REPORT OF THE 1995 BARK BEETLE STEERING COMMITTEE MEETING

October 24-26, 1995

Stateline, NV

CONTENTS

APPENDIX A

This appendix shows accomplishments in the 5-year bark beetle plans.

Year 1 represents activities conducted up to and including 1994.

Activities are designated as:

O = Ongoing or work currently in progress
C = Work has been completed
X = When activity was tentatively scheduled; or no work currently being conducted.
D = Project dropped or deferred
CO= Initial project completed; additional work ongoing

MOUNTAIN PINE BEETLE
5-Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Aggregation pheromone components						
a. Define, make improvements	X	X	X	X	X	
b. Define geographic differences	X	O	X	X	X	
2. Anti-aggregation pheromones components						
a. Verbenone enantiomers	X	C				
b. Combinations of other pheromones		C				
3. Pheromone effects on assoc. species						
a. Competitive displacement		O	X	X	X	
b. Flight periodicities		O	X	X	X	
c. Effect on species diversity		X	X	X		
4. Dynamics of endemic populations						
a. Managed stands	O	O	X	X	X	
b. Unmanaged stands	O	O	X	X	X	
c. Epidemic "triggers"		O	X	X	X	X
5. Beetle dispersal						
a. How far do they fly?	X	O	X	X	X	
b. Distance of pheromone response		O	X	X		
6. Pheromone effects on natural enemies		O	X	X	X	
7. Attraction to fire-weakened trees		C				
B. Long Term Basic Research:						
1. Semio-chemical based population monitoring			X	X	X	X
2. Fate of semio-chemicals in environment			X	X	X	X
a. Effect of stand microclimate			X	X	X	X
b. Effect of host condition			X	X	X	X
3. Fate of semio-chemical adjuvants		X	X	X	X	
4. Effect of semio-chemicals on non-target organisms		X	X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
5. Primary host attraction behavior	X	O	X	X	X	
6. Population "fitness" (genetics)		O	X	X	X	
7. Host/beetle interaction relative to semio-chemical response		O	X	X	X	
8. Biological control				X	X	X
9. Weather effects on populations	O	O	X	X	X	
10. Historic disturbance patterns	O	O	X	X		
C. Short Term Applied Studies:						
1. Hazard/risk rating systems for all hosts						
a. Managed stands	O	O	X	X	X	
b. Unmanaged stands	O	O	X	X	X	
c. In southwestern ponderosa pine	O	O				
2. Short-term modeling (expert system)			X	X	X	
3. Verbenone evaluations						
a. Aerial--Dose, formulation	X	X	X	X	X	
b. Bubble caps--Dose, formulation	X	O	X	X	X	
c. Individual tree protection		X	X	X	X	
d. Where do "dispersed" beetles go?			X	X	X	X
D. Long Term Applied Studies:						
1. Trap-out strategy--is it viable?		O	X	X	X	
a. Push-pull strategy			X	X	X	
2. Stand management based on stand micro-climate/beetle biology interactions	O	O	X	X	X	
3. Silvicultural treatments						
a. Unevenaged management	O	O	X	X	X	
b. Ecosystem management	O	O	X	X	X	
4. Model development and validation						
a. Western Pine Bark Beetle Model(ESSA)	O	O	X	X		
b. PROGNOSIS variant	X	X	X	X		
c. MPB life system model		O	X	X		
d. Dispersal		O	X	X		

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
5. Operational "decision support system"		O	X	X		
6. Permanent plot monitoring	O	O	X	X		
E. Operational Activities:						
1. "How To" publications			X	X	X	
2. Sanitation/Salvage effectiveness		X	X	X		
3. Individual tree protection alternatives		X	X	X	X	
4. Silvicultural treatment effectiveness						
a. Demonstration areas-thinning plots	O	O	X	X		
b. Effects in various hosts	X	X	X	X		
5. Bait and cut effectiveness	O	O	X	X		
6. Spray and bait effectiveness		X	X	X		
7. Evaluate hazard/risk-rating systems	O	O	X	X	X	
8. Evaluate/refine loss prediction model(s) for all hosts	X	O	X	X	X	

