

Pheromone Flakes: Semiochemical Sabotage of Bark Beetles

Nancy Gillette

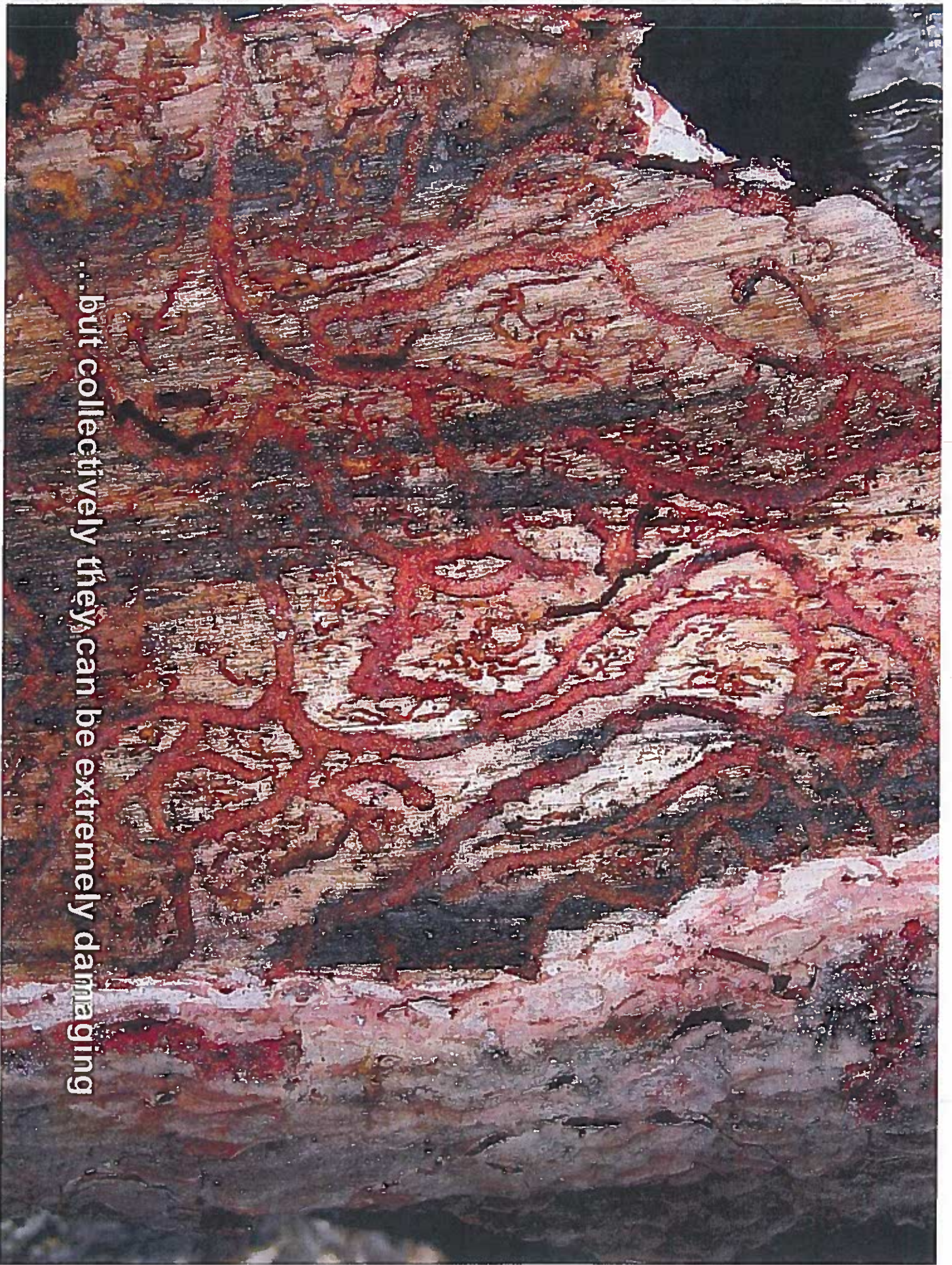
PSW Research Station

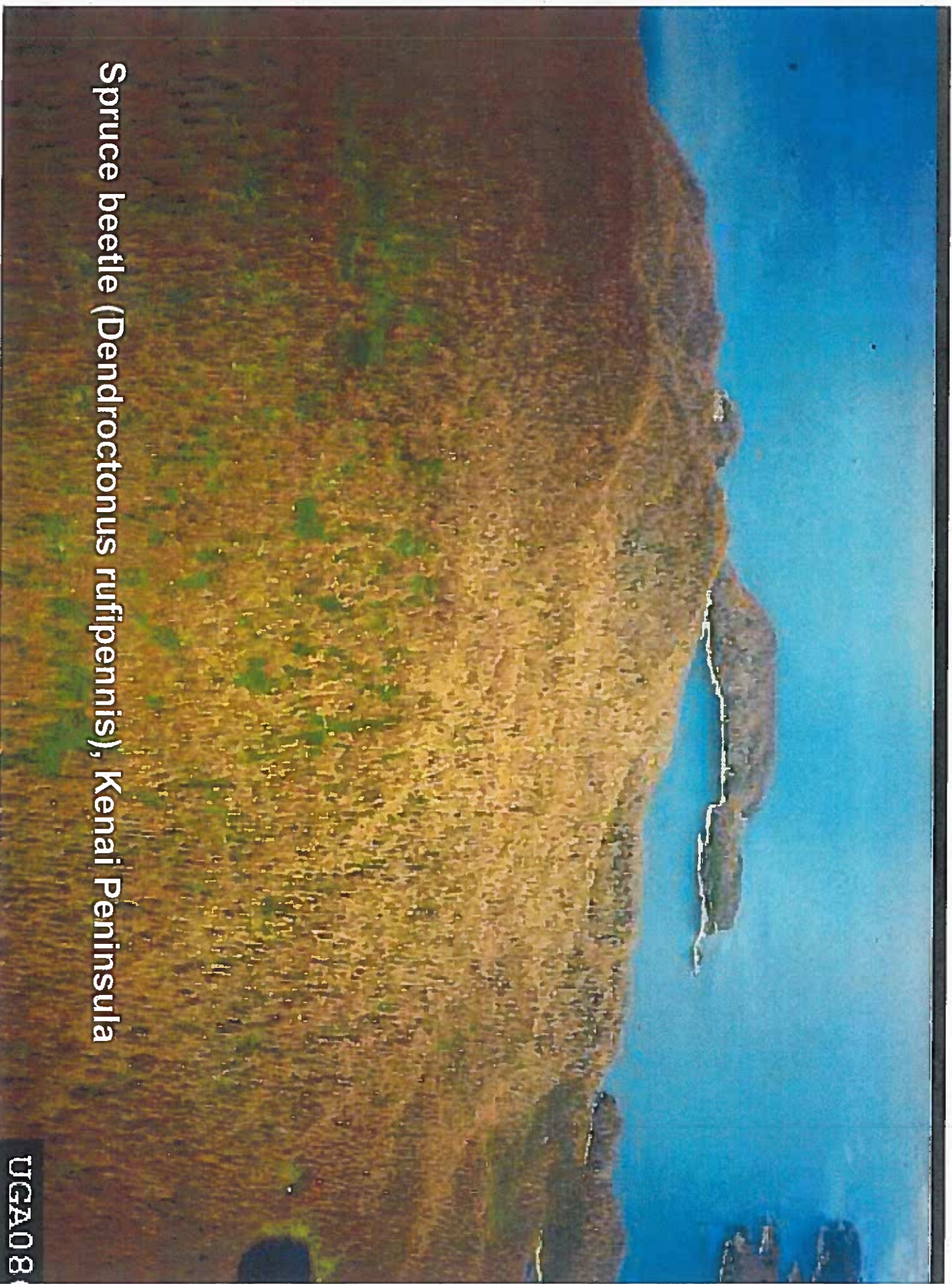
USDA Forest Service, Berkeley, CA



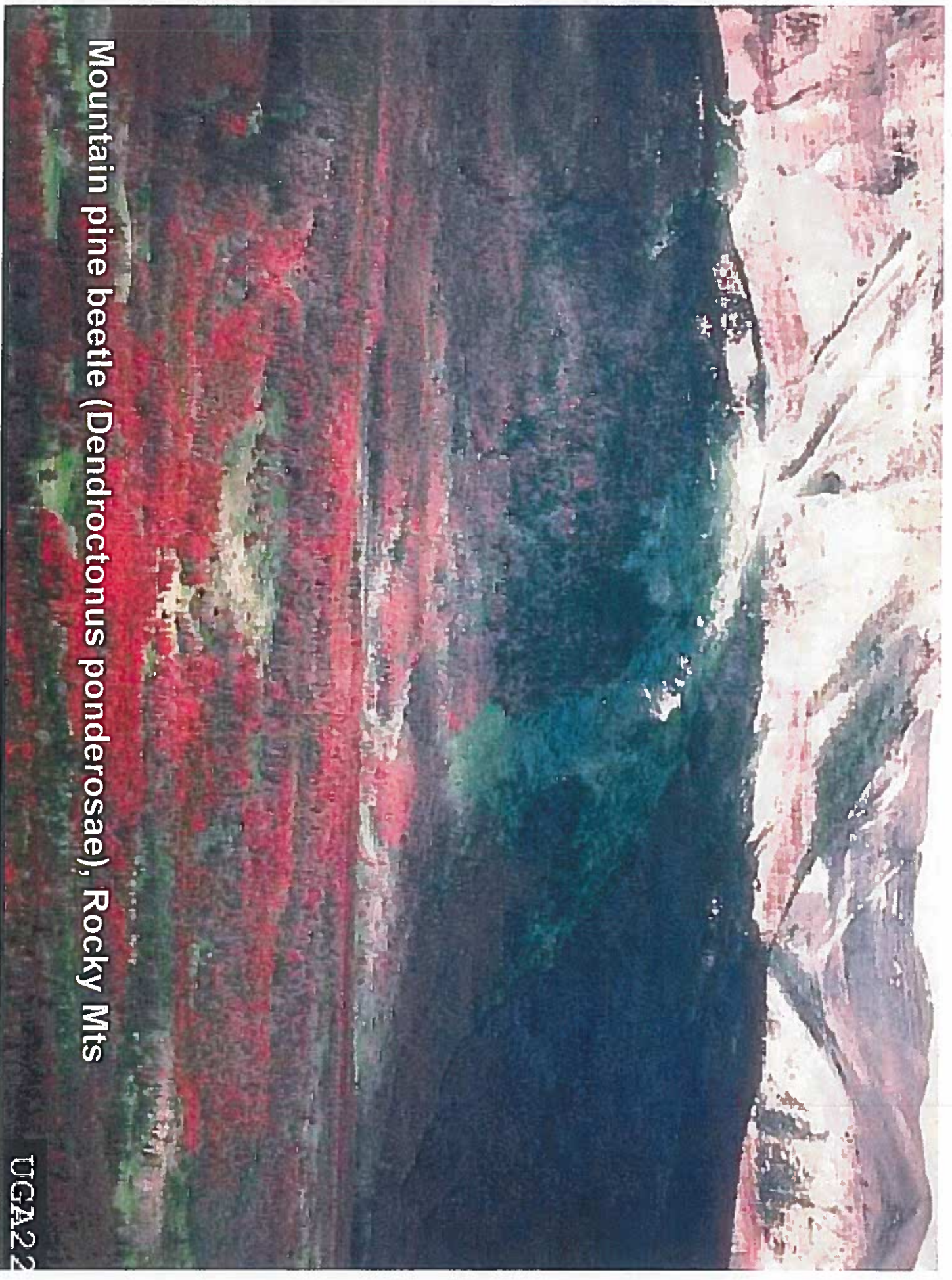
Dendroctonus spp. bark beetles are small...

