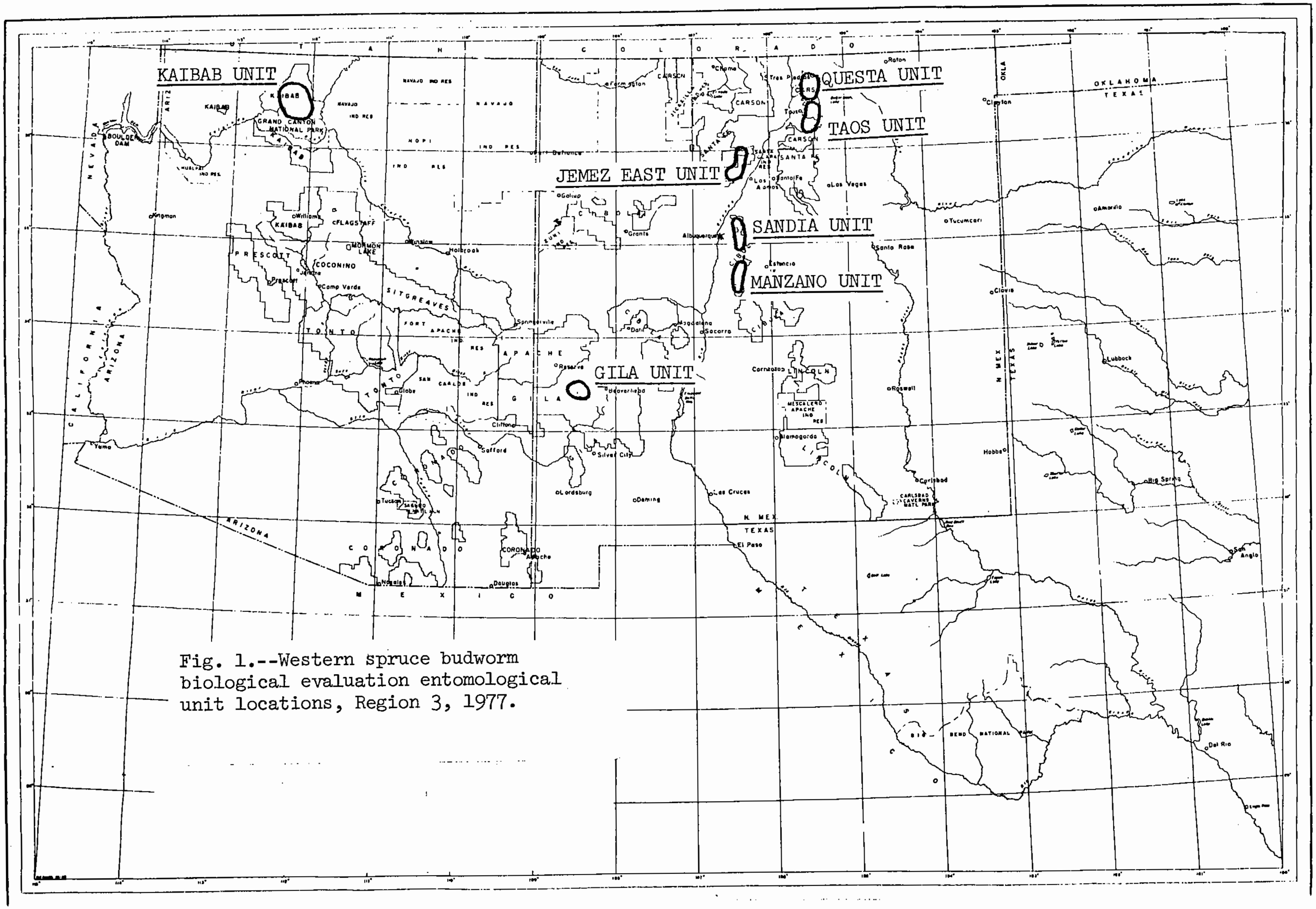

Fig. 1.--Western spruce budworm biological evaluation entomological unit locations, Region 3, 1977.

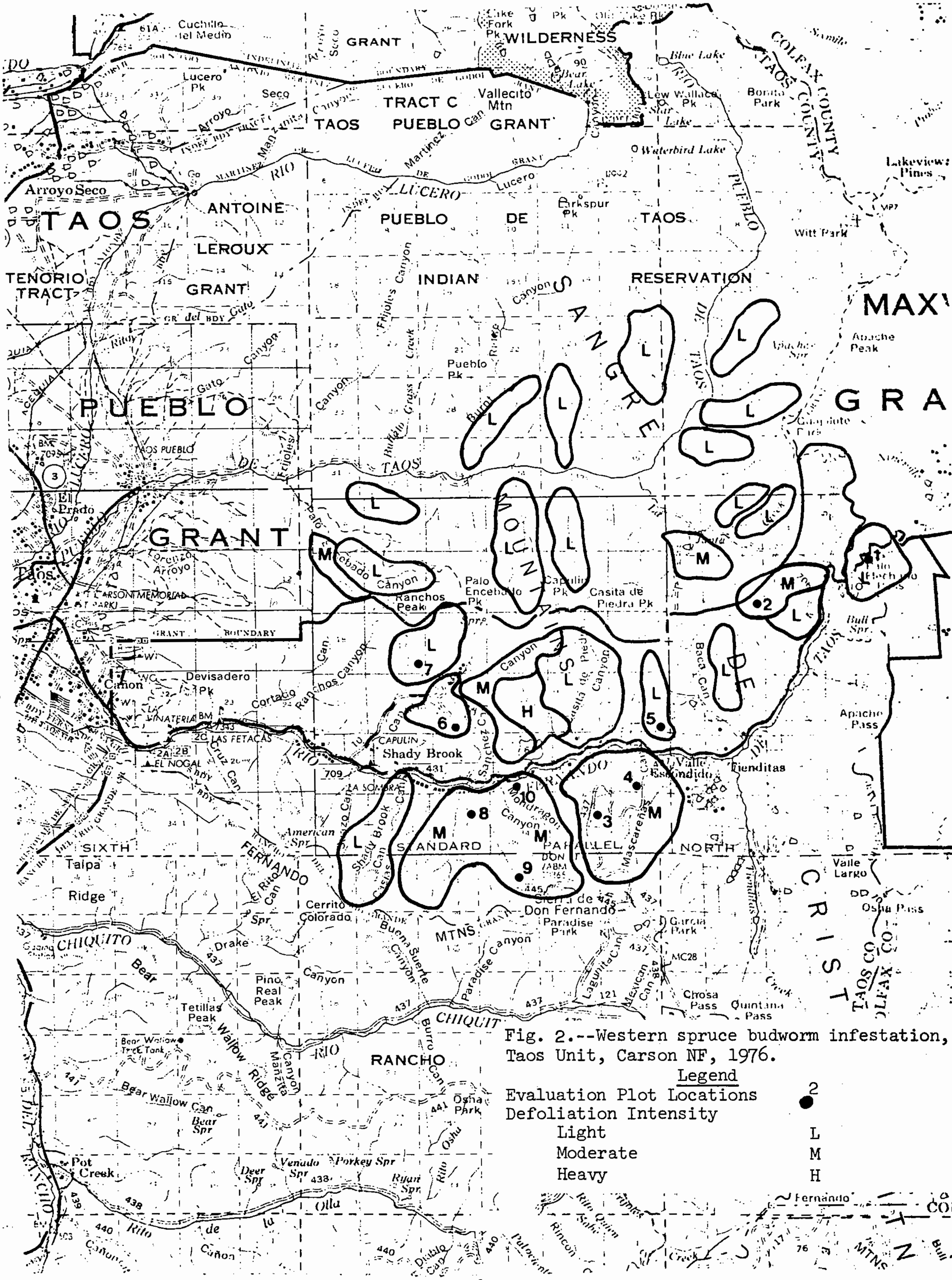

Fig. 2.--Western spruce budworm infestation, Taos Unit, Carson NF, 1976.

Legend

Evaluation Plot Locations ●2

Defoliation Intensity

Light	L
Moderate	M
Heavy	H

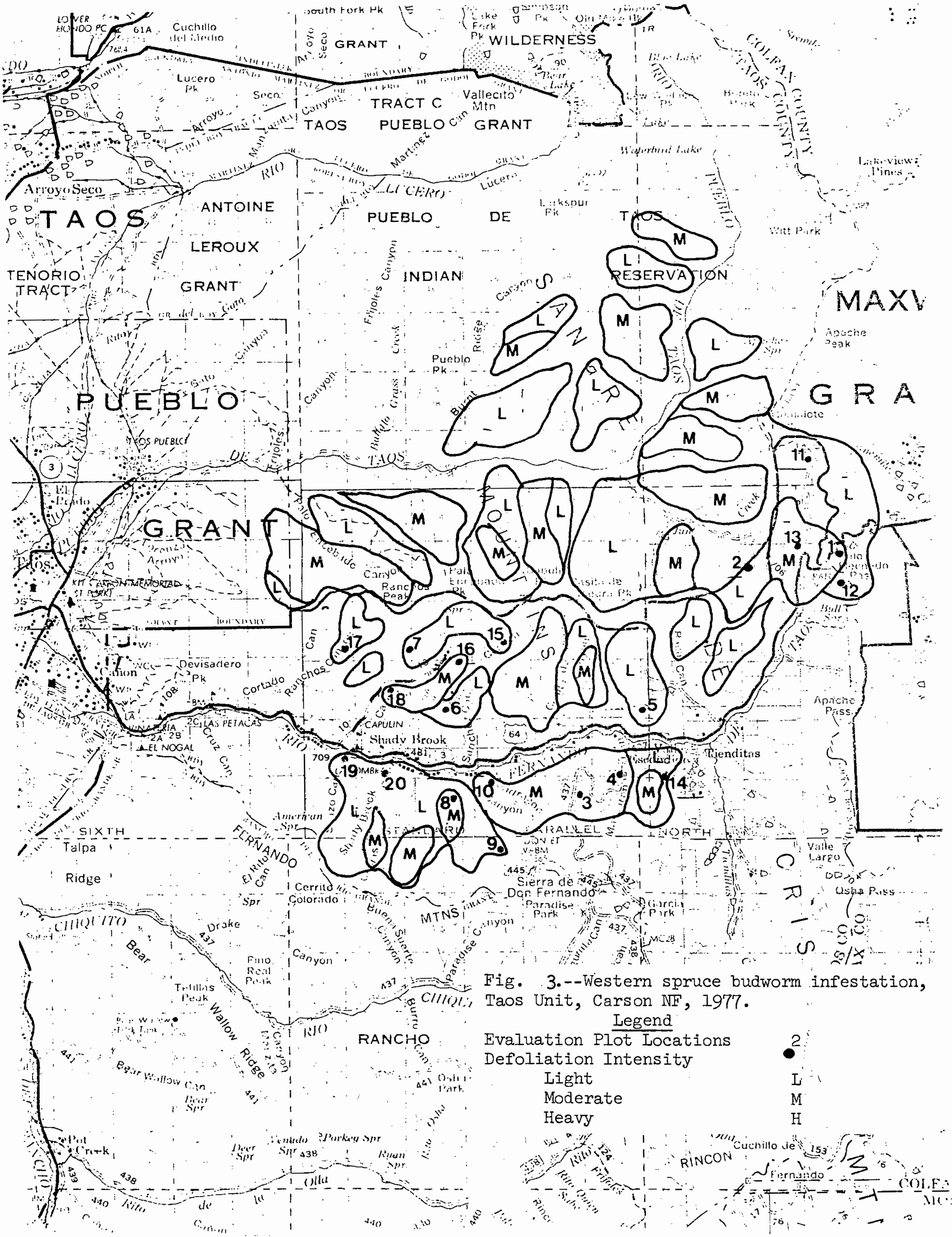

Fig. 3.--Western spruce budworm infestation, Taos Unit, Carson NF, 1977.