WESTERN PINE BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Beetle Dispersal						
a. How far do they fly	X	X	X			
b. How far is pheromone response effective	X	X				
2. Aggregation and Antiaggregation Pheromones						
a. Define pheromone spectra	X	C				
b. Determine dose responses to verbenone, ipsenol& ipsdienol		C				
c. Determine release rates and temperatures		C				
d. Determine nontarget effects particularly natural enemies	X	C				
e. Determine geographical variation in response to pheromones		O	X	X		
3. Biology						
a. Determine host selection behavior		X	X	X		
b. Explore host/prey interactions			X	X	X	X
B. Long Term Basic Research:						
1. Aggregation and Antiaggregation Pheromones						
a. Host/insect interactions relative to semiochemical responses	X	X	X	X	X	X
2. Biology						
a. Natural controls						
1. importation, augmentation, conservation	X	X	X	X	X	X
b. Behavior						
1. primary attraction			X	X	X	X
3. Determine the impact of WPB caused tree mortality on threatened and endangered species	X	X	X	X	X	X

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
C. Short Term Applied Studies:						
1. Aggregation and Antiaggregation Pheromones						
a. Efficacy of verbenone treatments						
1. field bioassay of different enantiomers	X	C				
2. Field bioassay of verbenone plus aggregation pheromone of competative species		C				
3. Different release rates			X	X	X	
4. Individual tree protection						
a. efficacy		O	X	X		
b. develop operational release device			X	X	X	
5. Effects on nontargets such as natural enemies		X	X	X	X	
6. Area protection						
a. efficacy		O	X	X	X	X
b. develop operational release devices		O	X	X	X	X
b. Efficacy of combination of protective sprays and baits						
1. determine optimum density of treatment centers		X	X	X		
2. effects on nontargets such as natural enemies		X	X	X	X	X
c. Efficacy of combination of baits and infested tree removal						
1. use of baits to prevent dispersal of overwintering populations		O	X	X	X	X
2. determine optimum density of treatment centers				X	X	X
3. effects on nontargets such as natural enemies				X	X	X
4. quantify "spillover" around baited centers			X	X	X	X
2. Silviculture or Stand Conditions						
a. Treatments						
1. trap trees	X	D				
b. hazard rating	X	O	X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
D. Long Term Applied Studies:						
1. Aggregation Pheromones						
a. Beetle monitoring systems						
1. optimum trapping density and pattern	X	D				
b. Trap out strategy for low level populations						
1. optimum trap/density pattern	X	X	X	X	X	X
2. effects on nontarget organisms such as natural enemies	X	X	X	X	X	X
2. Silviculture or Stand Conditions						
a. Efficacy of thinning	X	O	X	X	X	X
b. High risk tree removal	X	X	X	X	X	X
c. Efficacy of stand fertilization	X	X	X	X	X	X
d. Influence of pruning	X	D				
3. Impacts						
a. Loss and impact predictions	X	O	X	X	X	X
b. Growth and yield models	X	X	X	X	X	X
4. Role of WPB caused mortality on creating and maintaining critical wildlife habitat	X	O	X	X	X	X
E. Operational Activities:						
1. "How to" series of publications		X	X	X	X	
2. Sanitation/Salvage efficacy	X	O	X	X	X	X
3. Protective sprays for individual trees - identify new materials		C				
4. Use of Antiaggregants	X	X	X	X	X	X
5. Develop data visualization sequence	X	X	X	X	X	X

ROUNDHEADED PINE BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Applied Studies:						
1. Aggregation Pheromone						
a. optimum blend	C	CO	X			
b. optimum release rate	C	CO	X			
c. geographic difference in response	O	O	X			
2. Antiaggregants						
a. optimum blend	C	X	X	X		
b. optimum release rates	C	X	X			
c. geographic difference in response			X	X	X	
3. Dispersal						
a. flight periodicity	O	O	X			
b. flight distance		O	X			
c. pheromone effective distance			X	X		
4. Develop Hazard and Risk Models			X	X	X	
5. Determine Outbreak Triggers	O	O	X			
-site/stand factors assoc. with occurance		O				
6. Model Integration						
a. loss and impact prediction				X	X	X
b. growth and yield model				X	X	X
7. Association with other insects and pathogens			X	X		
8. Effects of outbreak on:						
a. stand structure and composition	X	X				
b. MSO habitat	X	X				
c. biodiversity	X	X				
d. visual quality			X	X		