...but collectively they can be extremely damaging



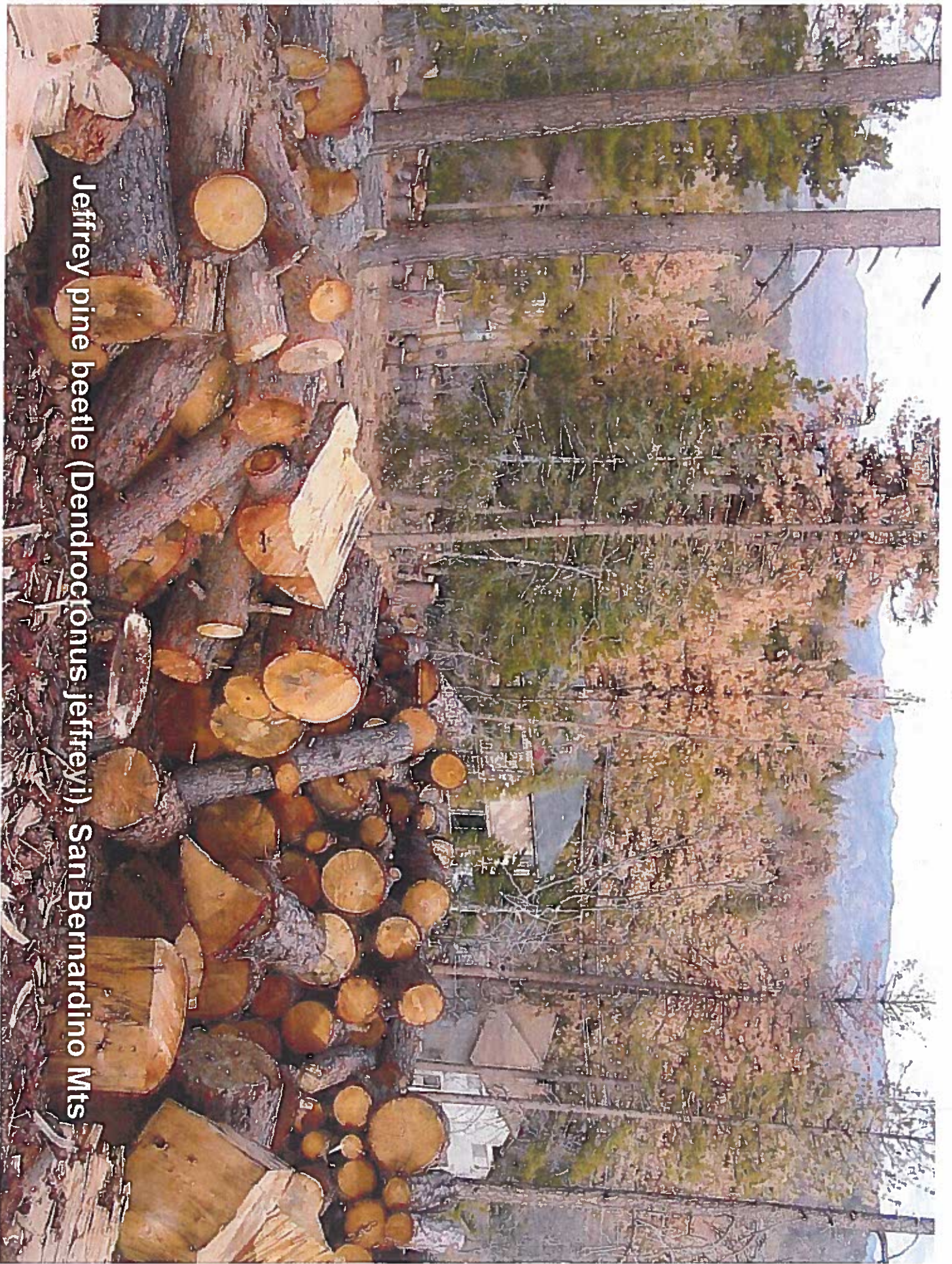


Spruce beetle (*Dendroctonus rufipennis*), Kenai Peninsula



Mountain pine beetle (*Dendroctonus ponderosae*), Rocky Mts

UGA22



Jeffrey pine beetle (*Dendroctonus jeffreyi*), San Bernardino Mts

Past attempts at control

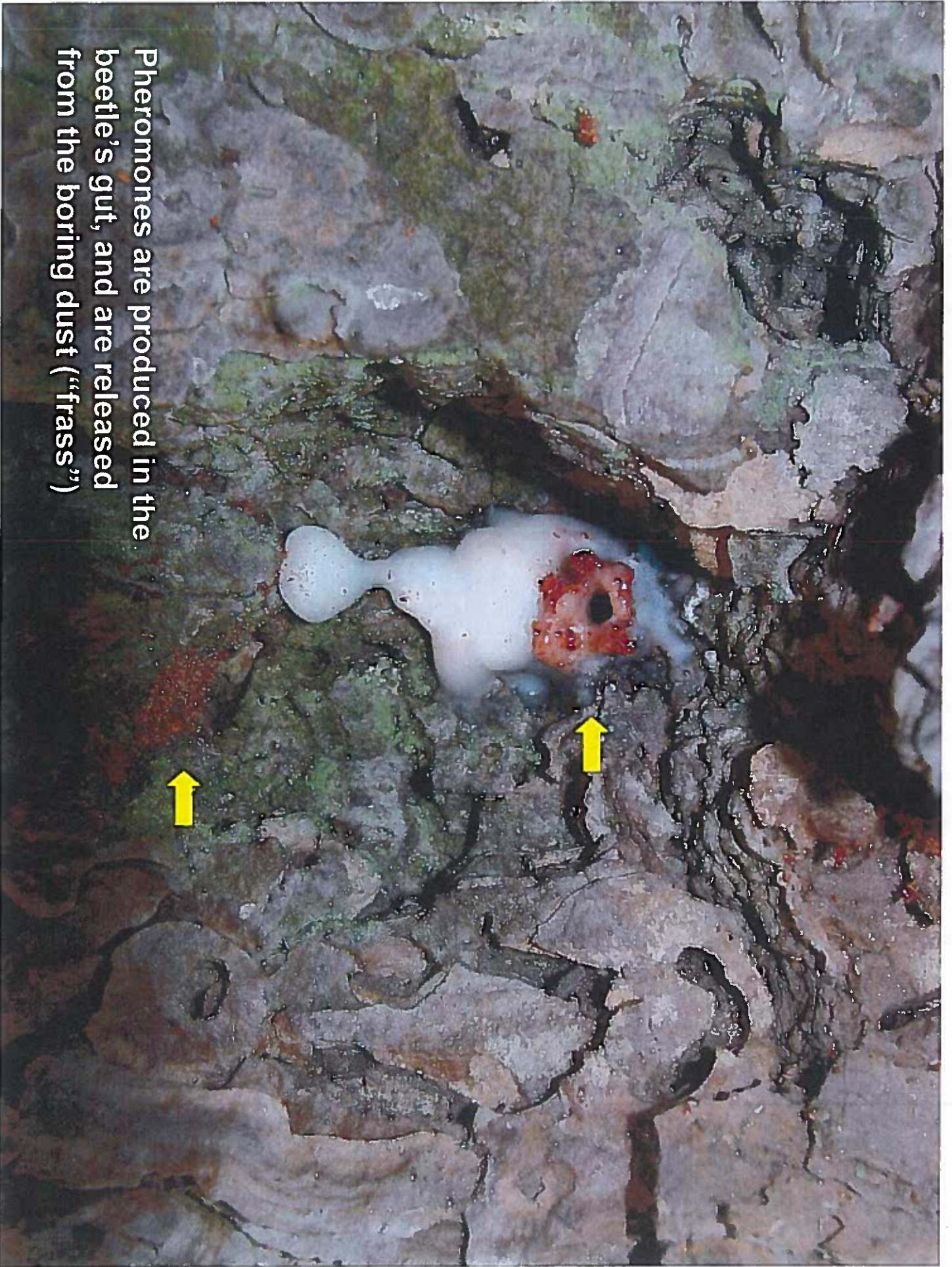
- Insecticides
- Silviculture *****
- Electrocution
- Dynamite
- Microwaves
- Liquid nitrogen
- Heat
- Biological control
- Semiochemicals *****

(***** = most promising for area-wide use)

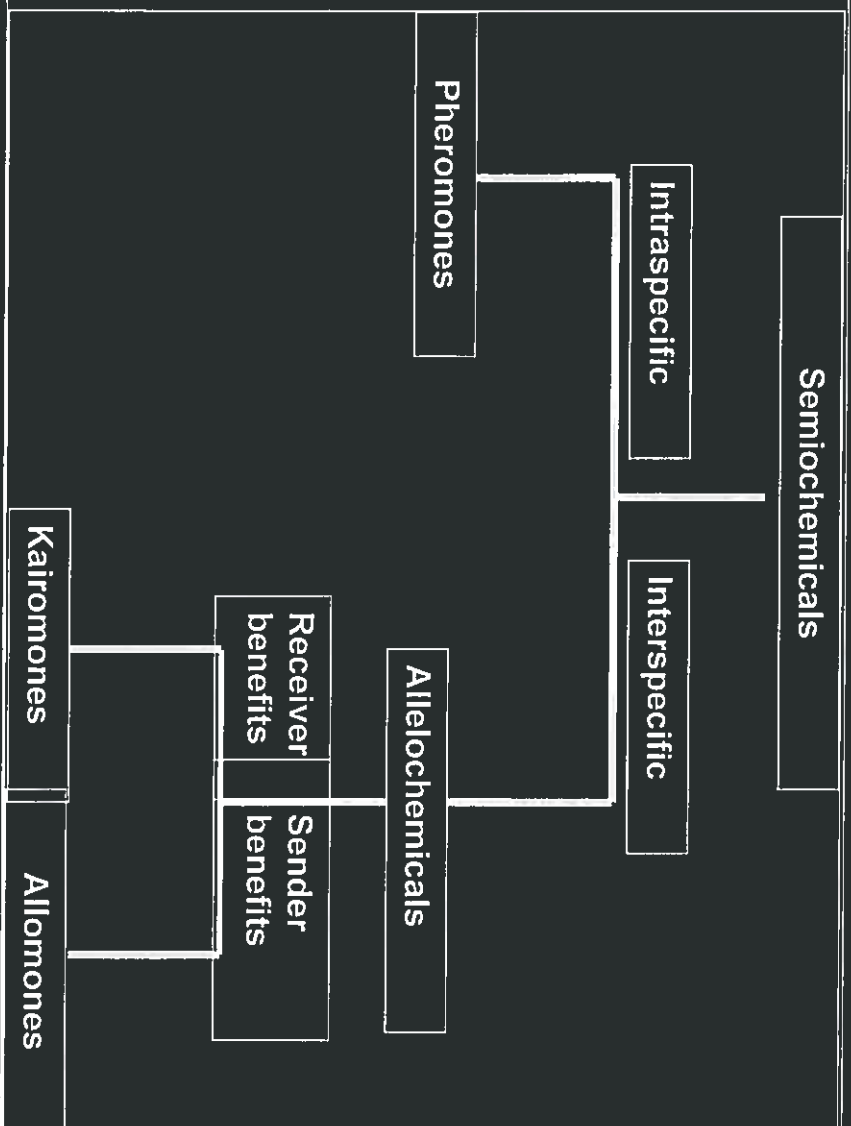
Bark beetle colonization of host

- Mountain pine beetles must overcome tree's defenses.
- "Pioneering females" produce aggregation pheromone.