Legend

Evaluation Plot Locations	2 ●
Defoliation Intensity	
Light	L
Moderate	M
Heavy	H

branch was then individually bagged in ¼-bushel (.03 cubic feet) paper sacks, sealed, labeled, and transported to the laboratory for examination. All sacks were stored in a walk-in cooler at about 40° F (4.4° C) prior to examination.

In the laboratory, the length and width of each branch was measured to obtain an estimate of the foliated branch surface area. Then, the foliage was examined under ultraviolet light for egg masses. Finally, new egg masses (deposited in 1977) were separated from old ones (deposited before 1977) by a professional entomologist. The number of old egg masses in a given year reliably estimates the number of new egg masses the previous year.

Mean densities of 1976 and 1977 egg masses per 1,000 square inches (.6 square meters) of foliage were calculated for each unit to determine infestation trend and predict defoliation expected in 1978. Infestation trend was based on testing the mean density difference between 1976 and 1977 egg masses with a "t" value ($P < .05$). Both increasing and decreasing infestation trends would have significant density differences from year to year, but an increasing trend would have a ratio of new (1977) to old (1976) egg masses greater than 1, while a decreasing trend would have a ratio of less than 1. A non-significant density difference would indicate a static infestation trend. Defoliation predictions were obtained from the density of 1977 egg masses using Table 1. Results of the 1977 survey are shown in Table 2.

IV. TREE DAMAGE FROM BUDWORM DEFOLIATION

Even though many severe budworm outbreaks have occurred in New Mexico since the early 1920's, no studies have been conducted to determine the damages that occurred. Damage estimates have been collected in other sections of the West; how these estimates approximate damages that occur in New Mexico is unknown. We know that impacts of the same forest insect often vary by geographic region.

An extensive review of the literature on budworm-caused damage has been presented in a previous environmental statement (USDA Forest Service, Region 1, State and Private Forestry, 1976).

> "Repeated defoliation by budworm causes loss of radial increment (Williams 1963, 1966, 1967), top kill (Silver 1960), and tree mortality. Radial increment in heavily defoliated trees in Oregon was reduced more than 41 percent in grand fir, but only 13 percent in Douglas-fir. Radial increment of Douglas-fir increased during the later stages of

Table 1.--Class limits for western spruce budworm egg mass densities and defoliation classes (From: McKnight et al. 1970).

Egg mass density1/	Predicted defoliation class2/
<1.0	Undetectable for all infestations
1.1 to 4.0	Undetectable for "static" infestations Light for "increasing" infestations
6.0 to 20.0	Light for "static" infestations Moderate for "increasing" infestations
>22.0	Moderate for "static" infestations Heavy for "increasing" infestations

1/ New egg masses per 1,000 square inches of foliage.
2/ Defoliation class limits (percent of new growth)
Undetectable = <5%
Light = 5 to 35%
Moderate = 35 to 65%
Heavy = >65%

Table 2.--Summary of western spruce budworm infestations, Region 3, 1977

Entomological unit	Estimated acres of host type	Defoliated acres1/	No. of plots sampled	Egg mass densities2/			Infestation trend	Predicted 1978 defoliation class
				1976	1977	Ratio 1977:1976		
Gila	40,000	L = 4,160 M = 2,320 H = 0	10	3.1 ± 0.8	6.7 ± 1.8	2.2:1	Increasing	Moderate
Jemez East	100,000	L = 56,872 M = 1,556 H = 0	97	2.0 ± 0.3	8.1 ± 0.8	4.1:1	Increasing	Moderate
Kaibab	125,000	L = 64,400 M = 5,920 H = 400	20	5.6 ± 1.2	18.3 ± 4.6	3.3:1	Increasing	Moderate
Manzano	20,000	L = 8,440 M = 1,240 H = 800	19	5.7 ± 1.7	9.4 ± 1.3	1.6:1	Increasing	Moderate
Questa	50,000	L = 13,080 M = 960 H = 320	20	1.9 ± 0.6	6.6 ± 1.3	3.5:1	Increasing	Moderate
Sandia	12,000	L = 10,000 M = 920 H = 560	20	5.6 ± 1.6	3.1 ± 0.6	0.6:1	Decreasing	Light
Taos	75,000	L = 15,040 M = 10,800 H = 0	20	5.2 ± 1.5	14.3 ± 2.4	2.7:1	Increasing	Moderate
Totals	397,000	197,788	206					

1/ Aerial survey estimates: L = Light; M = Moderate; H = Heavy.
2/ Mean per 1,000 square inches of foliage.
3/ Mean ± standard error.

the outbreak, but that of grand fir and Engelmann spruce was still declining (Williams 1963, 1966, 1967). In an infestation in British Columbia, many Douglas-fir had all their buds killed and lost over 90 percent of their foliage, but no trees on study plots were killed. Top and branch kill was common, but heavy adventitious budding made recovery rapid (Silver 1960). Williams (1963, 1966), however, did not observe top killing of Douglas-fir in Oregon. Defoliation has a severe impact on understory regeneration which has less foliage area than larger trees and constantly intercepts larvae dropping from overstory foliage (Ghent 1958). Mortality of understory regeneration generally occurs two to three years before permanent damage is noticeable in mature trees (Ghent 1958).

"Western spruce budworm is the most important insect enemy of Douglas-fir cones in Montana (Dewey 1969, 1970, 1972). Heavy infestations in cones have resulted in total failures of seed crops, resulting in a lack of natural Douglas-fir regeneration in areas which have suffered mortality from budworm defoliation (Dewey 1969, 1972)."

V. WORK GROUP RECOMMENDATIONS

A. Group 1

1. A suppression program was not recommended.

2. Salvage should be undertaken where it is feasible.

3. A tree damage survey should be done to get better information.

B. Group 2

1. A suppression program was not recommended.

2. An information and education program should be done to inform the public about the budworm infestation.

3. Ground application of insecticides was suggested for high-use areas.

C. Group 3

1. A suppression program was not recommended.

2. A tree damage survey should be done to get better information.

D. Group 4

1. A suppression program was not recommended.

2. Resource managers should identify management objectives.

3. Entomologists should offer to work with other resource specialists to determine effects of the budworm infestation.

VI. ACTUAL RECOMMENDATIONS MADE TO RESOURCE MANAGER (CARSON NATIONAL FOREST)

A. An aerial suppression program was not recommended.

B. An attempt was made to conduct a pilot project, but the program was dropped.

C. Ground application of insecticides was recommended in high-use areas.

D. A tree damage assessment program was recommended for 1978.

E. The resource manager was asked to identify management objectives to assess the impacts of the budworm infestation.

WORKSHOP: AVIAN PREDATION OF FOREST INSECTS
Moderator: Donald L. Dahlsten

Roy Shepherd (Canada Department of Forestry, Victoria) began this workshop by describing a study he conducted at Frazier Canyon, British Columbia, "The impact of defoliation on bird populations", which was part of a spruce budworm project. Two types of birds were studied: early-nesting birds (ones that establish nests before the budworm larvae come out) and flocking birds (ones that respond to food supplies, such as Evening Grosbeaks). Shepherd found that early-nesting birds tend to nest in areas with more cover. He also noted that flocking birds tend to congregate in areas with high spruce budworm populations.

Torgy Torgerson (U. S. Forest Service, Corvallis) followed with a description of his studies of avian predation on Douglas-fir tussock moth (DFTM) in Oregon. In one experiment, female DFTM cocoons were tied to Douglas-fir branches with thin wire and checked periodically; the results after two years (1976-77) showed that as the number of first instar DFTM larvae in one area declined, the percentage of cocoons preyed upon by birds decreased while the percentage of cocoons preyed upon by ants increased. Torgerson also wired cocoons with egg masses to branches, and found that (with some exceptions!) avian predation on those egg masses was greater in areas with less severe outbreaks than those with recent or historically severe outbreaks. As part of a larval cohort study, he stocked a series of branches with known numbers of larvae; each stocked branch was given one of three exclusion treatments. Many larvae "disappeared", possibly due to avian predation. In 1977, movie cameras set to take one frame every 30 seconds were focused on those stocked branches. The results of those movie-films plus direct observations by two ornithologists showed that red-breasted nuthatches and dark-eyed juncos were the dominant avian predators of DFTM. Nine other species of birds were observed preying on DFTM.

Gene Amman (U. S. Forest Service, Ogden) briefly described his findings on woodpecker impact on mountain pine beetle. He sampled at three different elevations. At low elevations, woodpeckers concentrate on larvae (second and third instars). However, at high elevations woodpeckers concentrate on parent bark beetles; 60-70% of the parent adults may be removed (if the phloem was thick, these parent adults would have laid more eggs in the spring).

Don Dahlsten (University of California, Berkeley) next presented his nine month study of avian predation on DFTM on white fir in California. Both egg masses and cocoons were glued to white-fir branches at three different densities and distributions and on the bole of the tree. Extensive DFTM mortality was noted, particularly due to predation by birds (at the higher densities) on the branches and by ants (on the cocoons placed on the boles of the trees). Artificial cryptic habitats (such as wooden blocks, paper cartons, etc.) placed on the boles were used as pupation sites by a surprisingly high number of DFTM larvae;

birds did not prey on these cocoons but ants preyed on a few of the cocoons. Dahlsten also mounted movie cameras on the backs of several nesting boxes used by mountain chickadees. The camera takes a single frame picture each time the bird enters or leaves the nest. From the film the food items can be identified and since there is a watch facing the camera inside the box, the food items can be quantified by hour and day, and the length of the visit is recorded as well. No DFTM larvae were found but a number of other defoliators from the white fir guild were recorded. The group generally felt that more avian predation studies on forest insects were warranted, but that it was extremely difficult to get these kinds of studies funded.

WORKSHOP: TRENDS IN FOREST INSECT RESEARCH
Moderator: Boyd E. Wickman

Approximately 60 people met to informally discuss the subject. There was some continued discussion on both the negative and positive effects of big bug programs on trends in FIR. The session examined three areas in a general, philosophical manner. They were: (1) organizational trends in universities, government, and private institutes, (2) subject matter changes or new trends in our research approach, and (3) the implication of the trends for educators and students.

WORKSHOP: NON-TARGET EFFECTS OF DIRECT CONTROL
Moderator: Patrick J. Shea
Participants: Charles Henny, Stamford Smith, Douglas Parker, John Schmid

The workshop on non-target impacts centered mainly around summaries from various investigators that have recently been involved in such studies followed by discussion from the attendees. In most of the discussions particular attention was paid to adequacy of sampling methodology and experimental design. Further, we distinguished between monitoring of non-target effects such as would be conducted during operational programs and research studies that attempted to measure the magnitude and significance of the effects. Monitoring efforts are usually planned and conducted to detect catastrophic events if such should occur, e.g., the intensity of the sampling effort is not very great.

(1) Douglas Parker, R-3, reported on the monitoring efforts conducted in conjunction with the New Mexico western spruce budworm operational demonstration. Some 37,000 acres were treated with 1 lb/acre of Sevin 4 oil in the summer of 1977. The only effects observed were those on aquatic insects when drift of the material entered small streams.