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
B. Long Term Applied Studies:						
1. Aggregation Pheromones						
a. population monitoring						
1) effective number of traps			X	X	X	X
2) trap placement			X	X	X	X
b. trap-out						
1) release rates				X	X	X
2) trap placement				X	X	X
c. bait and cut						
1) spot treatment				X	X	X
2) area-wide effects				X	X	X
2. Antiaggregants						
a. stand/area-wide protection		O	X	X	X	
C. Operational Activities						
1. Silvicultural Treatments To Reduce Risk/Hazard						
a. unevenaged regeneration		O	X	X	X	X
b. evenaged regeneration		O	X	X	X	X
c. thinning		O	X	X	X	X

JEFFREY PINE BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Determine flight periodicty		O	X	X		
2. Identify, isolate, and sythesize aggregation and antiaggregation phermones	O	O	X	X		
3. Field bioassay phermones		O	X	X		
4. Determine insect/pathogen interactions	O	O	X	X		
5. Determine geographical variation in response to pheromones		X	X	X		
6. Determine natural enemies	X	O	X			
B. Long Term Basic Research:						
1. Dispersal-- How far to beetles fly?	X	X	X	X	X	X
2. Host/insect/pathogen interaction	X	X	X	X	X	X
3. Role of associated species relative to semiochemical complex	X	X	X	X	X	X
4. Role of primary attraction in beetle behavior and host selection	X	X	X	X	X	X
5. Effects of JPB caused mortality on critical wildlife habitat	X	O	X	X	X	X
C. Short Term Applied Studies:						
1. Develope hazard rating system	X	X	X			
2. Test efficacy of 'bait and cut'		X	X	X		
3. Pilot test thinning and pruning (ie Toiyabe NF 1988)	X	O	X			
4. Test individual tree protection treatments (phermones/insecticides)	X	O	X			
5. Pilot test Sanitation/Salvage Treatments (ie LTBM campgrounds)	X	X	X	X		
6. Effects of hazard tree removal on area mortality	X	X	X	X		
7. Develope antiaggregation strategies for mortality reduction			X	X		
8. Effects of combining antiaggregation strategies with pheromones of competitors				X	X	
9. Test efficacy of fertilization	X	X	X			
10. Test efficacy of trapout strategy		X	X	X		
11. Removal of currently infested trees	O	O	X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
D. Long Term Applied Studies:						
1. Develop silvicultural strategies	X	X	X	X	X	X
2. Develop long term pheromone based monitoring system		O	X	X		
3. Role of pathogens in beetle attack/ host selection behavior	X	X	X	X	X	X
4. Role of natural enemies in the population dynamics of JPB	X	X	X	X	X	X
5. Develop population dynamics model coupled to growth and yield	X	X	X	X	X	X
6. Role of JPB in creating and maintaining unique wildlife hab. (snags, down woody material etc)	X	O	X	X	X	X
7. Establish demostration sites for documenting changes in vegetative structure, pre to post JPB events	X	X	X	X	X	X
E. Operational Activities:						
1. How to's			X	X	X	X
2. Sanitation salvage	X	X	X	X	X	
3. Demonstrate hazard rating system			X	X	X	
4. Demonstrate area effects of hazard reduction		X	X	X	X	
5. Develop data visualization series			X	X	X	