- When tree colonized, they produce antiaggregation pheromone ("no vacancy" signal).
- Antiaggregation pheromone ends attack on that tree.
- VBN and MCH are antiaggregation pheromones

Pheromones are produced in the beetle's gut, and are released from the boring dust ("frass")



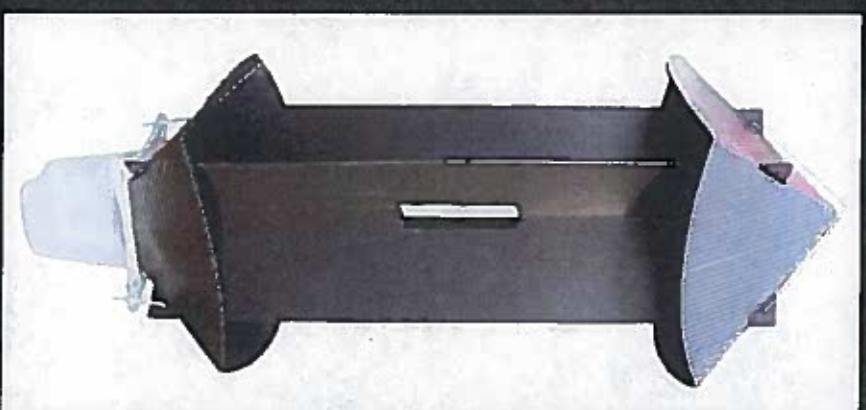
Semiochemical terminology



Semiochemical-based strategies

- “Pull” (trap-out using attractants, including trap-trees and attract-and-kill).
- “Push” (repel, interrupt, or inhibit aggregation and/or host location).
- “Push-pull” (combined strategy, with attractive pheromone at perimeter, repellent pheromone in center of stand).

Traps for trap-out, monitoring



Contech (Pherotech) Int.

Aptiv, Inc.