(2) John Schmid, RM, also working with the New Mexico operational demonstration, is investigating the effects of Sevin 4 oil on parasites of the western spruce budworm. This study will proceed for several years. Nothing to report at this time.

(3) Charles Henny, USDI-Fish and Wildlife Service, Corvallis, Oregon reported on two studies involving effects of forest insecticide spraying on birds. The 1974 DDT application to control Douglas-fir tussock moth has resulted in egg shell thinning in several species of raptors. In another research study the insecticide Orthene when applied at 1 and 2 lb/acre seriously depressed brain cholinesterase levels in several species of passerine birds. These studies were conducted in conjunction with the "Cooperative Non-Target Effects of Selected Chemicals Study" sponsored jointly by the Douglas-fir Tussock Moth Program and USDA-Forest Service, Pacific Southwest Forest and Range Experiment Station, Davis, California.

(4) Stamford Smith, Professor, Central Washington University, discussed the aquatic insect effect studies associated with the DFTM Program studies mentioned previously. Significant adverse effects on benthic populations were detected after an application of 2 lb/acre of Sevin 4 oil. Reductions in adult emergence patterns and species diversity were detected in 1977 one year after application. Plans are to return to the study sites in 1978 and continue the studies to determine if subject parameters have returned to normal.

WORKSHOP: NON-TARGET EFFECTS OF DIRECT CONTROL
Moderator: Patrick J. Shea
Participants: Charles Henny, Stamford Smith, Douglas Parker, John Schmid

Much discussion was generated from the reports and several distinct concerns arose:

(1) There is a need to continue non-target effects studies.

(2) There is a need to improve sampling methodology and experimental design associated with these studies.

(3) Both of the above should lead to increased reliability of data sets.

WORKSHOP: RESPONSE OF MOUNTAIN PINE BEETLE TO HOST AND ENVIRONMENT
Moderator: Gene D. Amman

This workshop was well attended but much too short to adequately discuss the subject. Several attendees were unable to present observations due to lack of time. The intent of the workshop was to cover the differential response of the mountain pine beetle to various factors when it emerges, selects trees (as affected by stand conditions) and infests them.

Starting with the emergence period, Rasmussen presented information on emergence and flight, which are strongly influenced by weather. Beetle flight begins when temperature is about 19°C and continues until the temperature reaches about the same in the evening. Flight begins and ends somewhat earlier in the northern part of the beetle's range. Temperature limits of flight are similar in both lodgepole and ponderosa pine forests.

Infestation of the host tree also is governed to some extent by temperature. The first and also most attacks occur on the north side of the tree. Temperatures of the north side have been demonstrated slightly cooler than other sides. Rasmussen observed that trees unsuccessfully attacked (not mass attacked) had slightly higher temperatures in the phloem-xylem interface than those trees that were infested and killed.

Hynum presented observations on flight studies of the beetle in lodgepole pine. Trapping studies showed that beetles landed on green lodgepole, dead lodgepole and nonhost species of trees with equal frequency. This was interpreted that the beetle examines all trees as potential hosts. After tasting, final host selection and mass attack occur.

Crookston briefly discussed Burnell's dispersal-aggregation model which is based on a random attack pattern and surface area relations of host trees. Members are referred to: Burnell, D. G. 1977. A dispersal aggregation model for mountain pine beetle in lodgepole pine stands. Res. on Population Ecology 19:99-106.

Mahoney discussed observations on the response of mountain pine beetles at the stand level. Beetle outbreaks that he observed were in stands where radial growth increment was declining, and that stands where beetle populations remained at endemic levels during the study period had a near constant or increasing radial growth. In these central Idaho and western Montana stands, the beetles caused proportionately higher tree losses in stands that had high crown competition factor (CCF) and a high proportion of lodgepole pine basal area. Based on these two factors, Schenk, Mahoney and their colleagues have applied the Stand Hazard Rating (SHR) developed by Schenk et al (Forest Science 23:103-110, 1977) for Scolytus ventralis in grand fir stands to mountain pine beetle in lodgepole pine. The SHR consists of total CCF for the stand multiplied by the proportion of the stand basal area that is lodgepole pine.

The SHR method has been applied to lodgepole pine stands in south central Montana (McGregor) and southeastern Idaho and northwestern Wyoming (Amman) with opposite results from Schenk and Mahoney. In these stands proportional loss either declined as SHR or CCF increased (McGregor) or was unrelated (Amman). These opposite results suggest that beetle behavior differs in the more moist range of lodgepole pine in parts of the northern Rocky Mountains from that in dryer portions of the northern and central Rockies.

WORKSHOP: PROBLEMS ASSOCIATED WITH AERIAL SPRAYING OF INSECTICIDES

Moderator: Jerald E. Dewey

Panelists: Wesley Yates, Jack Barry, George Markin

Approximately 20 people attended this workshop. Presentations were made by those listed above. Presentations and subsequent discussion focused on three primary problem areas. These were:

--Considerations relative to spray equipment selection (spray ship and spray system).

--Prespray check and validation of equipment.

--Spray application problems.

Wesley Yates, Department of Agricultural Engineering, University of California, Davis, discussed what should be considered in the selection of spray aircraft and spray systems. He indicated that every spray project has uniquenesses that should dictate the type of spray ship and system selected. Some things influencing selections include topographic features, material to be sprayed, dosage to be applied, cost of application, desired droplet spectrum, size of area to be sprayed, precision of application needed. Dr. Yates reviewed with slides a variety of sizes of fixed-wing and rotary aircraft. He discussed their characteristics and under what conditions each should be considered for aerial spray projects. He also compared the features of flat fan, Beeco-mist, and other commonly used spray tips. He discussed calculating project costs for various equipment. This is done by obtaining the operator's fee per hour and determining acres/hour that an aircraft can spray. Information needed for this determination includes time spent for taxiing, ferrying, spraying, turning, and loading. Aircraft speed and the various distances are needed to calculate these times.

Jack Barry, USFS, Methods Application Group, Davis, California, discussed checking and validating the aircraft and spray system prior to application. He suggested providing the applicator with new spray tips, for experience has shown that many applicator problems result from old, worn spray tips. Barry feels it is very important, prior to actual spraying, to verify over spray deposit cards what the droplet spectrum is. He emphasized the necessity of establishing a good line of communication with the spray pilot and the need to make sure he knows what we need and how we want the job done. The pilot should be a part of all briefing sessions and should be familiarized with spraying demands by prespray flights. Barry indicated that the spray contract is the mechanism to insure that specific project needs are met. Watch closely what goes into contracts, be specific. He suggests including in the contract the option allowing pre-contract awarding inspections to make sure potential contractors really do have the numbers and type of aircraft and spray systems necessary to meet project needs.

Tony Jasumback, USFS, Equipment Development Center, Missoula, Montana, was scheduled to discuss spray application problems; i.e., proper swath spacing, maintaining correct release height, how to compensate for meteorological influences, and how to monitor such spraying characteristics as flow rate, pump pressure, air speed, and spray temperature. Airline difficulties stranded Jasumback in Denver. However, George Markin, USFS, Pacific Southwest Forest and Range Experiment Station, Davis, California, who was in the audience, had recently attended a demonstration of an aircraft positioning system which could help maintain proper swath spacing. He reviewed the highlights of the demonstration. The system was the Motorola Mini-Ranger III Airborne Positioning System. The system was mounted in a Bell 205 Turbo-jet helicopter equipped with a fertilizer application system. The positioning system operates on a radar frequency band from two or more reference stations. It is a line sight system with a range of 20 nautical miles and a probable range error of ± 10 feet. The unit that is located in the aircraft weighs about 40 pounds. The complete system can be leased for $4,000/month or purchased for about $40,000.

PANEL: Colorado Vegetation Management Pilot Project (FRP) (Insect control and fire hazard reduction through forest management in the densely populated Front Range forests)

Moderator: Ron Gosnell and Rich Selle
Colorado State Forest Service

A brief summary was presented identifying the agencies involved and the interagency relationships to achieve a common objective for multiple ownerships of the 36,000 acre pilot area.

FRP participants include private, Bureau of Land Management, United States Forest Service, Boulder County, City of Boulder, and Denver Water Board ownerships.

The visual impact and wild fire hazard situation of the current Mountain Pine Beetle epidemic was presented through slides, as was the goals of the project and means of attainment.

Discussions between the moderators and attendees followed covering:

1. Possible problems associated with secondary insect buildups i.e. ips, red turpentine, etc. with high levels of silvicultural activity over relatively short periods of time.

2. Agency commitment to common goals or similar management philosophies.

3. Applicability of Critical Path method of accomplishment and progress monitoring.

4. Acceptance of Forest Management and Commercial Forestry on small acreages.

5. Implementation of an Evaluation Plan by the U.S.F.S. Rocky Mountain Range and Experiment Station for "measuring result."

6. The establishment of photo points for long term evaluation.

7. The usage of substantial FIDM monies for long term protection (silvicultural) practices - the setting of a precedent even though only a pilot.

8. The need for more "understandable" accomplishment reporting through the FRP newsletter stating not only work done but work remaining to be completed in reference to the 36,000 acre total area.

WORKSHOP: STATUS OF BEHAVIOR-MODIFYING CHEMICALS (BMC) IN FOREST INSECT MANAGEMENT

Moderator: Dave Wood

Scientists engaged in behavioral chemical research were invited to review the status of their research including: identification of new compounds, formulation, results of suppression and survey studies, registration proposals, etc. Also, they were asked for their views on the key problem areas that need to be solved before these compounds can become operational, and on the promise of behavioral chemicals for survey and suppression of forest pest species.

The following results and points of view were extracted from submitted summaries.

Defoliators

Gary Daterman* and Lonne Sower

Rhyacionia buoliana (European pine shoot moth) pheromone is a strong sex attractant for at least 7 western *Rhyacionia* spp. Pheromone: E-9-dodecenyl acetate.

R. rigidana (eastern sp.) pheromone is a strong sex attractant for two other western *Rhyacionia* spp. Pheromone: E, E-8, 10-dodecadienyl acetate.

Eucosma sonomana (western pine shoot borer) pheromone is a two component system consisting of about 80% Z-9 and 20% E-9-dodecenyl acetate. These compounds also attract some other western *Eucosma* spp.

Choristoneura occidentalis (western spruce budworm) pheromone is a multi-component system, and probably consists of a blend of at least 3 different chemicals.

Orygia pseudotsugata (Douglas-fir tussock moth) pheromone dispersed by aircraft in hollow CONREL fibers has disrupted mating and lowered egg-mass density in small plots. The results were considered successful enough to warrant larger scale tests. Pheromone-baited survey traps are being tested for wide-scale (many states) distribution to help predict sudden increases in populations.

Problems:

1. Specific requirements and guidelines are needed from EPA(and other agencies) on safety and efficacy criteria for registration.

2. Better controlled-release formulations are needed.

3. Information on the effect of insect dispersal on suppression and survey efforts using pheromones is needed. For example, where do insects go in an interruption treatment?