SOUTHERN PINE BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Host-tree/insect interactions						
a. determine responses important to resistance to SPB attack and brood development in plantation-grown loblolly pine across a range of stand and site conditions	O	O	X			
b. mechanisms of tree response to attack and fungal inoculation	O	C				
2. Determine the role of natural enemies in the population dynamics of SPB						
a. determine which natural enemies cause substantial mortality of SPB						
1. numerical and functional response from clerids	C	X	X			
2. clerid SPB/IPS switching	C	X				
b. identify and isolate parasitoid host-detection cues	O	O				
c. determine seasonal dynamics of natural enemies	O	C				
3. Identify beetle characteristics (environmental or gentically-based) that indicate SPB population fluctuations.						
a. develop a continuous (artificial) rearing technique	O	O	X	X		
4. Investigate the role of symbiotic associates of SPB/beetle quality in SPB population dynamics.						
a. lipid-fungal associates	D	D				
b. effect on beetle of nematodes	O	C	X			
c. valid annosum/SPB associate	C					

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
5. Develop and improve technology to predict changes in insect populations in space and time.						
a. Winter biology-seasonal dynamics	C					
b. Movement model						
1. dispersal pattern	C					
2. SPB movement model	C	X	X			
3. definition of SPB population concentration around mass-attacked pine trees	C	X				
4. influence of tree spacing and composition on movement	C	X	X	X		
6. Investigate new prevention & suppression strategies using natural enemies, selective chemicals, and pheromones.						
a. impact of semiochemicals on SPB natural enemies	C					
B. Long Term Basic Research:						
1. Host-tree/insect interactions						
a. environmental conditions	O	O	X	X	X	X
2. Determine the role of natural enemies in the population dynamics of SPB						
a. determine which natural enemies cause substantial mortality of SPB - survey of natural enemy occurrence	O	O	X	X	X	
b. determine if natural enemies are responsible for the initiation or termination of SPB outbreaks	O	O	X	X	X	X
c. clerid dispersal		O				
3. Identify beetle characteristics (environmental or gentically-based) that indicate SPB population fluctuations.						
a. identify & determine heritability of characteristic attributes of endemic and epidemic populations	O	O	X	X	X	
b. determine the potential critical relationship of these attributes relative to SPB population dynamics	O	O	X	X	X	
4. Investigate the role of symbiotic associates of SPB/beetle quality in SPB population dynamics.						
a. explore bacterial/viral control	O	O	X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
5. Develop and improve technology to predict changes in insect populations in space and time.						
a. general bark beetle movement model	O	O	X	X	X	X
b. landscape level models	X	X	X	X	X	X
6. Investigate new prevention & suppression strategies using natural enemies, selective chemicals, and pheromones.						
a. identify and evaluate possible SPB biological control agents, include microbial agents and insect natural enemies	O	X	X	X	X	X
7. Evaluation of area-wide efficacy of direct control stategies		O	X	X		
C. Short Term Applied Studies:						
1. Develop and improve technology to predict changes in insect populations in space and time.						
a. modification of spot growth model	O	X				
b. clerid/SPB trap prediction scheme	O	C				
2. Validations						
a. control tactics	O	O	X			
b. prediction models	X	O	X			
3. Management tool						
a. ISPBEX II	C	X				
b. INFORMS	O	O				
c. CLEMBEETLE	O	O				
d. Pine Plantation Hazard Rating	C	C				
4. Investigate new prevention & suppression strategies using natural enemies, selective chemicals, and pheromones.						
a. use of host-based compounds for individual tree protection	O	O				
b. use of semiochemical-based tactics in remedial control						
1. antiaggregation chemicals for SPB	O	O	X			
2. SPB and behavioral chemicals	O	O				
3. push-pull spot strategy	O	C				
c. augmented feeding for parasitoids		O	X	X		

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
5. Use of selective chemicals for remedial control.						
a. evaluation of systemic chemicals for SPB control	X					
b. evaluation of synthetic pyrethroids for remedial control			X	X	X	X
6. Influence of RCW habitat management strategies on SPB populations	O	O	X			
D. Long Term Applied Studies:						
1. Validation						
a. SPB Demonstration Area Project	O	O	X	X	X	X
E. Operational Activities						
1. "How To" for semiochemical for suppression			X	X		
2. Use of aerial vieography to evaluate SPB in special management areas		O	X	X	X	
3. Management recommendtaions and guides based on results of SPB demonstration area.				X	X	X