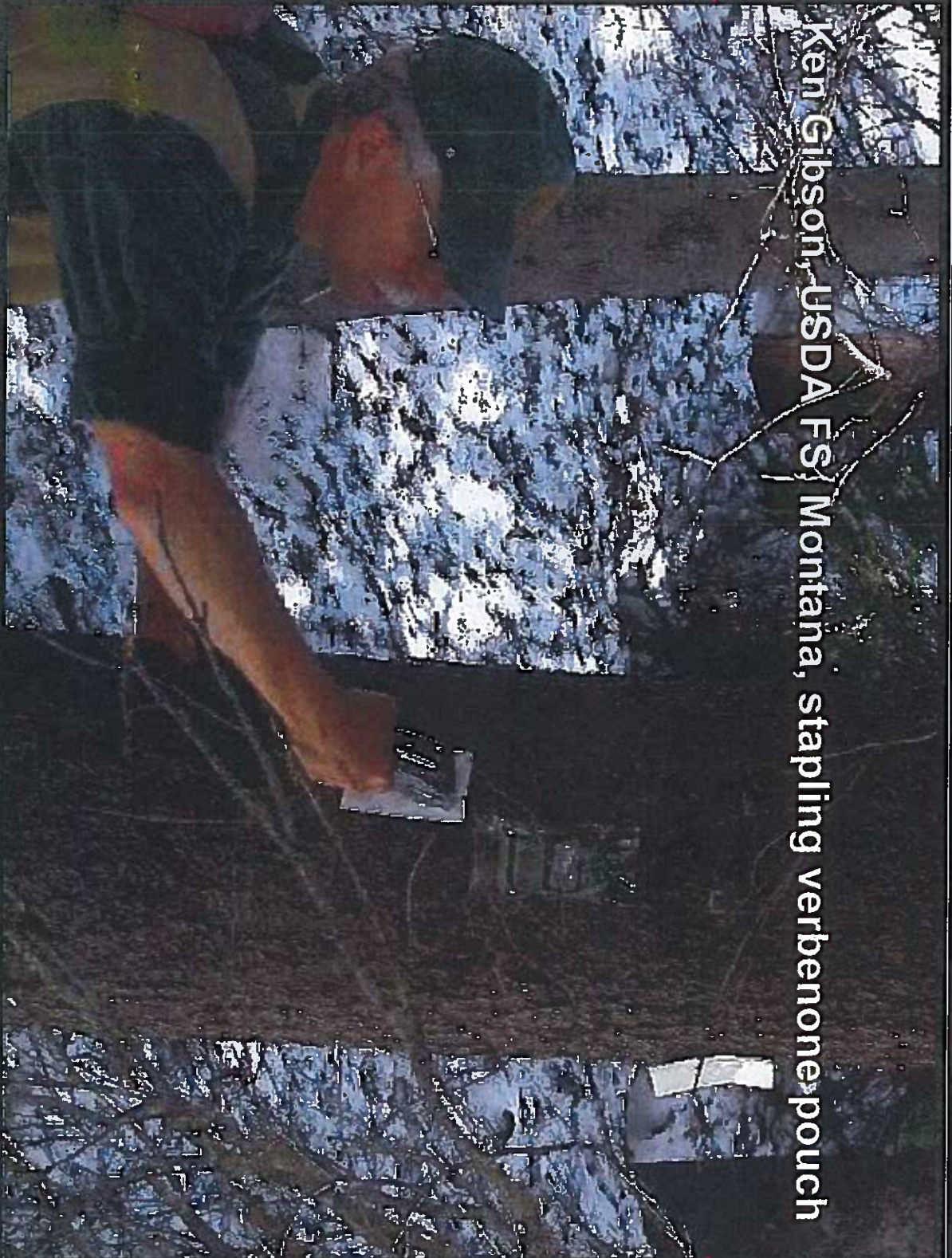
Bubblecap and pouch lures



Synergy Semiochemicals



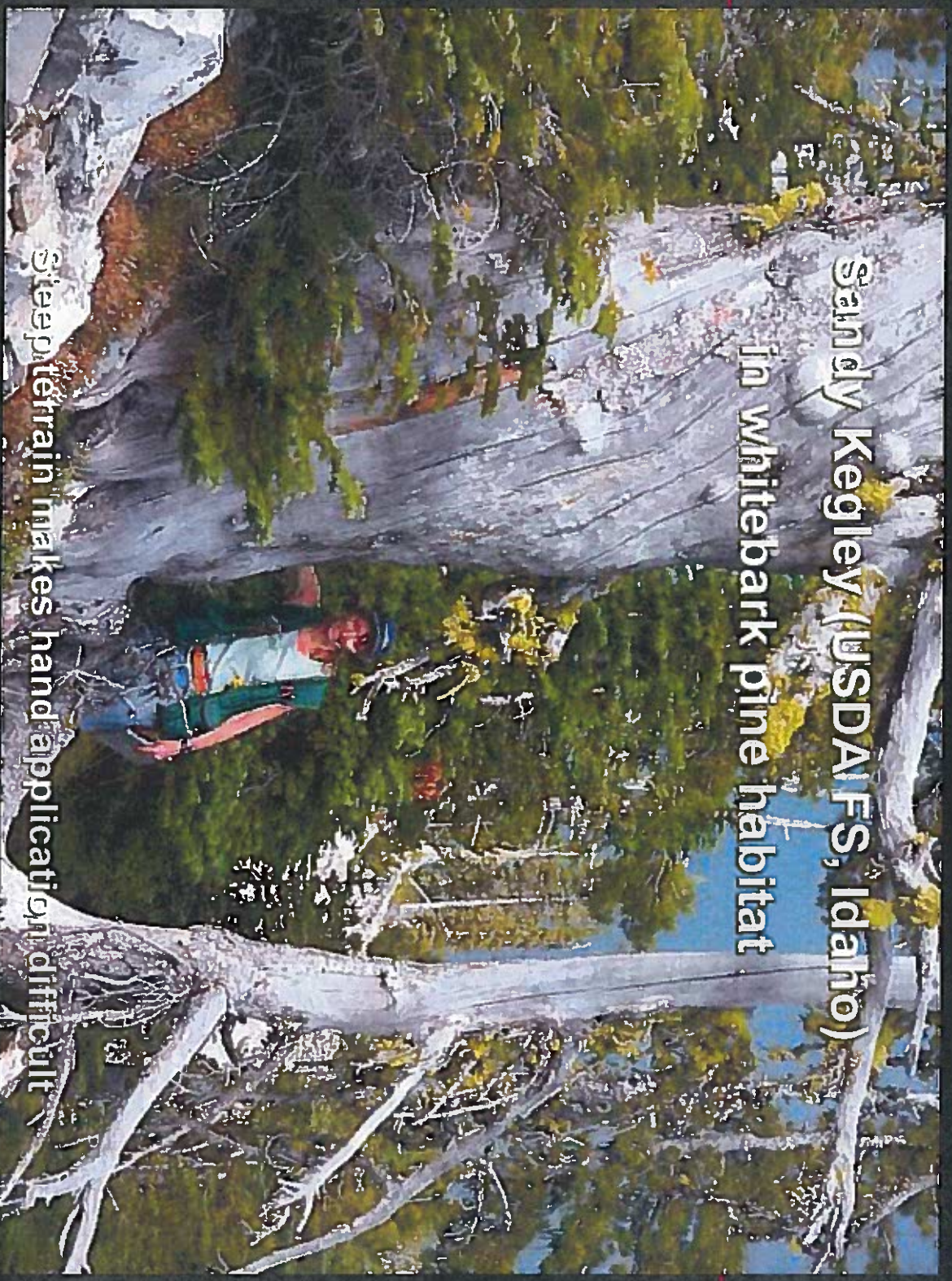
Ken Gibson, USDA FS, Montana, stapling verbenone pouch