Promise:

1. Detection and survey for European pine shoot moth is operational in some areas.

2. There is a strong possibility that a survey trapping system for tussock moth will become operational.

3. A suppression method is only a matter of time.

<u>Alan Cameron</u>*

<u>Porthetria</u> <u>dispar</u> (Gypsy moth)

Problems:

1. Cannot adequately control release rate in the field.

2. Some doubts that the pheromone chemistry is complete i.e., is it only a one compound system?

Promise:

1. Detection and survey of the gypsy moth is operational.

2. Could be an important tool for estimating populations.

Bark Beetles

Bill Bedard

Dendroctonus brevicomis (western pine beetle)

The U.S. Forest Service and the University of California have jointly undertaken a program to develop suppression and survey methods based on behavior modifying chemicals (BMC). Three research areas leading from discovery to operational use are: 1) identify BMC's; 2) develop use patterns; and 3) determine the effects of operational-scale treatments. Four use patterns have been investigated; 1) individual tree protection using verbenone; 2) tree protection/beetle suppression using attractants as interruptants; 3) suppression by trapping; and 4) survey. All four methods have shown promise in small scale tests. The effects of operational scale treatment for trapping and survey have been evaluated. Analyses and reporting of the unpublished portions of this work are under way.

Problems:

1. What should be the size of the treatment and check areas for: a) mass trapping and b) interruption?

2. What should be the length of the evaluation following the treatment?

3. Would estimates in the trend in density before, during and after treatment be an adequate population measure of treatment effects?

Promise:

1. Four methods have shown promise in small-scale tests.

Jack Coster and Tom Payne*

D. frontalis (southern pine beetle)

An area-wide attempt to reduce tree mortality by interrupting flight behavior with endo- and exo-brevicomin did not influence general flight activity but, the number of beetles landing and boring into trees, amount of gallery construction, oviposition, and number of beetles produced were reduced. Under epidemic conditions endo brevicomin and verbenone together did not prevent trees from being attacked. Attempts to interrupt beetle aggregation in large infestations with frontalure may not have been successful. Many trees were attacked around the synthetic pheromone sources thus creating many new sources of pheromones, simultaneously.

Using frontalure-baited traps in a line from a group of infested trees, the number of beetles caught decreased exponentially to 75 m where none were caught. Mark and recapture experiments in areas with no beetle-infested trees and far removed from groups of infested trees revealed zero population density estimates. More potent attractants are needed for survey traps to be more effective.

Problems:

1. The chemicals involved in the natural system of attraction and their relative roles have not been fully elucidated.

2. More effective pheromone release devices are needed.

3. Reliable population and tree estimation techniques are needed to assess the efficacy of these compounds.

4. More information is needed on flight biology in order to time treatments more effectively.

5. Do we need to estimate beetle populations to determine efficacy of a treatment or are estimates of tree mortality sufficient?

Promise:

1. Attractants have not received sufficient attention to judge their potential in the suppression of the southern pine beetle. Inhibitors or anti-attractants are of greatest interest at present. However, attempts to interrupt aggregation in large infestations may not be successful.

2. The use of behavioral chemicals for survey does not look promising with the compounds that are available presently.

<u>David Dyer*</u>

Problems:

1. Determination of the best pheromone complex to produce the desired reaction in the target insect and

to have this fully competitive with natural insect-host functions.

2. Improvement of the integrated use of pheromones with all forms of crop protection and management.

3. Development of more efficient methods of pheromone release over time and space.

4. Study the host-pest biology to determine the most suitable conditions for pheromones to be effective.

Mal Furniss

D. pseudotsugae (Douglas-fir beetle) and other species.

Present work involves field testing of Douglas-fir beetle pheromones including its natural attractant against eastern larch beetle, D. simplex in Alaska. That work is in cooperation with Dr. Richard E. Werner of the Institute of Northern Forestry at Fairbanks. We also have a test in progress involving measurment of the antiaggregative effectiveness of MCH as a liquid and as a controlled-release formulation against spruce beetle, D. rufipennis, in white spruce in Alaska. Another effort was begun this year to test the antiaggregative effect of Ipsenol against pine engraver in second-growth ponderosa pine in northern Idaho. Similar work involving Ipsenol and Ipsdienol was conducted in southern Idaho last spring by Pat Shea of the Pacific Southwest Forest and Range Experiment Station, Davis, California, in cooperation with Gary Pitman and Dick Schmitz, now of Ogden, Utah.

Problems:

1. The aggregative pheromones result in alot of spill-over into live surrounding trees which adds to the attraction and greatly increases the catch, thereby distorting its proportional relationship to the true population. If on the other hand, aggregative pheromones are put in clearings or in nonhost forests, the catch is so diminished as to be distorted in the opposite direction. In any case, to relate with any precision the magnitude of catch by an aggregative pheromone treated trap and the surrounding population density is a tremendous undertaking, and I doubt that there is any published instance of it having been done. The work at Bass Lake may be an exception.

2. If many trees should become inoculated with disease organisms by sublethal attacks by a particular scolytid, the total subsequent damage would be enormously greater than if no application had been made. However, I have found that even with a very effective antiaggregative pheromone some beetles still succeed in attacking the trees to be protected, in this case windthrown trees. Traditionally a build up of beetle populations occurs in this material and they then kill standing trees. In downed trees, the lack of resistance allows low density attacks to succeed and the lack of intraspecific competition results in high brood survival. The upshot of all this is that low attack density is compensated for by high brood production. The trick is going to be to see what level of attack density is required to obtain a lessening of damage to live trees by the subsequent beetle generation.

Promise:

1. As regards control, I think that the best future bet lies with anti-aggregative pheromones. The reason is simply that a massive use of aggregative pheromones in the forest to confuse a beetle population is bound to result in a prolific amount of trees being attacked in varying intensities, albeit many of them may not directly kill the tree. I do still hold out a glimmer of hope that anti-aggregative pheromones may still prove useful in disrupting attraction to beetles such as the pine engraver, Douglas-fir beetle, and spruce beetle, all of which depend on felled trees for amassing numbers necessary to cause significant damage in the forest.

2. I doubt that aggregative pheromones will be set out in the future at relatively close intervals throughout the forest resource to monitor the generation-by-generation magnitude of troublesome beetles.

3. Pheromones are just great for collecting an odd assortment of associated insects and some of their predators and parasites.

<u>John McLean and John Borden</u>*

<u>Gnathotrichus</u> <u>sulcatus</u> (ambrosia beetle)

Six sticky traps each with a surface area of 2.7 m^2 were baited with sulcatol from late April to late October, 1976. Each trap was placed next to a load of lumber (Chemainus Sawmill, Vancouver Island) so that one vane was perpendicular to the side of the load. The release rate of sulcatol was about 100 mg/day. The population attacking the loads of lumber and the number trapped were estimated each week. A suppression ratio, defined as the number caught on the traps divided by the sum of the number caught on traps plus the number of estimated attacks was calculated for each location. Over 42,000 beetles were trapped. There was wide variation in catch from location to location. A rise in number of attacks in each location usually followed major flight periods indicating that spill-over set up competitive secondary attraction during the following weeks. The better suppression ratios (90%+) were obtained in warmer weather (June-August) when pheromone evaporation rates were higher, lumber dried quicker becoming less suitable for attack, and populations of G. sulcatus were relatively low.

Problems:

1. Wood odor in the mill enhances attraction, especially of the male beetle that initiates the gallery. Identification of this attractant(s) would help to increase the catch at traps baited with sulcatol.

2. Spill-over and the subsequent production of pheromones in the lumber piles competes with the synthetic attractant.

Promise:

1. The lumber industry was sufficiently impressed with the results to continue the trapping program themselves in 1977. The technique of mass-trapping is a promising tool in ambrosia beetle control.

John Peacock

Scolytus multistriatus (smaller European elm bark beetle)

About 2.5 million beetles were caught on 657 pheromone-baited traps in Ft. Collins, Colorado during 1977, which is 20% more beetles than were trapped in 1976. Since the beetle population increased slightly, it is obvious that the 1976 trapping program did not suppress the establishment of broods. The percentage of the beetles trapped could not be ascertained because the amount of infested wood in 1976 and 1977 was not known and because beetles may have immigrated into the plots from surrounding areas. It was concluded that the catch was not sufficient to cause significant changes in the Dutch elm disease rate.

The pattern of catch at various trap sites in 1977, like the total catch, was similar to 1976. In general, those sites that caught the most beetles in 1976 also caught the most in 1977. The type of trap standard had an unusually large effect on the catch, i.e. mean catch on traps affixed to trees was about 775 beetles during the summer, while the mean catch on traps affixed to poles was about 5,300 beetles. The density of traps per unit area had only a small effect on the catch per trap, while the total catch increased in proportion to the number of traps in a particular area.

Problems:

1. The density of traps and the size of the trapping area needs to be determined.

2. The relationship between catch and population size needs to be determined.

Promise:

1. Substantial progress has been made to improve the effectiveness of mass-trapping and thus justify continued testing.

Gary Pitman

D. pseudotsugae (Douglas-fir beetle)

Interruptive pheromones (MCH and *trans*-verbenol) were incorporated in polyvinyl chloride tubes [5 mm long x 1.25 mm OD] enclosed in a polyethylene sheet 0.4 mm thick. These slow release devices were mixed with wheat for bulk and dispensed from a Simplex Seed Spreader attached to the landing carriage of a helicopter. All treatment and check plots were at least 400 m apart and each contained groups of Douglas-fir infested with *D. pseudotsugae*. During a three-year period (1975-77) pheromone was applied at 2, 4 and 10 mg/hr/0.4h. Ground and aerial surveys of the 1976 and 1977 plots revealed a significant reduction in tree mortality in 1976 and no mortality in 1977. Aerial surveys indicated that beetles did not leave the plot and kill trees in the surrounding areas.

Promise:

1. This technique appears to be very effective and the results warrant a large-scale test to determine if we are ready to seek registration.

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* Not in attendance at the workshop.

WORKSHOP: METHODS APPLICATION GROUP: PURPOSE AND ACCOMPLISHMENTS
Moderator: William M. Ciesla

The U.S. Forest Service, Forest Insect and Disease Management/ Methods Application Group (FI&DM/MAG) was established in August 1975. Its mission is to improve FI&DM program and project activities through technical assistance and implemention of new knowledge. The unit is staffed with a team of specialists which provide skills not normally available in Region/Area FI&DM staffs such as biometrics, computer science, remote sensing, and pesticide application technology. FI&DM/ MAG's mission is national in scope and is administratively a staff group attached to the Director of FI&DM in the Washington Office.

Progress made by FI&DM/MAG working with R-2 and R-4 in design and conduct of surveys to measure loss by the mountain pine beetle was reviewed by Bill Klein, the unit's survey systems specialist. Objective of this survey is to provide sound data on annual mortality on a statewide-basis. Two pilot surveys were conducted in 1977; on the Targhee National Forest in Idaho (Lodgepole pine), and the Black Hills National Forest in South Dakota (Ponderosa pine). Aerial sketch mapping, large scale color aerial photography, and ground surveys were combined into a multistage survey.

Future plans call for a study to evaluate feasibility of small scale (1:30,000) color IR photography for stratification of infestation levels as a possible replacement for aerial sketch mapping.

John Wong, mathematical statistician, reviewed statistical and mathematical support service available to Regions/Areas through FI&DM/MAG. These include assistance in design of pilot projects, impact evaluations, other special projects, and analysis of resultant data. Internal training is available to enable Regions/Areas to independently access programs and data files at the USDA Fort Collins Computer Center (FCCC). FI&DM/MAG is investigating merits of computerized mapping systems for analysis, storage and retrieval of survey data, and is participating in development, transfer, and maintenance of national FI&DM data management systems. Systems that the group has been working with include ASCAS, a system for analysis of aerial spray deposits, a multi-Regional western spruce budworm defoliation prediction model, based on egg-mass densities and the Doulgas-fir tussock moth stand outbreak model, a product of the USDA expanded Douglas-fir tussock moth R&D program.