SPRUCE BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Spruce Beetle Dispersal:						
a. How far do they fly?	CO	C				
b. How far is pheromone response effective?		X	X			
2. Anti & Aggregation Pheromones:						
a. Determine optimal release rates and temps.		O	X			
b. Geographic differences among spruce beetles	O	O	X	X		
c. Develop plume model	O	O				
B. Long Term Basic Research:						
1. Population dynamics & attack behavior of spruce beetle in Sitka spruce.		O	X	X	X	X
2. Effect of semiochemicals on non-target organisms		O	X	X		
3. Effect of semiochemicals on species diversity			X	X	X	X
4. Host resistance	O	O	X			
C. Short Term Applied Studies:						
1. Develop Hazard & Risk Models for Sitka spruce	CO	C				
2. MCH Evaluations:						
a. Aerial--dose, formulation	C	X	X			
b. Bubble caps--dose, formulation	O	O	X			
c. Individual tree protection	O	O	X	X		
3. Competitor species pheromone						
a. Use with & without MCH	O	O				
b. Aerial/ground--dose, form.			X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
D. Long Term Applied Studies:						
1. Aggregation pheromones:						
a. Population monitoring--# of traps, trap placement	C					
b. Trapout--release rates, trap placement	C					
2. Silvicultural treatments:						
a. Uneven-aged management			X	X	X	X
b. Thinning and pruning	O	O	X	X	X	X
c. Fertilization	C	CO	X	X	X	X
3. Modeling integration:						
a. Loss & Impact Predictions	C	CO	X	X	X	X
b. Obtain rec. & aesthetic impact info	C	X	X	X	X	X
c. Wildlife habitat impact info	O	O	X	X	X	X
d. Growth & Yield Models	X	X	X	X	X	X
E. Operational Activities:						
1. Demonstration areas:						
a. Thinning	C	CO	X	X	X	X
b. Bait & Cut		X	X	X		
2. "How to" series of pubs.		O	X	X		
3. "Best Management Practices" Guidelines		O	X	X	X	X

DOUGLAS-FIR BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Dispersal of MCH and related material						
a. Dispersal and fate in air	O	O				
b. Release characteristics of dispensors	O	O				
2. Dispersal Patterns of DF beetle	O	O	X			
B. Long Term Basic Research						
1. Population dynamics						
a. Factors predisposing trees to attack	O	O	X	X	X	
b. Fungi associated with beetle damage	O	O	X	X	X	
c. Natural enemies of DFB	O	O	X			
C. Short Term Applied Studies						
1. Test MCH						
a. Test beads for green tree protection	D	X				
b. Test MCH bubble caps for:						
standing green trees - eastside	O	CO	X			
down trees - westside			X	X		
standing green trees - westside			X	X	X	X
c. Develop improved formulation			X	X	X	
d. Effects of MCH on non-target animals		X	X	X		
2. Test mitigants such as MCH in coastal area			X	X	X	
3. Determine usefulness of new attractants	C	CO				
4. Develop hazard/risk rating models.	O	O	X	X		
5. Test methods for individual tree protection	O	O				
6. Develop methods for population monitoring	O	O	X			

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
D. Long Term Applied Studies						
1. Silvicultureal Treatment for management of uneven aged stands		X	X	X	X	
E. Operational Activity						
1. Literature search		X	X			
2. Popular article			X	X		
3. Forest Insect Pest Leaflet up-date				X	X	
4. Up-date on DFB management "How To"			X	X	X	
5. Register MCH with EPA	O	O	X			
6. Establish demonstration areas to demonstrate management using MCH		O	X	X	X	