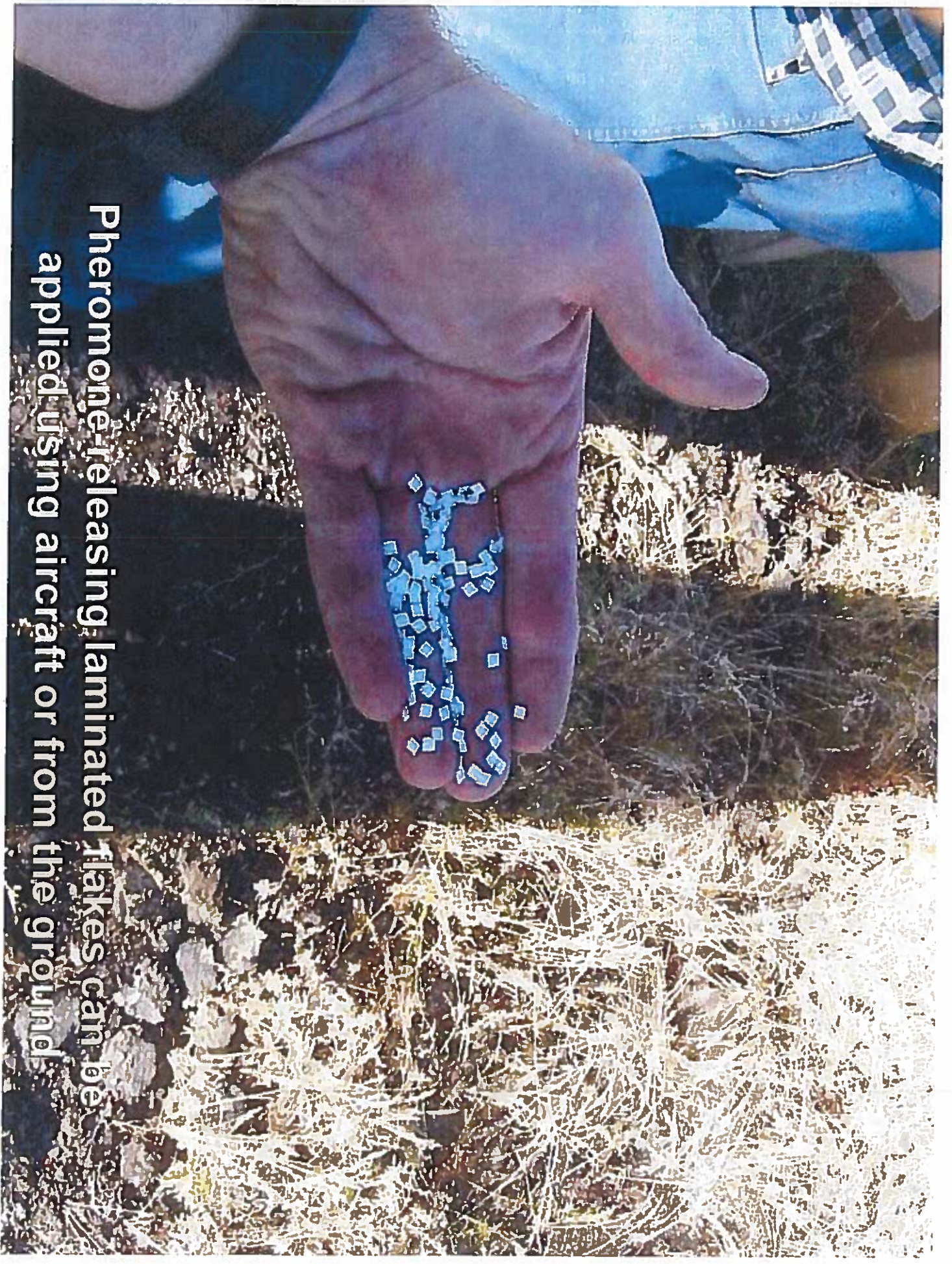
Challenges in western North America

- Steep terrain (worker safety)
- Otherwise inaccessible terrain (distance, road conditions)
- Difficulty of timely applications over large areas

**Sandy Kegley (USDA/FWS, Idaho)
in whitebark pine habitat**



Steep terrain makes hand application difficult



Pheromone-releasing laminated flakes can be applied using aircraft or from the ground.

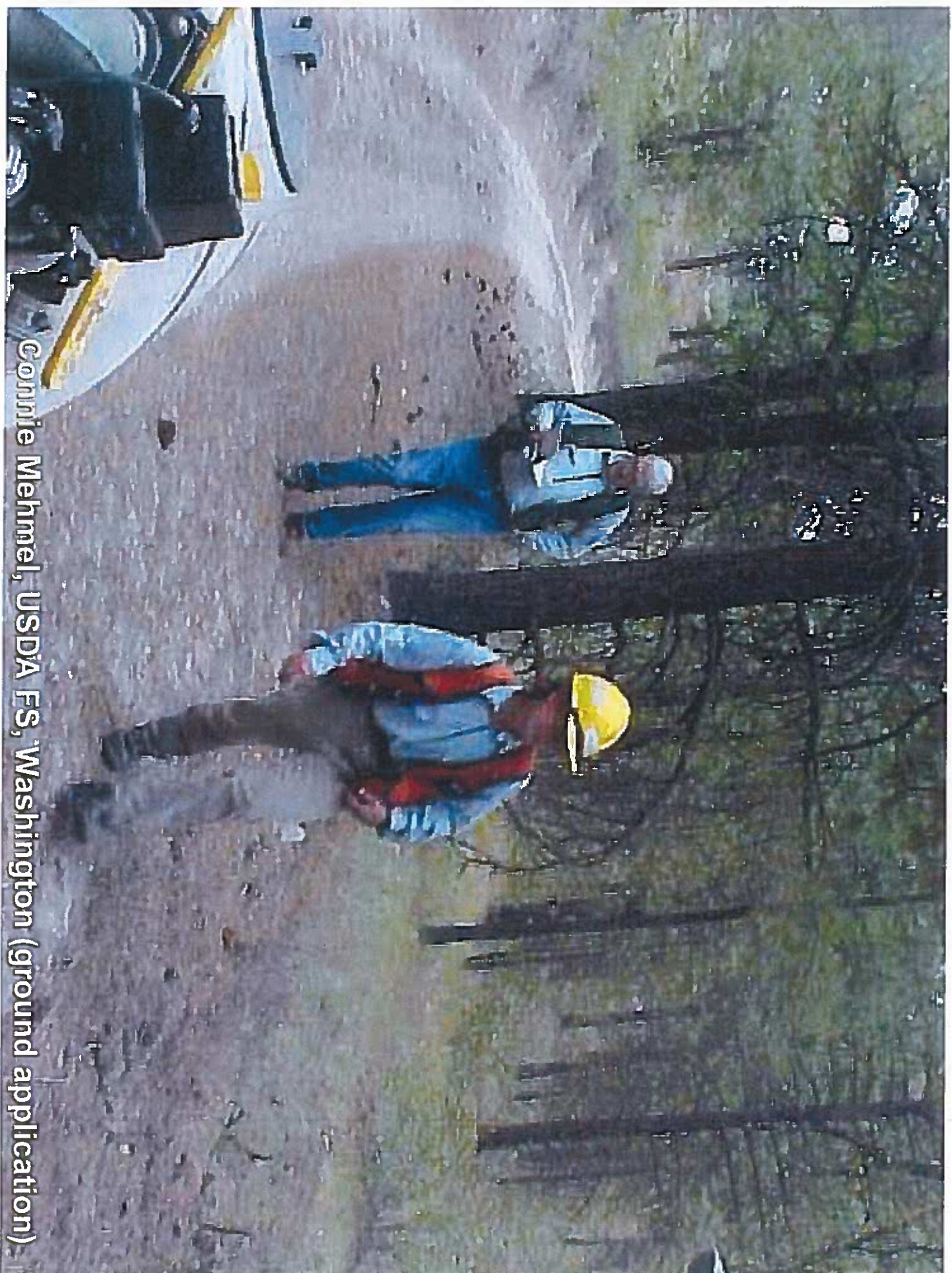
Verbenone and Methylcyclohexenone

Tests of laminated flakes

- **VBN: Mountain pine beetle**
 - Whitebark pines, simulated aerial application
 - Lodgepole pines, aerial application and individual tree (ground) application
- **MCH: Douglas-fir beetle**
 - Douglas-fir, aerial application