Support for pilot and operational control projects was reviewed by Jack Barry, the unit's pesticide application specialist. Overall objectives of services provided is to improve application quality in order to maximize efficacy of the chemical or microbial pesticide being applied and minimize undesireable side affects such as contamination of sensitive areas. FI&DM/MAG has described techniques for on-site characterization of spray aircraft, assessment of spray deposit and has provided training in calibration and characterization of spray equipment.

Region and Area FI&DM staffs, the primary users of MAG specialists, represented at the workshop were asked to respond to two questions regarding effectiveness of FI&DM/MAG.

1. How has the existence of this group changed your way of doing business?

2. What services should be provided to Region/Area FI&DM staffs by FI&DM/MAG?

Responses were highly variable. On the positive side FI&DM/MAG has materially strengthened ability to conduct pilot control projects by providing technical support in design, spray system calibration and characterization, deposit assessment, and data analysis. Additional FI&DM staffs are now making effective use of the USDA Fort Collins Computer Center for data analysis. Coordination of a multi-Regional effort to improve western spruce budworm egg-mass surveys for forecasting defoliation has been of considerable help but new techiques are not in full operational use yet.

Degree of help required by a Region or Area FI&DM staff from MAG is dependent on skills already available. For example, a unit that frequently conducts aerial spray projects may have sufficient expertise to deal with problems independently and not require services of MAG pesticide application specialist.

Existence of an FI&DM/MAG unit has increased workload at the field level because of MAG's activity in impact evaluation. In addition, field units view MAG as another step in the review process which special projects must undergo prior to funding.

Types of services that the unit should provide include:

1. Function as a repository for models and other national data management systems. Provide training in system use.

2. Continue evaluation of alternative computer mapping systems for storage and retrieval of survey data.

3. Maintain liaison with other technology transfer groups such as the Forestry Applications Group, NASA in Houston.

4. Function as a trouble shooter with regard to impact evaluation and pilot control projects.

Region and Area FI&DM staffs should actively seek assistance from MAG specialists. MAG activities should relate to the management job on the ground. Level of communication should increase to maximize effectiveness of national specialists and keep them responsive to needs of the field.

WORKSHOP: REDUCING DUPLICATION OF EFFORT IN WRITING ENVIRONMENTAL IMPACT STATEMENTS ON THE SAME INSECT

MODERATOR: Max Ollieu

This workshop allowed the participants to discuss the environmental analysis process as it pertains to forest insect problems. The group focused on methods to lessen the effort and volume of material produced. Several avenues were discussed to accomplish reductions. These are given below but not necessarily in the order discussed.

Alternatives to the environmental impact statement (EIS) surfaced throughout the workshop. For proposed projects, are they major federal actions affecting the environment? If not, it is very possible that much time and money can be saved by stopping before proceeding further. For instance, some of the important questions we faced in the EIS on western spruce budworm for the Boise-Payette infestation still needed answers after filing the Final. Therefore, were we premature in carrying the process on to an EIS? If answers are available and it is possible to culminate the process at the Environmental Analysis Report (EAR), much effort may be saved with an EAR and a negative determination by the responsible land manager.

Another approach is to include discussions on particular significant forest insects in higher level planning documents. Much data considered in the environmental analysis process of forest insect problems come from various planning documents. Therefore, plans such as Area Guides, Land Use Plans and Timber Management Plans which include discussions on forest insects and related management may be adequate coverage should chemical insecticide be proposed for suppression.

If the environmental analysis process is used for a specific insect, consideration of all host range within the Region may negate the necessity to prepare more than one EIS for the insect in that particular Region. However, a more broad brush approach would probably be used with Region-wide coverage.

Within the EIS, the toxicological section was pointed out as a portion which could be eliminated with a considerable saving of paper. This assumes that the insectides considered have been registered. A statement as follows might be included: "Only registered pesticides are considered for use. The probable environmental consequence of the use of these pesticides is the suppression of western spruce budworm. Implicit with EPA registration is the ability to avoid any significant adverse effects when using the products according to label directions and precautions."

Workshop participants were of the opinion a separate summary of the EIS should be prepared for individuals or groups who don't need the full statement. This should also cut down on number of EIS copies required.

PANEL: PHEROMONE TRAPPING FOR TUSSOCK MOTHS
Moderator: Lonne L. Sower
Panelists: Ladd Livingston, Roy Shepherd, Dave Holland

Pheromone trapping systems for Douglas-fir tussock moths have been developed for simple detection of moths and for an improved system to help predict the periodic outbreak characteristic of this pest. The use of strong baited traps for simple presence or absence of moths has been found effective and reliable so this aspect of the subject was not discussed in detail.

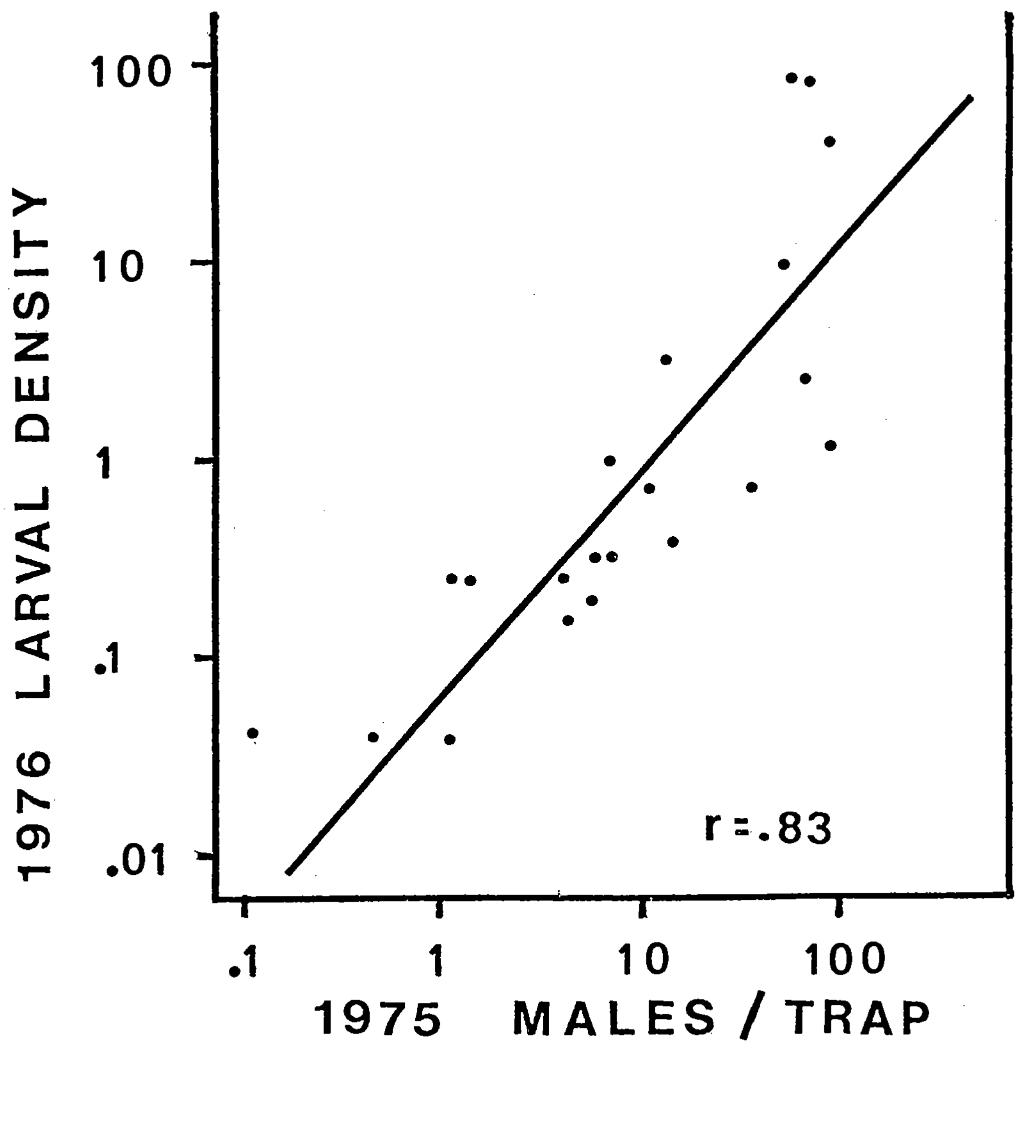
Trapping for prediction of outbreaks is inherently difficult but potentially very valuable because of the apparent rapid buildup of populations that typically are not detected until substantial damage is already done. Pheromone traps are quite sensitive and we feel that these can be deployed cheaply enough to be readily accepted by land managers. Alternative methods rely on counts of larvae obtained by lower crown beating or mid crown sampling of branches. These methods are inherently more costly and may be reserved for more intensive sampling of suspected trouble spots if a pheromone trapping system can be successfully developed.

Studys have thus far shown that trap data can be correlated with past and future larval densities (Fig. 1 and 2). The figures were taken from Gary Daterman's 1977 report to the Tussock Moth Program. Since 1975, survey trapping tests have continued in California, Oregon, British Columbia, Idaho, New Mexico, and other locations. Progressively weaker baits have been incorporated into the tests each year on account of a tendancy for stronger baits to fill the trap to capacity with moths at even moderate or low population levels. Weaker traps, baited with 0.001% of pheromone in polyvinyl chloride pellets, now appear most promising (Fig. 2). Daterman (not present) indicates that the weak baits can now be used to identify areas with low populations that can be eliminated for further consideration as potential outbreak areas in the immediate future.

Figure 2 shows a good correlation between larvae present and moths captured. However, two points on the figure, both taken in New Mexico outbreak area by Holland, are substantially off line. Possibly, this reflects a behavioral effect caused by high numbers of attractive females which are out-competing the weak trap baits. Host tree density in the area was also low which might cause part of the discrepancy since data were correlated to larvae/in^2 of foliage rather than to total numbers of larvae present over the area. Participants and others seem generally aware of these problems.

Livingston reported that Idaho is going operational with the traps in selected areas. Shepherd also indicated that the Canadians are considering some operational use, perhaps with more than one bait strength. Further guidelines are expected soon from Daterman and John Wenz (not present) on standard trap set up and optimum numbers of traps per sample. Participants generally agreed that we need to go through a complete outbreak cycle before final methods can be determined. Shepherd feels that the traps are more reliable in wet areas if they are hung upside down. A consensus was reached that placing baits on insect pins inserted in the trap wall is time consuming and messy, a simpler method is desirable. Daterman has previously found that simply tossing a bait pellet in the trap works fine and this may be the way to go.