FIR ENGRAVER
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Isolate, identify, synthesize pheromone complex	X	D*				
2. Field bioassay candidate compounds		D*				
3. Determine geographic variation to pheromones		D*				
B. Long Term Basic Research:						
1. Dispersal- How far do beetles fly?			X	X	X	X
2. Primary attraction behavior			X	X	X	X
3. Host/insect/pathogen interaction						
a. root diseases	X	X	X	X	X	X
b. localized defect due to beetle attack			X	X	X	X
4. Interaction of beetle attacks on triggering latent infections of Indian paint fungus	X	X	X	X	X	
5. Effects of semiochemicals on natural enemies			D*			
6. Effect of fir engraver caused tree mortality on threatened and endangered species habitat	X	X	X	X	X	X
7. Effect of fir engraver caused tree mortality on creating and maintaining critical and unique wildlife habitat	X	X	X	X	X	X
8. Use of synomones to prevent attack				X	X	X
C. Short Term Applied Studies:						
1. Develop hazard rating system for grand fir/Inland Empire			X	X	X	
D. Long Term Applied Studies:						
1. Develop various semiochemical based management strategies for population manipulation			D*			
2. Area management of fir engraver			X	X	X	
3. Test trap-out strategy			D*			
4. Develop silvicultural treatments						
a. effect of timing of thinning			X	X	X	X
. Develop pheromone based monitoring system			D*			

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
E. Operational Activities:						
1. Develop How to's						
a. Hazard rating systems for California, white & red fir		X	X			
b. Hazard and risk rating systems for Inland Empire.			X	X	X	
2. Silvicultural Treatments						
a. Hazard reduction	X	X	X	X	X	X
b. Sanitation/Salvage	X	X	X	X	X	X
c. Use of trap trees			X	X	X	X

Research has determined there is no identifiable attractant pheromone for fir engraver so all activities relating to testing or using the pheromone have been dropped.

ARIZONA FIVE SPINED IPS
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Identify bait	X	X	X	X		
2. Identify antiaggregant	X	X				
B. Short Term Applied Research:						
1. Determine optimum bait blend		X	X			
2. Determine optimum bait release rate			X			
3. Determine flight periodicity				X	X	
4. Determine optimum antiaggregant blend				X	X	
5. Determine optimum antiaggregant release rate				X	X	
C. Long Term Applied Studies:						
1. Determine outbreak triggers		X	X	X	X	X
2. Determine relationships with stand factors		X	X	X	X	X
3. Develop hazard rating system			X	X		
D. Operational Activities:						
1. Evaluate effectiveness of baited slash in trap-out strategy				X	X	X
2. Evaluate effectiveness of anti-aggregrant in protecting slash piles					X	X
3. Validate and modify slash disposal recommendations	O	O	X			

CALIFORNIA FIVESPINED IPS
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Determine geographic variation in response to established aggregation and antiaggregation pheromones		C				
2. Determine response of natural enemies to various pheromones of the CFIB	X	C				
B. Long Term Basic Research:						
1. Determine the effects of semiochemical based management strategies on the natural enemy complex		X	X	X	X	X
2. Dispersal- How far do beetles fly?	X	X	X	X	X	X
3. Interaction between CFIB and pine engraver via semiochemicals		C				
C. Short Term Applied Studies:						
1. Test efficacy of semiochemical based management strategies on prevent CFIB build-up in slash	O	C	X	X	X	
2. Test efficacy of a combination of semiochemical based management strategies to prevent build-up of CFIB and pine engraver simultaneiously	O	O	X	X		
D. Long Term Applied Studies h:						
1. Develop pheromone based monitoring system		X	X	X	X	X
E. Operational Activities:						
1. Operation test of antiaggregation efficacy for preventing build-up of ips beetles in slash.				X	X	X

IPS PINI
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. I. pini dispersal:						
a. How far do they fly?			X	X		
b. How far is the pheromone response effective?			X	X		
c. Determine flight periodicity	O	O	X	X		
B. Long Term Basic Research:						
1. Aggregation pheromone blends:						
a. pheromone components	X	C	X	X	X	
b. geographic variation	X	O	X	X	X	
2. Antiaggregation pheromone blends of associated species:						
a. pheromones of different species	X	C	X	X	X	
b. enantiomers	O	O	X	X	X	X
c. geographic variation		O	X	X	X	X
3. Fate of applied semiochemicals in the environment.			D			
4. Determine impact of feeding attacks.			X	X	X	X
5. Determine live host selection behavior			X	X	X	X
6. Effect of drought on live tree susceptability			X	X	X	X
C. Short Term Applied Studies:						
1. Continue development of antiaggregants to prevent attack of slash by I. pini.						
a. Improve bead formulations			X	X	X	X
b. Evaluate bubble caps	O	O	X	X		