Individual tree protection test

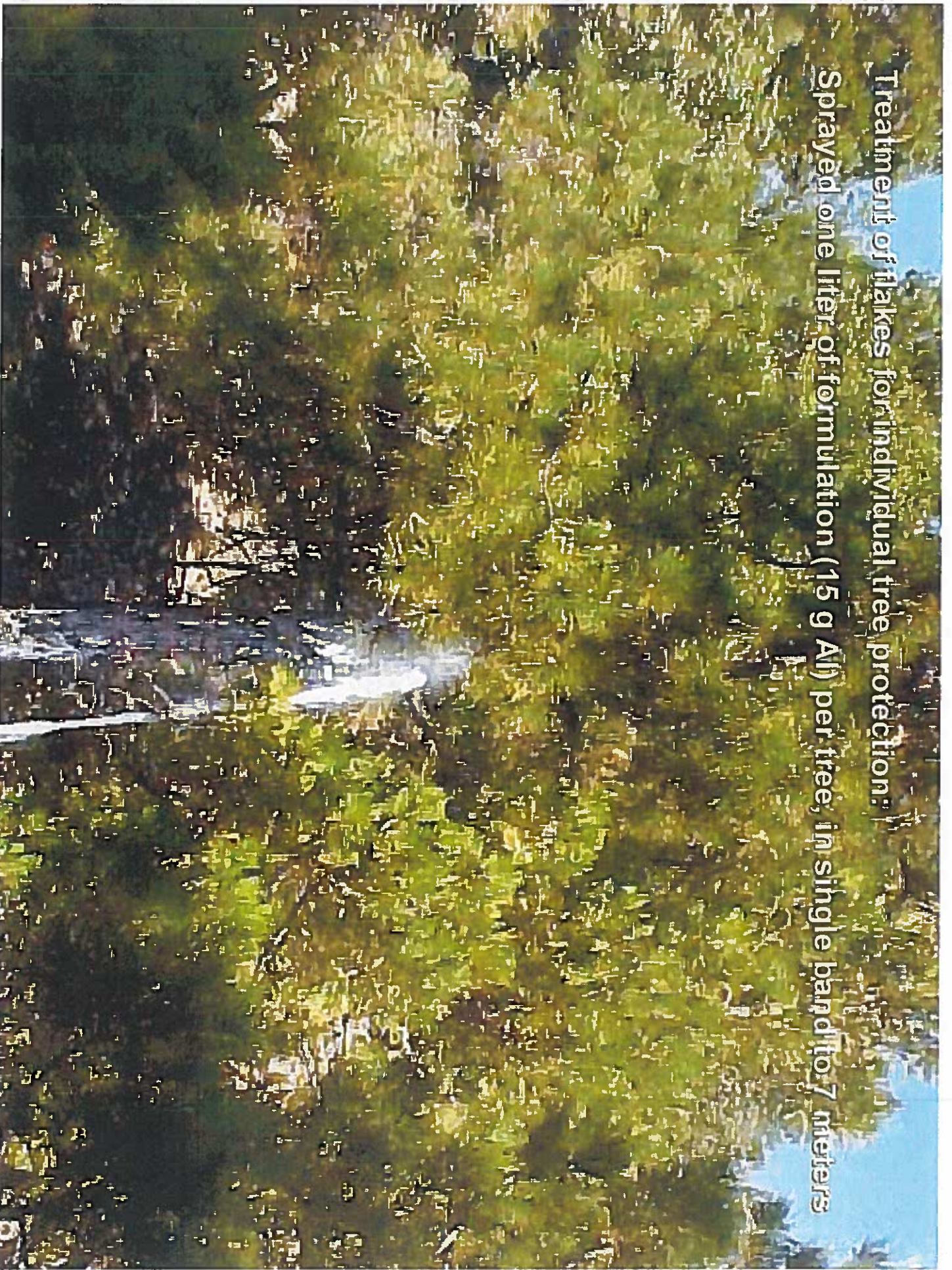
Application made to trunks of
individual, high-value trees



Connie Mehmel, USDA FS, Washington (ground application)

Treatment of flakes for individual tree protection:

Sprayed one liter of formulation (15 g AlI) per tree, in single band 1 to 7 meters





Verbenone flakes on pine bark.

Twenty treated trees, twenty controls.

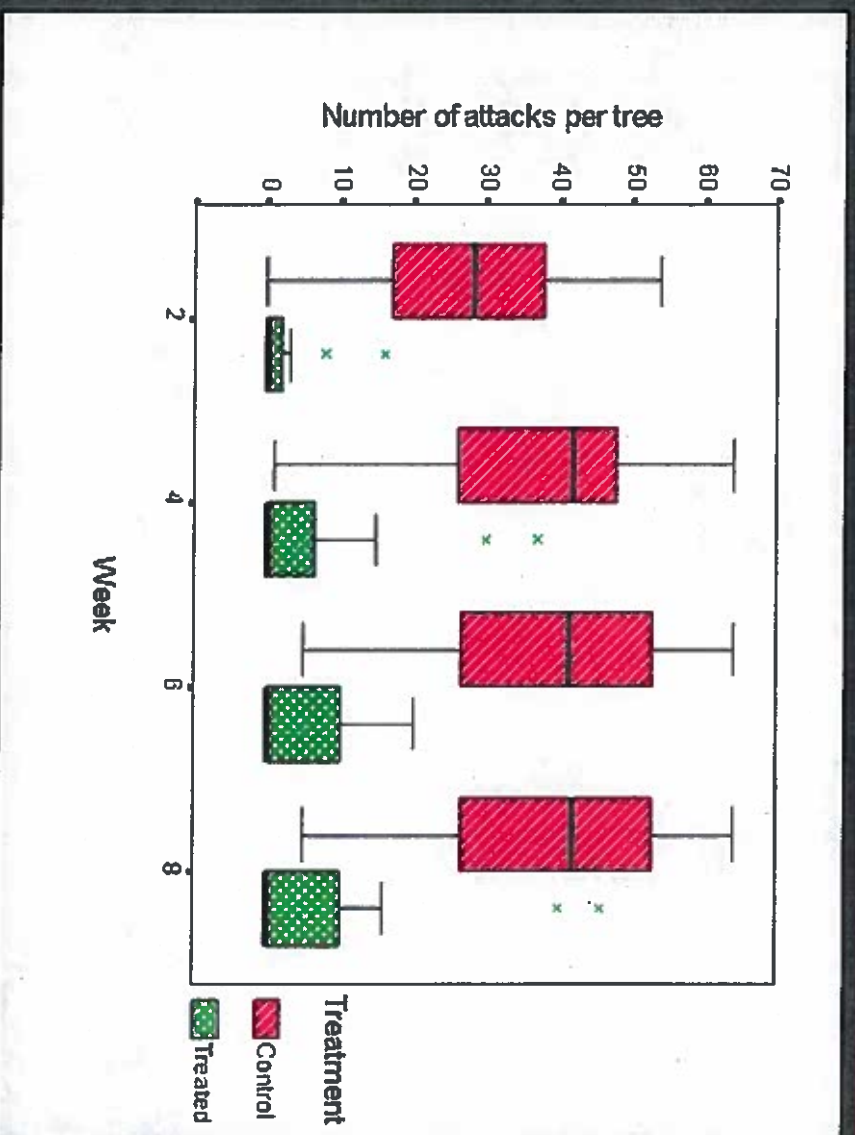
Application was made using guar gum and Gelva as stickers.

Flakes adhered well for at least 8 weeks following application.

Trees were baited with aggregation pheromone immediately following application to challenge repellency of flakes

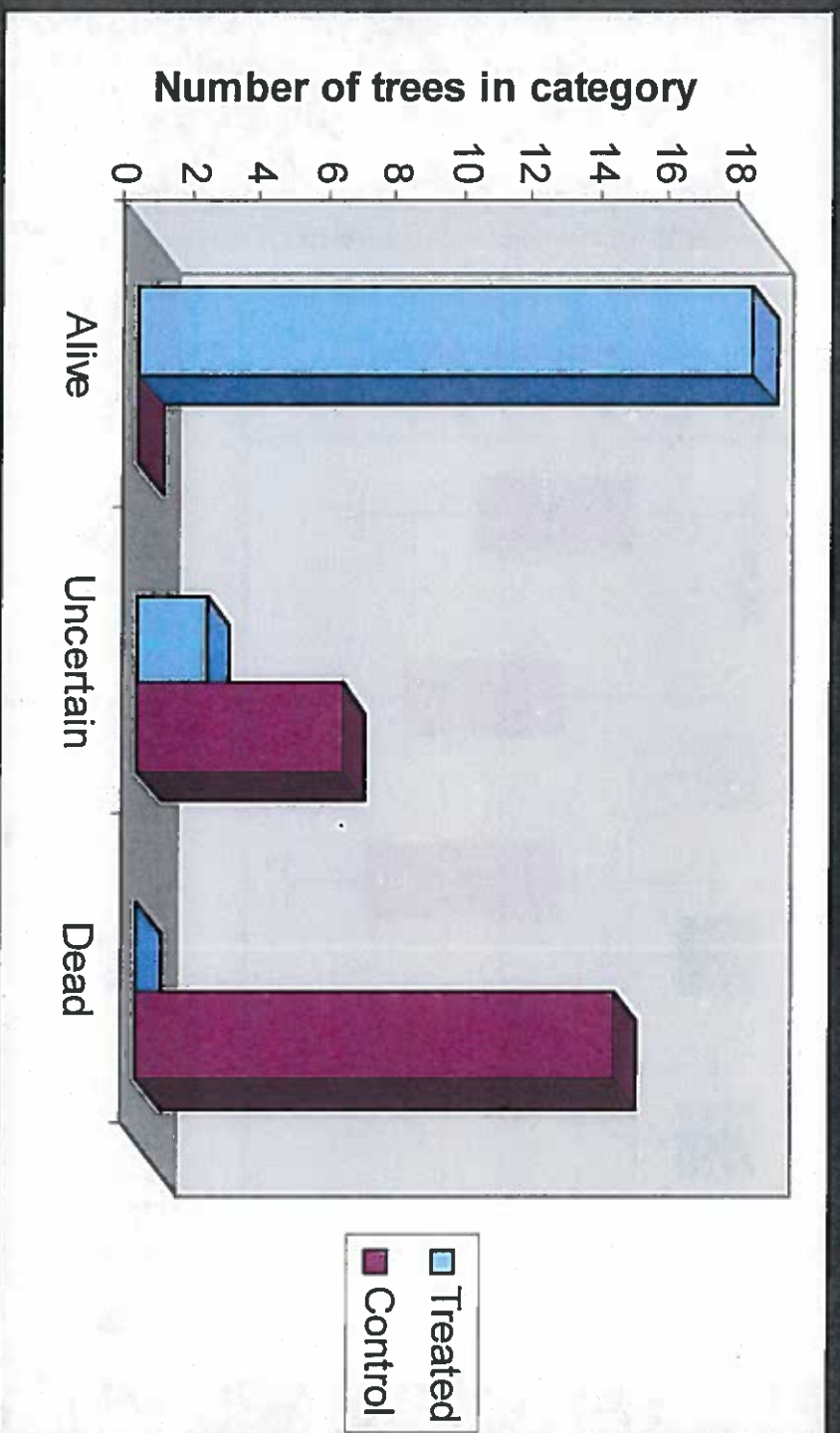
Mountain pine beetle attacks: Individual trees treated with verbenone flakes