Figure 1



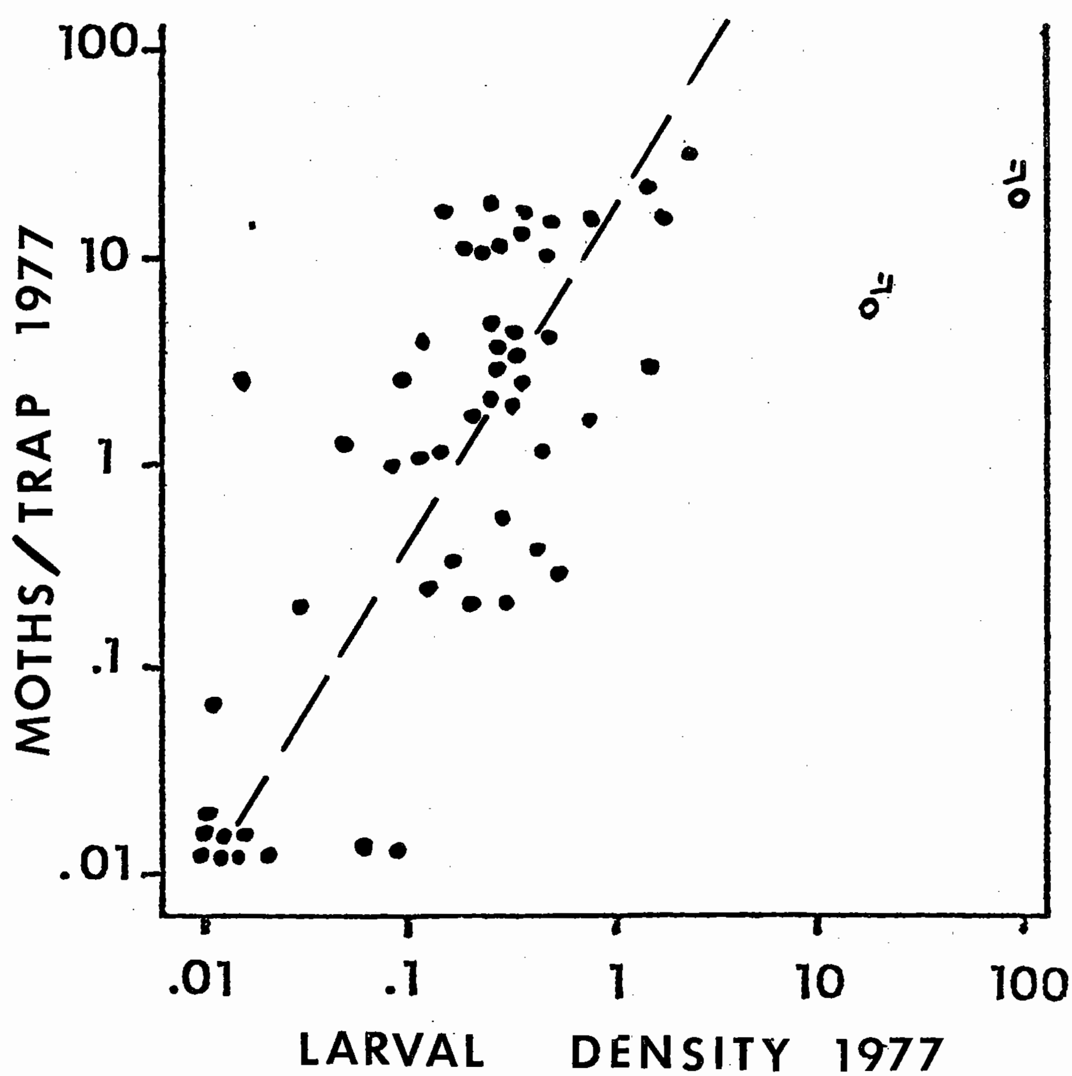


Figure 2.--Relationship of 1977 larval counts and 1977 moths trapped on plots in New Mexico, Arizona, California, southern Idaho, and southern Oregon. Larval densities are in terms of numbers of early instars per 1000 square inches foliage. All plots are not included here because larval and/or adult sample data was not available for all areas at the time of writing.

1/ Outbreak areas near Los Alamos, New Mexico

SESSION: INSECT IDENTIFICATION
Cochairmen: Malcolm M. Furniss and Torolf R. Torgersen

Thirty-one persons participated in discussing opportunities and problems involved in obtaining specific determinations of forest insects and associated mites and nematodes. A directory of participants and their fields of interest was developed.

The group noted that, whereas field personnel deal increasingly more with population differences, it has become difficult to obtain specific determinations in several important taxa. For example, physiological differences occur in geographically different populations as shown by enzyme analysis and response to pheromones. The problem of specifically identifying insects is accentuated in western North America--critically so in Mexico--where species, hosts, and distributions are poorly known. Expanded research on Douglas-fir tussock moth and spruce budworms, and intensified forest resource utilization and management are also contributing to increased needs for expert, systematic assistance.

Situation in Mexico

David Cibrian Tovar of the National Agricultural College, Chapingo, Mexico, spoke of complexity inherent in Mexicn forests (37 pine species, 8 firs, hundreds of hardwoods). Mexico lacks specialists and the question of what to send to whom is bewildering. They are seeking to build a reference collection of determined species and would welcome visitation by specialists. Scolytids are of major importance as are cone and seed insects and plantation insects. David maintains collection data on cards filed numerically, by host, and by species, similar to the Hopkins system.

Taxonomist's Viewpoint

From the taxonomist's viewpoint, problems are of different sort but equally sore. An ESA survey estimated that 120 million specimens reside in U.S. museums. One-third million specimens are identified by the Systematic Entomology Laboratory, Beltsville, Maryland, each year, without charge.

Lloyd Knutson, Chairman of SEL, provided a list of topics and questions for discussion, but was stranded in Denver and could not reach Durango in time for the session. Research needs include study of *Choristoneura* spp. to better delineate geographic and physiologic entities and their parasites. There is great need to associate immatures with adults of many taxa, particularly Coleoptera. Entomophagous Diptera and the gall midges are in need of study and revision. Cooperative field work and research between museum taxonomists and forest entomologists should be encouraged, including participation of SEL scientists in field studies. Field personnel could collect taxa needed by SEL. Reference collections at field locations need to be inventoried and made available for wider use. SEL scientists could provide short courses or specialized training in identification of forest insects.

About 30 percent of the time of 27 SEL taxonomists involves identifications, many of which include interesting and valuable specimens and associated data. SEL is planning to computerize its record system. The Hopkins system is an important source of information, but should be automated for easier search. Specimens received by SEL should have legible labels containing Hopkins number, host, date, locality, and collector; and be accompanied by one copy of the card, containing additional information.

SEL does not presently have capability to identify Orthoptera, Thysonoptera, Aleyrodidae, or Tortricoidea. To the extent possible, such taxa are referred to cooperating taxonomists, but SEL lacks staffing for a complete referral service.

Regional Service Centers

Development of regional or specialized service centers has been suggested in order to supplement the SEL. John Lattin, Department of Entomology, Oregon State University, proposed a prototype satellite systematic facility to handle identifications of taxa involving the Spruce Budworms R&D Program. This pilot center would conduct taxonomic investigations of critically important groups, hosts, and habitats; provide identification service, prepare manuals for field use, and provide literature retrieval service.

John Moser of the Forest Service, Pineville, Louisiana, described his mite clearing-house service by which mites received in 70% alcohol are mounted by technicians and identified or sent to specialists. A similar service for nematodes is planned when Donald Kinn is trained.

Lists of Taxonomists

An annually revised list of SEL taxonomists and their specialties is available from Dr. Lloyd Knutson, Room 1, Building 003, Agricultural Research Center-West, Beltsville, Maryland 20705. An annotated list of workers on systematics and faunistics of Canadian insects, 1977, is available from Biological Survey Project, 202-1316 Carling Avenue, Ottawa, Ontario, Canada K1Z 7L1.

Standing Committee Appointed

WFIWC Chairman William Ives appointed a standing committee to deal with forest insect identification matters. Members of the committee are:

David Cibrian Tovar, National Agricultural College, Chapingo, Mexico

Thelma Finlayson, Simon Fraser University, Burnaby, B.C., Canada

John D. Lattin, Oregon State University, Corvallis, Oregon

Steven J. Kohler, Montana Division of Forestry, Missoula, Montana.

Robert E. Stevens, Forest Service, Fort Collins, Colorado

Torolf R. Torgersen, Forest Service, Corvallis, Oregon

Malcolm M. Furniss (Chairman), Forest Service, Moscow, Idaho

The committee is charged with the following activities:

1. Provide a forum on forest insect identification matters by which cooperation and communication can occur among field personnel, taxonomists, and administrators.

2. Define problems, needs, and opportunities involving description and identification of western forest insects.

3. Develop and maintain a current list of taxonomists specializing in forest insects of western North America.

4. Inventory forest insect collections at field stations in order to make them more broadly available.

Progress by the Committee will be reported at the next WFIWC meeting in Boise, Idaho. Anyone wishing to communicate on the subject should contact Chairman Furniss, Forestry Sciences Laboratory, 1221 S. Main Street, Moscow, Idaho 83843.

FINAL REPORT

FIELD TEST OF THE INSECTICIDE RELDAN AGAINST THE WESTERN SPRUCE BUDWORM IN THE PAYETTE NATIONAL FOREST, IDAHO

1977

by

George P. Markin, PSW-RWU-2206

and

David G. Grimble, FIDM/MAG

ABSTRACT

The chemical insecticide Reldan (chlorpyrifos-methyl) was field tested against an outbreak population of the western spruce budworm, <u>Choristoneura</u> <u>occidentalis</u> Freeman, in grand fir in the Payette National Forest of west central Idaho in June and July 1977. Reldan was aerially applied using a Bell 47 helicopter, equipped with 8002 flat fan nozzle tips, flying at 45 mph and 50 ft above tree tops. Reldan was mixed with diesel fuel with Rhodamine B dye added as a marker. Dosages of 8 oz, 4 oz, and 2 oz A.I. per gallon resulted in unadjusted mean population reductions of 90.2%, 88.3%, 63.4% mortality (check mortality 30.0%) at 15 days after treatment. Respective percent defoliation at time of completion of pupation in the treated plots was 71.2%, 73.9%, and 77.2% (81.5% for check plot). The degree of control obtained using Reldan was considerably below that routinely obtained with two other chemicals, Sevin-4-oil (1 lb/acre) and Orthene (1/2 lb/acre), presently registered for control of the spruce budworm. It was therefore determined that Reldan at these dosage levels and treatment strategies did not justify further consideration as a control method for the western spruce budworm.

FIELD TEST OF THE INSECTICIDE RELDAN AGAINST THE WESTERN SPRUCE BUDWORM IN THE PAYETTE NATIONAL FOREST, IDAHO -- 1977

I. INTRODUCTION

In western North America the western spruce budworm (*Choristoneura occidentalis* Freeman) is the most persistent, and over a long period of time, the most serious defoliator of the western fir forests (Carolin and Honing, 1972). During an extensive outbreak the accepted method of control has been the aerial application of chemicals against the feeding larvae. Such programs were first initiated in the northwest in 1948 using DDT (Eaton et al. 1948). By the early 1960's DDT began to be replaced by more environmentally acceptable chemicals and was eventually banned in 1972. Malathion was one of the replacements which was tried in the mid-60's and eventually registered (USDA 1974), but occasionally yields unacceptable mortality (Lyon et al. 1969) and in 1976 gave only 83% control (Mounts 1976). Zectran is also registered for control of this pest (USDA 1974), but was lost as a control when its manufacturer discontinued its production in 1974.

In an effort to find a suitable replacement, the U.S. Forest Service has conducted extensive laboratory screening tests and field tested numerous candidate materials. In 1977 the decision was made to field test the insecticide Reldan.

Reldan (manufacturer Dow Chemical, also known as Dowco 214 and chlorpyrifos-methyl) is a relatively new insecticide with a broad range of activity against a variety of insects. Reldan was the most effective material tested by Dimond in 1975 against the eastern spruce budworm, giving 99% control of larvae at both 0.25 and 0.125 lb A.I./acre. Reldan had not been field tested against the western spruce budworm.