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
D. Long Term Applied Studies						
1. Development /document silvicultural strategies.						
a. Timing of creation of slash	O	O	X	X	X	
b. Use of trap trees/slash(green chain)				X	X	
c. Use of prescribed fire on overwintering adult populations			X	X	X	
d. Effects of overstory density on brood production in slash (Arizona)	O	C				
e. Development of a Hazard/Risk rating system			X	X	X	X
2. Models:						
a. Loss and impact predictions				X	X	X
b. Insect phenology/population dynamics				X	X	X
3. Beneficial role of Ips populations in reducing stand basal area					X	X
E. Operational Activities:						
1. "How to"(Public use) series publications Work for Az and NM completed			X	X	X	X
2. "Best Management Practices" Guidelines, update			X	X		

IPS PERTURBATUS
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Ips beetle dispersal:						
a. How far do they fly?	C					
b. Do they fly across openings?	C					
2. Antiaggregation pheromones:						
a. Release rates of ipsenol and methyl butenol (beads & caps)	O	C				
3. Determine characteristics of overwintering sites	X	X				
B. Long Term Basic Research:						
1. Effects of semiochemicals on non-target organisms			X	X	X	
2. Effect of semiochemicals on species diversity			X	X	X	X
3. Interrelationship between spruce beetle and Ips			X	X	X	
4. Effect of budworm defoliation and Ips attack	O	C	X	X	X	
5. Effect of ice/snow breakage on Ips population buildup		O	X	X		
C. Short Term Applied Studies:						
1. Effect of ipsdienol on parasites & predators	O	O	D-to be dropped in 96			
2. Evaluate efficacy of anitaggregants on Ips populations	O	C				
3. Develop hazard and risk models for white spruce			X	X		

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
4. Effects of prescribed fire on over-wintering populations in leaf litter of cutover areas				X	X	
D. Long Term Applied Studies:						
1. Silvicultural treatments:						
a. Even-aged/unevenaged management				X	X	X
b. Thinning	X	X	X	X	X	X
c. Fertilization			X	X	X	X
2. Models:						
a. Loss and impact predictions				X	X	X
b. Growth and yield models				X	X	X
3. Role of Ips beetle activity on white spruce ecosystem stability			X	X	X	X
4. Beneficial role of Ips populations in reducing stand basal area			X	X	X	X
E. Operational Activities:						
1. Demonstration areas:						
a. Thinning		X	X	X	X	X
b. Fertilization		X	X	X	X	X
2. "How to" series publications		C	X	X	X	
3. "Best Management Practices" Guidelines		X	X	X	X	

WESTERN BALSAM BARK BEETLE
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Biology						
a. Life history		O	X	X	X	X
- Life cycles						
- Geographic & elevational influences on development						
- Attack densities & pattern						
- Brood sizes						
- Symbiotic fungal associations						
- # of generations						
- Re-emergence patterns						
- Hosts						
- Insect associations						
b. Adult flight	O	O	X	X		
- Periodicity						
- Distances						
- Dispersal						
- Orientation						
2. Pheromones						
a. Aggregants						
- How far is response effective			X	X	X	
b. Antiaggregants						
- Define			X	X		
B. Long Term Basic Research:						
1. Biology						
a. Predators & Parasites			X	X	X	X
- Define						
- Effect						

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
2. Host/WBBB Interactions						
a. Root disease associations	O	O	X	X	X	X
b. Habitat type associations			X	X	X	X
c. Climate/weather associations			X	X	X	X
d. Host response to attack			X	X	X	X
e. Susceptibility to attack			X	X	X	X
- tree size						
- tree age						
- stand density						
- stand damage						
C. Short Term Applied Studies:						
1. Treatments						
a. Increase stand vigor & susceptibility to attack through fertilization.			X	X	X	
b. Thinning	X	X	X	X	X	
c Pruning		O	X	X	X	
d. Insecticides			X	X	X	
- Identify						
- Develop application techniques						
2. Pheromones						
a. Mode of application -						
- Aggregants			X	X	X	
- Antiaggregants					X	X
b. Strategies for population management.						
- Trap out			X	X	X	
- Lethal traps			X	X	X	
- Bait & cut			X	X	X	
c. Population monitoring		D				
3. Impacts						
a. Economic				X	X	
b. Changes in stand density			X	X	X	
c. Changes in species comp.			X	X	X	
d. Changes in snow retention				X	X	X
D. Long Term Applied Studies:						
1. Develop hazard rating scheme				X	X	X
2. Develop silvicultural techniques to reduce stand hazard				X	X	X
3. Model development					X	X
4. Expert system					X	X