(shaded boxes = interquartile ranges; black bars = mean attack densities)



Gillette, N.E., Stein, J.D., Owen, D.R., Webster, J.N., Fiddler, G.O., Mori, S.R., and Wood, D.L. 2006. Verbenone releasing flakes protect individual *Pinus contorta* trees from attack by *Dendroctonus ponderosae* and *Dendroctonus valens* (Coleoptera: Curculionidae: Scolytinae). *Agricultural & Forest Entomology* 8: 243–251.

LPP mortality 10 months later:



Gillette, N.E., Stein, J.D., Owen, D.R., Webster, J.N., Fiddler, G.O., Mori, S.R., and Wood, D.L. 2006. Verbenone-releasing flakes protect individual *Pinus contorta* trees from attack by *Dendroctonus ponderosae* and *Dendroctonus valens* (Coleoptera: Curculionidae, Scolytinae). *Agricultural & Forest Entomology* 8, 243–251.

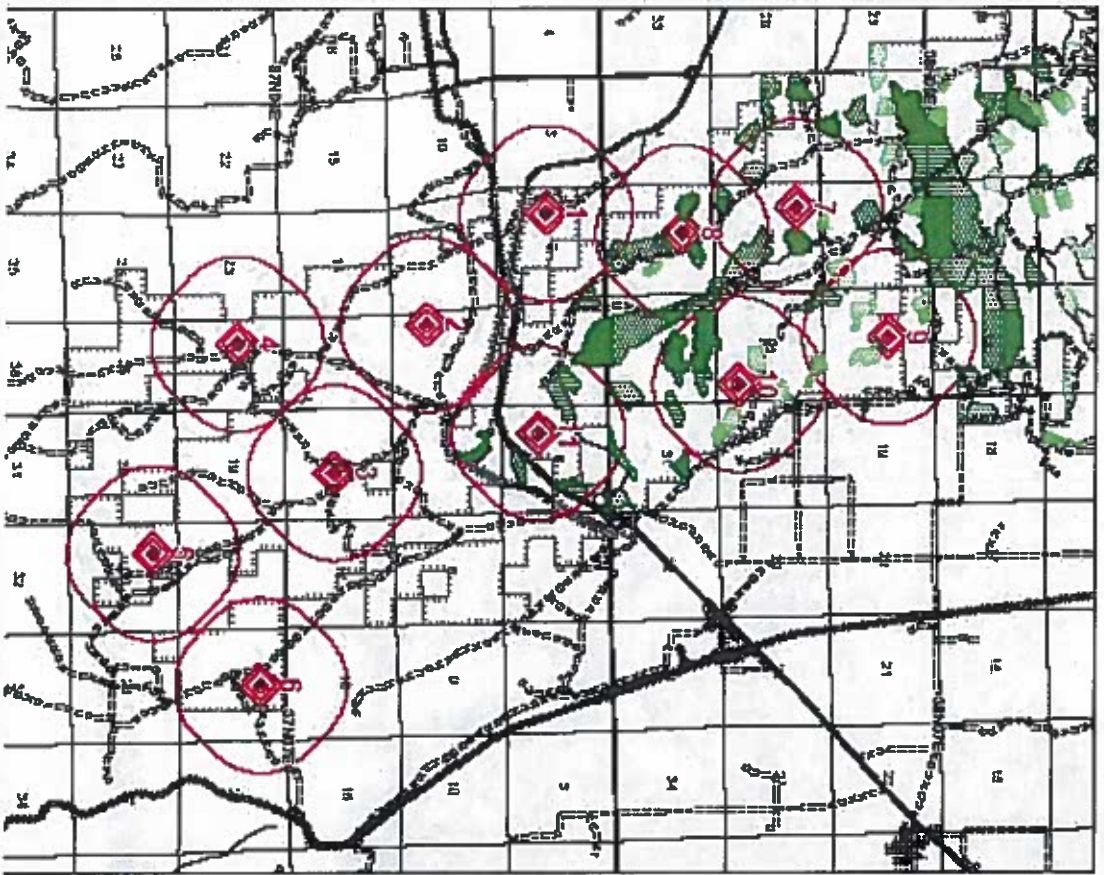


07/03/2008

Area-wide protection of stands

Aerial or simulated
aerial applications

2004 Verbenone Plots
Scale 1 inch = 1 mile



Aerial application, Big Valley Mountains, Lassen County, CA.

Ten 50-acre plots selected with matching stand conditions and existing beetle infestations

Plots located at least 1 km apart

Five plots randomly selected as treatments, five as controls

Flakes applied at 150 grams All/acre (3-4 flakes per square foot)