II. OBJECTIVE

The objective of this study was to evaluate Reldan at three dosage rates to determine its effectiveness in controlling a natural infestation of the western spruce budworm. Effectiveness was evaluated by determining (1) a percent mortality of larvae occurring in treated plots as compared to untreated checks, and (2) by determining the percent of the present year's foliage destroyed by the larvae in treated and untreated plots..

III. METHODS AND MATERIALS

The field experiment was conducted in the Payette National Forest, approximately 100 miles north of Boise, Idaho and directly northwest of the small community of New Meadows, Adams County. All experimental plots lay within a radius of 7 miles of Brush Mountain and were located on the drainages of Boulder Creek, Round Valley Creek, and Mud Creek. Elevation of the plots ranged from a low of ca. 4800 ft to a high of ca. 5600 ft.

Reldan was applied at the rate of 8 oz, 4 oz, and 2 oz A.I./gal of diesel fuel with 3.8 grams of Rhodamine Extra Base dye and 90 cc of oleic acid (used as a carrier for the dye) added per gallon as a marking agent. Application was by a Bell 47 GB3 helicopter with a Simplex spray system. The spray system contained two 60 gal tanks, a hydraulic driven pump and a 30 ft boom. Calibration of the equipment showed that 8002 nozzles at 40 lbs pressure gave a flow rate of 0.25 gal/min/nozzle. To obtain the desired 4.54 acre/min application rate we utilized 19 nozzles on the booms, mounted forward and down for maximum breakup.

Plots were either rectangular (1000 ft by 2000 ft) or square (1400 ft by 1400 ft) with a total area of approximately 45 acres. Within each 45 acre plot the first 200 ft of treated area inside the boundaries contained no sample trees. The area within this buffered strip was used for the actual sample area. In setting up the experiment, 30 potential plots were located and preliminary samples taken to determine their budworm populations. Later, ten of the plots were discarded when it appeared their populations would not exceed 20 insects per 100 buds. The remaining 20 plots were selected for use and the three Reldan treatments and check treatment assigned to them randomly.

Fifteen sample trees were selected per plot, all at least 200 ft from the border (not within the buffer strip) and at least 100 ft distance from each other. In designing the test it had originally been planned to use Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) as the sample tree, however, upon examining the plots it was found that grand fir, *Abies grandis* (Dougl.) Lindl., were the predominant trees within the sample plots and contained higher populations of the budworm. For this reason it was decided to use grand fir as the sample tree rather than Douglas-fir. Sample trees were between 30 and 60 ft high and open grown so that approximately 1/2 their foliage was within 30 ft of the ground. Larval population densities were determined for each tree 24 hrs prior to spraying and at 5, 10, and 15 days following treatment.

All plots were marked by placing fluorescent panels in trees at the four corners to serve as markers for the spray pilot. The helicopter applied the spray material by making passes 50 ft apart at an elevation 50 ft above mean tree tops, at a speed of 45 mph. An observer on the ground directed the helicopter to the plot to be treated and remained in contact with him during treatment to check swath spacing, watch for closed nozzles, leakage of spray, etc. The helicopter actually carried 50 gallons of spray so at the finish of each 45 acre plot there was usually 5 gallons left. This he was ordered to spray outside and upwind of the plot so he would return to the heliport with empty tanks.

The sample procedure used was basically that described by Carolin and Coulter (1972) and consisted of counting the number of larvae and buds on two 15-inch branches removed from midcrown of the sample trees at pre-spray sampling and four branches at postspray.

Sample branches were cut with a 25-foot extendable pole pruner with an 18 inch cloth basket fastened just below the cutting head and lowered to the ground and placed in paper bags, 1 bag per tree. Bags were sealed, marked with plot number, tree number and date, and stored in a cooler 45^{o}F until examined..

All samples were brought to a field laboratory where workers removed larvae by beating the branches inside a plastic barrel, according to the sampling technique developed by Martineau and Benoit (1973). Data recorded consisted of number of buds and total number of budworm larvae or pupa per branch. Population density was expressed as the number of spruce budworm larvae per 100 buds.

A defoliation estimate was made from the foliage collected at the last sampling interval by visually examining each bud and estimating the amount of foliage consumes or destroyed by larval feeding. Each bud was categorized into 1 of 4 defoliation classes (25%, 50%, 75%, and 100%), then averaged to give the percent of defoliation for the 4 branches sampled from each tree.

During spraying meteorological readings were made to measure air temperature, humidity, and wind speed at 15-minute intervals starting one-half hour before treatment of each plot and continuing until one-half hour after treatment. Smoke bombs ignited at the beginning of treatment were used to determine direction and approximate speed of very low winds at ground level.

White Kromekote cards (4x5") were used to determine spray deposit at ground level. One card was placed in an opening adjacent to each sample tree the morning of spraying. After spraying the cards were left out for approximately one hour to assure complete drying of the spray, (but not long enough to allow sunlight to fade the dye), collected, placed in bundles, wrapped with paper and marked with the appropriate plot number.

Reading of the cards was contracted to the University of California, Davis, Department of Advanced Instrumentation. Each card was analyzed to determine volume mean diameter (VMD) of the drops, number of drops per square centimeter and gallons per acre (GPA) as indicated by the cumulative volume of the material in different drop size categories. No spread factor for Reldan was available so an arbitrary spread factor of 3, a figure chosen as being representative for several other oil based sprays when diluted with diesel fuel (Waite 1977).

Population data was analyzed using a computer program prepared by Robert W. Young, Biometrician, U.S. Forest Service, Methods Application Group, WO-FIDM, Davis, California. Analysis of variance and analysis of covariance were both utilized.

IV. RESULTS

Larval density and the distribution of larvae among the various instars at the time of spraying is shown in Table 1. Treatment was timed so that the new flush of foliage would be completely open, exposing the budworm inside, but before appreciable numbers had reached 6th instar or begun to pupate, In this test over 50% of the larvae were in the 5th instar. Less than 5% were in the 6th instar and no pupation was detected at the time of spraying.

The treatment began on June 22 and was finished on June 24. Spraying started at about 6 am and was completed by 8:45 am. Meteorological conditions at the time of spray were near ideal. Temperatures were cool, above 45^{0}, but no spray was applied at temperatures higher than 60^{0}. No major winds occurred, only normal down slope and down valley wind drainages. No rain occurred or threatened during the treatment and the first detectable rain fell 10 days afterwards on July 3 (0.2 in) with a heavy rainshower occurring on July 4 (0.52 in). No additional rain fell for the duration of the test. Table 2 shows the time and date of spraying of each plot and meteorological conditions existing in the plot at ground level at time of spraying.

Mixing of Reldan was done immediately before spray in a 120 gallon mixing tank at the heliport. For each dosage level to be sprayed that day, only enough spray was mixed and loaded into the helicopter. While the first dosage rate was being applied, the second dosage rate was mixed. Upon returning, the residual material remaining in the boom and cross arm under the helicopter was drained out and the new batch loaded into the helicopter. In this way, the batch for each dosage level was mixed separately immediately before spraying. Reldan was found to be an easy insecticide to work with. It mixed readily into the diesel fuel and presented no problems in mixing. During application no problems were encountered with clogged nozzles, screens, or dissolved gaskets. The helicopter took less than 15 minutes to treat each 45 acre plot.

Results of spray coverage determined, by spray deposit assessment on Kromekote cards placed out at ground level within each plot, are shown in Table 3. In general, coverage was acceptable with the expected variation occurring between trees within plots. All of the cards collected after spraying contained some spray spots; no apparent skips were detected in the coverage of the plots. If the amounts of spray materials recovered, either drops/cm^2 or gallons per acre appears small it should be remembered that the cards were placed at ground floor in a heavily forested area and the majority of material was probably intercepted by the forest canopy.

Volume for VMD and GPA are also tenative since an exact spread factor for the 3 dosage rates used were not available and the spread factor for diesel fuel was used instead. Deposit assessment data of this type is at best only a general indication of whether a particular sample tree or a particular plot was treated and not a specific record of the amount of material that reached the spray target, i.e., the budworms within the forest canopy.

Samples of spray were collected from the mixing tank at time of loading of the helicopter and analyzed for the actual amount of Reldan in the final mix. A higher than expected degree of variation occurred in the concentration of final mix. Reasons for part of this discrepancy were lated identified when an actual sample of the Reldan was tested and, instead of the expected 6 lb A.I./gal, the sample was found to contain 6.43 lbs A.I./gal.

Effectiveness of the Reldan treatment against the western spruce-budworm larvae expressed as unadjusted population reductions, and as percent mortality is shown in Table 4. At 15 days, the end of the sampling interval, insect population reduction was significantly greater in all treated plots than in the check plots. The 8 oz and 4 oz treatment results did not differ significantly from each other but did differ significantly from the 2 oz treatment. Most of the mortality apparently occurred within the first five days after treatment with some additional mortality occurring between 5 and 10 days. No additional mortality occurred after 10 days.

Defoliation of the sample trees within the treatment plots is shown in Table 4. A superficial examination of the data indicates that highest estimated defoliation was found in the check plots and subsequently lesser amounts of defoliation with each of the higher dosage rates. However, an analysis of variance of this data showed no significant differences between any of the four treatment levels.

V. CONCLUSIONS

In general, the test went very smoothly, in large part due to the excellent help and cooperation of the Payette National Forest. The twenty plots used were satisfactory, all of them contained good populations of the insect, and we experienced no unusual mortality or disease outbreak during the test. There were no problems with the application of the material due to weather or equipment failure, and deposit assessment showed that the coverage in all plots was normal or better than normal. The low mortality therefore appeared to be a failure attributable to the insecticide Reldan and not the result of some problem with application or environmental conditions. Possibly, better results could be obtained in a new test, if higher dosages in the range of 2 lb/acre or more were used. A higher dosage rate, however, may not be either environmentally or economically acceptable.

Conclusions from this test are that Reldan does not appear to be an acceptable insecticide for use as a control of the western spruce budworm. Better mortality can be obtained at lower dosage rates with other available insecticides, such as Orthene and Sevin-4-oil. We therefore recommend that no further effort be expended on field testing this material at this time, but that available money and effort be concentrated on other more promising insecticides.

VI. ACKNOWLEDGMENTS

The successful completion of this project could not have been obtained without the extensive help of numerous people. In particular we wish to express our thanks to Jerry Knopf and Max Ollieu, entomologists, FIDM, R-4, Boise, for their help in locating and choosing test sites and general support for this study, to William Sendt, Forest Supervisor, for allowing us to work on the Payette National Forest, and to Pete Walker of the New Meadows Ranger District for cooperation while working on his district.

A very special thanks are particularly due to Larry Hill, of the Payette National Forest for his help in the form of administrative support for this study, and to Bob Young, Biometrician, Methods Application Group, Davis, California, for statistical help in analyzing the data.