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
E. Operational Activities:						
1. "How to" series of publications			X	X	X	X
2. Sanitation/Salvage methodology			X	X	X	X
3. Trap trees			X	X	X	
4. Hazard tree removal			X	X	X	X
5. Insecticide treatment individual tree protection				X	X	X
6. Silvicultural treatments				X	X	X
7. Bait & cut strategies				X	X	X
8. Data Visualization Series			X	X	X	X

TOMICUS PINIPERDA
5 Year Strategy

	YEAR SCHEDULED					
	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
A. Short Term Basic Research:						
1. Life History of *T. piniperda* in the United States						
a. Overwintering behavior	O	CO	X			
b. Flight activity/periodicity	O	CO	X			
c. Reproduction, brood development, and re-emergence	O	CO	X			
d. Identify fungal associates	O	CO				
e. Determine internal pathogens	O	D	X			
f. Determine predators & parasites	O	O	X			
g. Determine within-tree attack pattern.	O	CO				
h. Determine survival in cut Christmas trees	O	CO	X			
2. Life history of the exotic clerid *Thanasimus formicarius* in the United States						
a. Import clerid from Europe		O	X			
b. Develop lab rearing techniques		O	X	X		
c. Determine impact on non-target native scolytids			X	X	X	
d. Determine impact on non-target native natural enemies			X	X	X	
e. Potentially field release and monitor				X	X	
B. Long Term Basic Research:						
1. Life History of *T. piniperda*						
a. Determine host-selection behavior	O	CO	X	X	X	X
b. Determine interactions with native bark beetles	O	CO	X	X	X	X
c. Determine dispersal potential		CO		X	X	X
d. Determine genetic similarity among different US sub-populations	O	CO	X	X	X	
2. Evaluate Ability to Shoot-feed and Reproduce in Native Conifers						
a. Describe shoot-feeding behavior in Scotch pine and native conifers	O	CO	X	X		
b. Describe reproduction in Scotch pine and native conifers	O	CO	X	X		
c. Describe ability to attack and kill live North American conifers			X	X	X	

	(94) 1	(95) 2	(96) 3	(97) 4	(98) 5	(98+) 5+
C. Short Term Applied Studies:						
1. Develop Survey/Trapping Methodologies						
a. Determine attraction to alpha-pinene	O	D				
b. Determine radius of attraction of alpha-pinene lures		D	X			
c Develop use of trap trees as a survey tool		O	X	X		
d. Develop methods to estimate population levels using shoot-feeding damage		D	X	X		
2. Develop Control Tactics						
a. Develop methods to prevent within and between-stand spread	O	O	X	X		
b. Determine effectiveness of insecticides for control	O	O	X			
c. Determine effectiveness of chipping and tarping for control	O	D	X			
d. Determine effectiveness of verbenone	O	D	X	X		
e. Evaluate shoot feeding behavior for timing nursery stock shipment	O	D				
f. Determine effect of methyl chavicol	O	D				
D. Long Term Applied Studies:						
1. Develop Impact Studies	O	O	X	X	X	
2. Develop Silvicultural Strategies						
a. Timing of logging operation	O	O	X	X	X	
b. Slash treatment	O	O	X	X	X	
c. Use of trap trees	O	O	X	X	X	
d. Handling methods for infested logs		D	X	X	X	
E. Operational Activities:						
1. Develop Best Management Practices		O	X	X	X	
2. Develop "How To" publications			X	X	X	
3. Produce slide/tape series			X	X	X	
4. Develop a compliance program		O	X	X		