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Table 1. Budworm larvae population density and development of plots at time of treatment, 1977 Reldan Field Test, Payette National Forest, Idaho

Treatment	Replicate	No. larvae per 100 buds[1]	% larvae by instar[2] 2	3	4	5	6
Reldan 8 oz	A	59.9	0	7	29	64	0
	B	22.1	0	0	31	68	1
	C	50.0	0	0	22	78	0
	D	29.6	0	10	35	54	0
	E	35.5	0	6	30	69	5
Reldan 4 oz	A	45.8	0	11	39	50	0
	B	47.9	0	3	50	47	0
	C	35.5	0	7	51	42	0
	D	28.6	0	0	26	68	6
	E	28.2	0	9	16	63	12
Reldan 2 oz	A	38.8	0	12	36	52	0
	B	34.4	0	0	22	72	6
	C	39.3	0	0	14	86	0
	D	40.3	0	6	34	60	0
	E	46.1	0	7	68	25	0
Check	A	31.5	0	9	16	75	0
	B	35.1	-[3]	-	-	-	-
	C	35.9	0	0	23	77	0
	D	37.5	0	17	78	5	0
	E	34.8	-[3]	-	-	-	-

[1]Density at pre-spray, 24 hr before treatment

[2]Counts made from 50 to 100 insects collected from 5 pre-designated trees, not sample trees, 2 to 4 days before treatment

[3]Data missing

Table 2. Meteorological conditions at start of aerial spraying, 1977 Reldan Field Test, Payette National Forest, Idaho

Treatment	Replicate	Date Treated	Time	Temp. °F	% Relative Humidity	Wind mph
Reldan 8 oz	A	6/23	0730	52	89	3
	B	6/22	0740	55	73	0
	C	6/23	0703	57	60	2
	D	6/24	0550	54	62	0
	E	6/24	0630	56	65	4
Reldan 4 oz	A	6/24	0755	48	88	<2
	B	6/22	0713	45	84	<2
	C	6/24	0815	51	88	0
	D	6/23	0600	47	94	0
	E	6/23	0631	49	83	<2
Reldan 2 oz	A	6/23	0830	50	82	<2
	B	6/23	0800	52	89	<2
	C	6/24	0730	59	63	2.5
	D	6/22	0631	54	60	0
	E	6/24	0700	51	77	<2

Table 3. Summary of spray deposit assessment data, 1977 Reldan Field Test, McCall, Idaho

		Spray Deposit			Tank Sample
Treatment	Replicate	Drops/cm²	VMD	GPA	% of expected amount[1]
Reldan 8 oz	A	10.46	92.4	0.346	92
	B	19.46	107.9	.419	104
	C	8.83	93.0	.310	104
	D	5.97	84.7	.204	127
	E	5.22	105.2	.310	127
	Average	9.98	96.6	.318	110
Reldan 4 oz	A	14.77	93.6	.483	94
	B	5.66	92.3	.242	89
	C	5.62	92.4	.197	89
	D	17.71	86.3	.433	103
	E	5.66	92.3	.241	103
	Average	9.88	91.4	.319	96
Reldan 2 oz	A	18.76	83.3	.394	Unknown
	B	15.44	99.6	.677	107
	C	10.01	90.8	.339	109
	D	19.03	83.4	.384	116
	E	2.95	99.6	.164	116
	Average	13.24	91.3	.390	112

[1]Analysis of material supplied by manufacturer showed 6.43 lb A.I./gal rather than the expected 6 lb A.I./gal or 107.1% of the expected amount.

western spruce budworm larvae (uncorrected for natural mortality) and defoliation, Payette National Forest, Idaho -- 1977

		Mean larvae/100 buds				Mean % population			
		Prespray	Postspray			reduction at			%
Dosage	Replicate	24 hr	5 day	10 day	15 day	5 day	10 day	15 day	defoliation
8 oz/acre	A	59.9	29.5	9.7	10.4	50.7	83.8	82.7	80.0
	B	22.1	5.6	1.2	1.4	74.8	94.4	93.5	88.5
	C	50.0	4.0	3.3	3.7	91.9	93.4	92.6	46.8
	D	29.6	3.0	2.2	3.1	89.9	92.4	89.5	71.7
	E	35.4	5.2	4.7	2.6	85.3	86.6	92.7	69.1
	Average	39.4a[1]	9.5a	4.2a	4.2a	78.5a	90.1a	90.2a	71.2a
4 oz/acre	A	45.8	10.1	3.4	5.1	78.0	92.5	88.9	57.1
	B	47.9	8.1	4.3	4.0	83.1	91.1	91.6	75.8
	C	35.5	16.2	7.4	8.5	54.5	79.1	76.0	76.6
	D	28.6	2.0	2.1	1.3	92.5	92.3	95.3	72.1
	E	28.2	3.6	4.1	2.9	87.4	85.5	89.9	88.1
	Average	36.8a	8.0a	4.2a	4.3a	74.1a	88.1a	88.3a	73.9a
2 oz/acre	A	38.8	26.1	25.7	18.9	32.7	33.8	51.2	77.8
	B	34.4	16.8	12.0	24.3	51.3	65.2	29.4	68.6
	C	39.3	24.1	16.7	8.7	38.8	57.5	77.8	89.2
	D	40.3	11.9	5.6	4.2	70.5	86.2	89.6	68.4
	E	46.1	11.5	15.4	14.2	75.1	66.7	69.1	82.1
	Average	39.8a	18.1b	15.1b	14.1b	53.7b	61.9b	63.4b	77.2a
Check	A	21.5	26.6	21.7	25.9	0.0	0.0	0.0	97.1
	B	35.1	29.1	23.5	25.0	17.0	33.0	28.6	77.9
	C	35.9	33.8	28.0	26.7	5.6	21.9	25.6	74.5
	D	37.5	19.1	16.3	15.8	49.0	56.6	29.4	76.9
	E	34.8	19.5	13.6	11.8	44.1	60.9	66.2	81.0
	Average	33.0a	25.6a	20.6b	21.1c	23.1c	34.5c	30.0c	81.5a

[1]Means in same columns followed by same letter do not differ significantly at the 5% level.

Durango, Colorado Presentation for Western Insect Work Conference (F. L. Hastings)

Introduction and Methodology

This presentation encapsulates the preventive aspects of researchers funded by the Southern Pine Beetle Program. Three materials have now been identified from laboratory and field bioassays which are promising replacements for lindane. During the 1975 and 1976 seasons two of these materials, chlorpyrifos and chlorpyrifos-methyl, were field tested by the 'hanging bolt' technique. This technique was devised by Dr. C. Wayne Berisford of the University of Georgia. This technique involved spraying blocks of uninfested trees, felling trees at various time intervals, and transporting bolts from these trees to active southern pine beetle (SPB) infestations. The bolts were hung in the area of greatest beetle activity and baited with frontalure. Sticky traps were attached to the bolts to monitor beetle visitation and the bolts were left in the field for 25 days. The bolts were then returned to the laboratory and two 1000 cm^2 areas (one from each end) were examined and peeled to determine number of successful attacks and the length of the egg galleries. These data were used in judging preventive efficacy. The reduction in successful attacks and length of egg galleries as compared to control (bolts from untreated trees) were the basis of judging preventive efficacy. Residue analyses were conducted throughout the time course of these studies.

Two preventive studies were conducted in 1977 in the Gulf Coast and Atlantic Coast States. The criteria of data collection was whether the trees lived or died. Plot design was as follows: there were six treatments/plot; 1.0% and 2.0% chlorpyrifos and chlorpyrifos-methyl, 0.5% lindane and untreated. To assure equal beetle pressure treated and control areas were baited with frontalure. Spot choice was based on the following requirements: at least 25 active trees; 8-20' dbh; at least 100 ft^2 basal area. Beetle visitation and residue dissipation was also determined. Plans called for 12 plots in the Gulf Coast States and 6 plots in the Atlantic Coast States.

Results

Results with the 'hanging bolt' technique were somewhat mixed i.e. in some studies, 0.5% was as effective as 1.0%. However, it can be unequivocally stated that 1.0% and 2.0% concentrations of chlorpyrifos and chlorpyrifos-methyl did effectively reduce number of attacks and egg gallery length. We interpreted this to mean that under the conditions of the test these materials would have protected standing trees. Neither chlorpyrifos or chlorpyrifos-methyl was as effective as lindane after 12 months.

To date only 3 plots have been installed in the Atlantic Coast States. All control treatments are under attack and most of these trees are dead. So far beetle pressure has been low to moderate and all materials appear to be effectively preventing beetle attack.

In the Gulf Coast States 12 plots have been installed and beetle pressure has been high to extremely high. In two sites where this pressure was extreme all trees died regardless of treatment. In these plots bi-weekly traps averaged 900-1200 beetles/trap. Control trees in the other 10 plots are all dead and only one treated tree has died. Generally we interpret these results to mean that we can protect standing trees except in cases of extreme beetle pressure. Studies in 1978 are directed toward an assessment of how closely the results of the 'hanging bolt' technique parallel the results of the tree mortality studies.

TWENTY-NINTH WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Final Business Meeting
March 7-9, 1978

Durango, Colorado

Chairman Rick Johnsey called the meeting to order at 8:30 a.m.

Minutes of the initial business meeting were read and approved.

Rick expressed appreaciation in behalf of the Conference members to the Program Chairman, Charlie Minnemeyer, and Local Arrangement Chairman, Donn Cahill for an excellent conference. Thanks were also extended to personnel of Mesa Verda National Park for the tour of the Indian ruins.

Doug Parker made a final invitation to have the 1980 Conference somewhere in the Southwest. A motion was made and passed to accept the offer. Bill Ives again extended the offer to have the 1981 Conference in Alberta, Canada.

Bob Thatcher invited members to attend the Southern Pine Beetle Program Review near New Orleans on April 4-7. Ron Stark reminded members about the Mountain Pine Beetle Symposium in Pullman, Washington, April 25-27.

Chairman Johnsey asked for committee reports:

Nominating Committee - Chairman Dave Wood nominated Bill Ives as new chairman, Les Safranyik as new Secretary-Treasurer, and Bill Ciesla as new Councilor. There being no nominations from the floor, nominees were elected by acclamation.

Ethical Practices Committee - Members Paul Buffam, Bill McCambridge, and Dan Dahlsten discussed the activities of several candidates. They were generally disappointed in the behavior of the "younger" members, and therefore had to elect an "older" member who has been trying hard to receive the award for the past 25 years - Ron Stark humbly accepted the award.

Common Names Committee - The Common Names Committee met at 7 p.m. on March 8, 1978. Present were Dr. T. Finlayson, Ms. F. Shon, Mr. L. Stipe, Dr. K. Stoszek, and Dr. T. Torgerson (Chair.). The Committee received preliminary proposals for three common names; formal action on these names will be taken this calendar year and recommendations presented at the Spring 1979 meeting. The Committee will be examining the text of Furniss and Carolin's, Western Forest Insects, and MP 1339, for common names that have not been adopted by the ESA. Names that are not on the approved ESA list will be checked, and appropriate names will ultimately be submitted to ESA for consideration and adoption. Dr. R. W. Acciavatti was appointed as a new member to the Committee. Absent from the meeting were Dr. W. Brewer and Mr. D. McComb.

Attention was called to the fact that Ron Stark was nominated to receive the Canadian Gold Medal Award.

Rick Johnsey then turned the meeting over to the new Conference Chairman, Bill Ives. There being no further business, the meeting was adjourned at 9:00 p.m.

TREASURER'S REPORT

Twenty-ninth Western Forest Insect Work Conference
Durango, Colorado

Balance on hand, March 1, 1978		$ 447.21
Receipts:		
Received from registration	$3,183.75	
		$3,630.96
Expenses:		
Ramada Inn, Durango	$1,085.15	
San Juan Tours, Durango	674.80	
	$1,759.95	$1,871.01
Balance on hand, March 10, 1978		$1,871.01

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