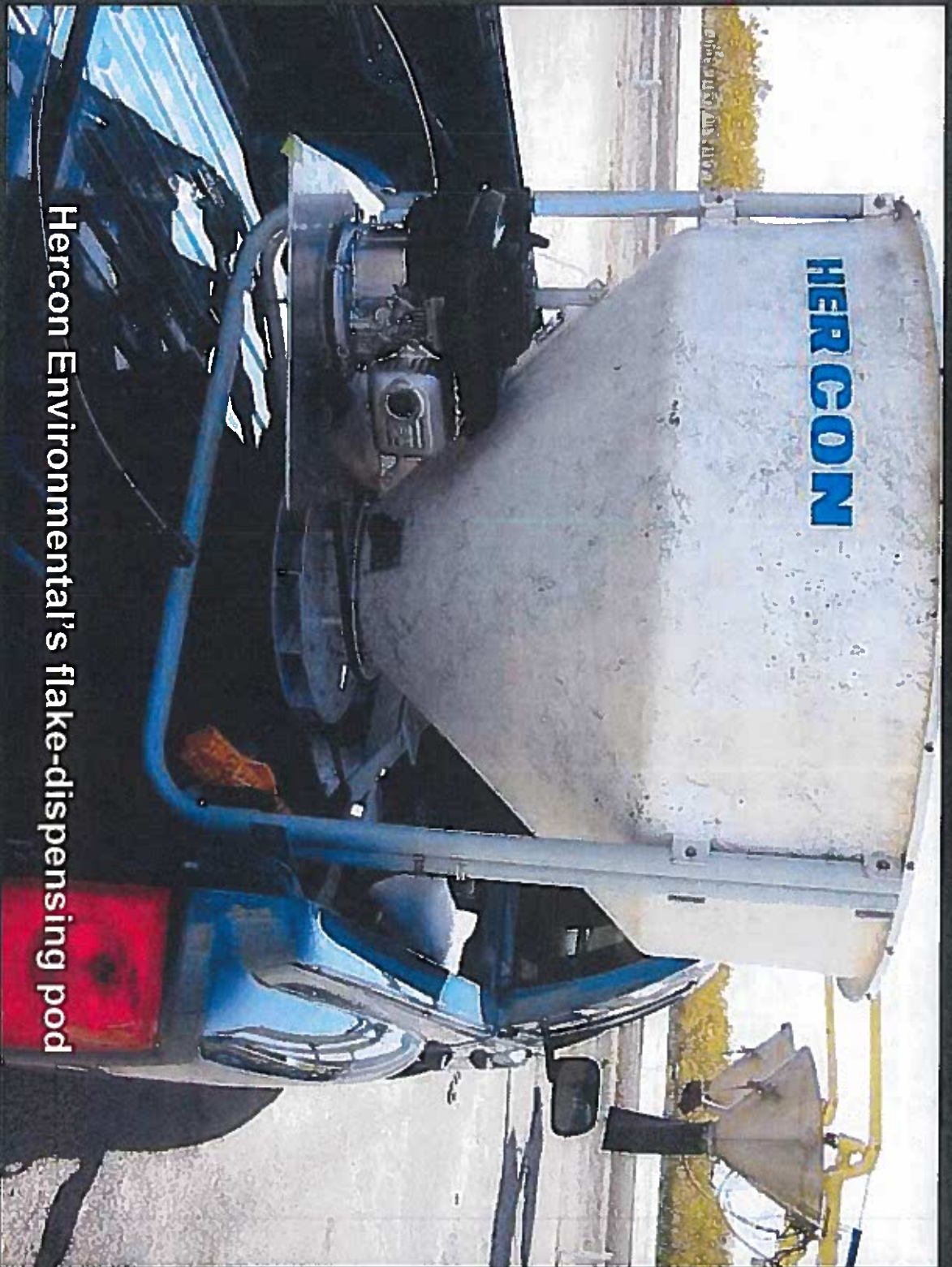


Fixed-wing application of flakes

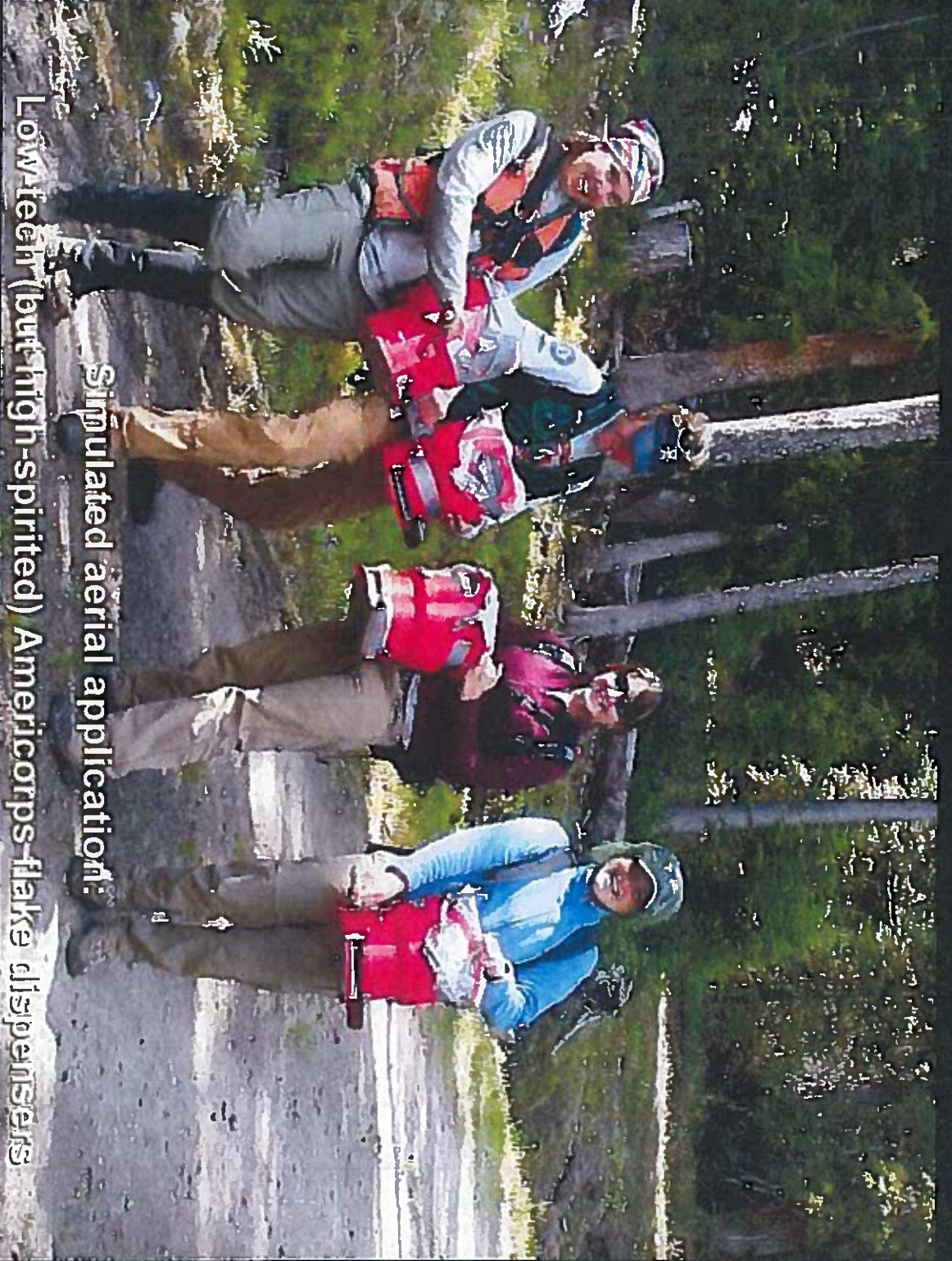




Helicopter application of flakes
(Jeff Webster, Total Forestry, Anderson, CA)



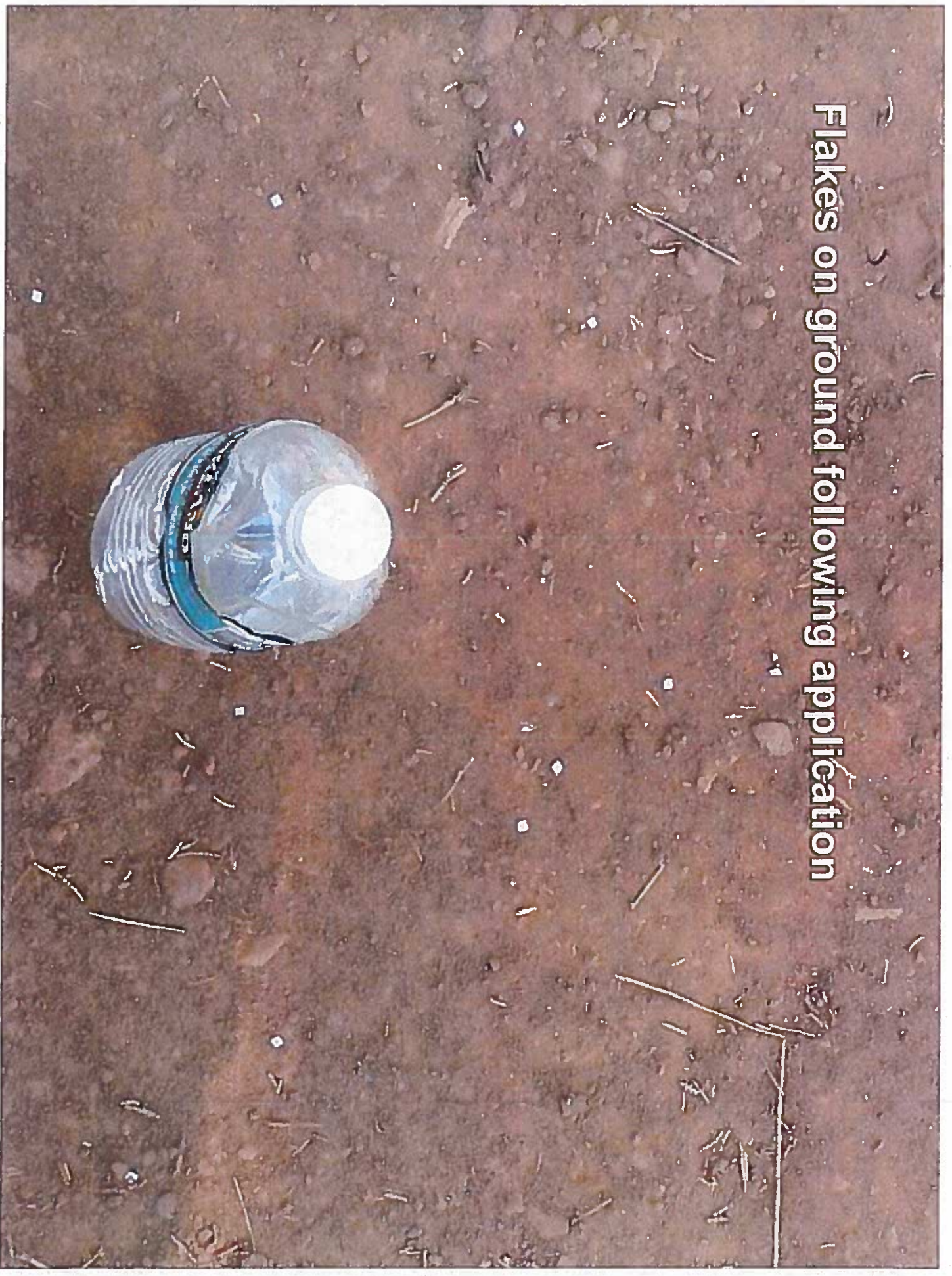
Hercon Environmental's flake-dispensing pod



Low-teen (but high-spirited) Americorps-flake dispersers

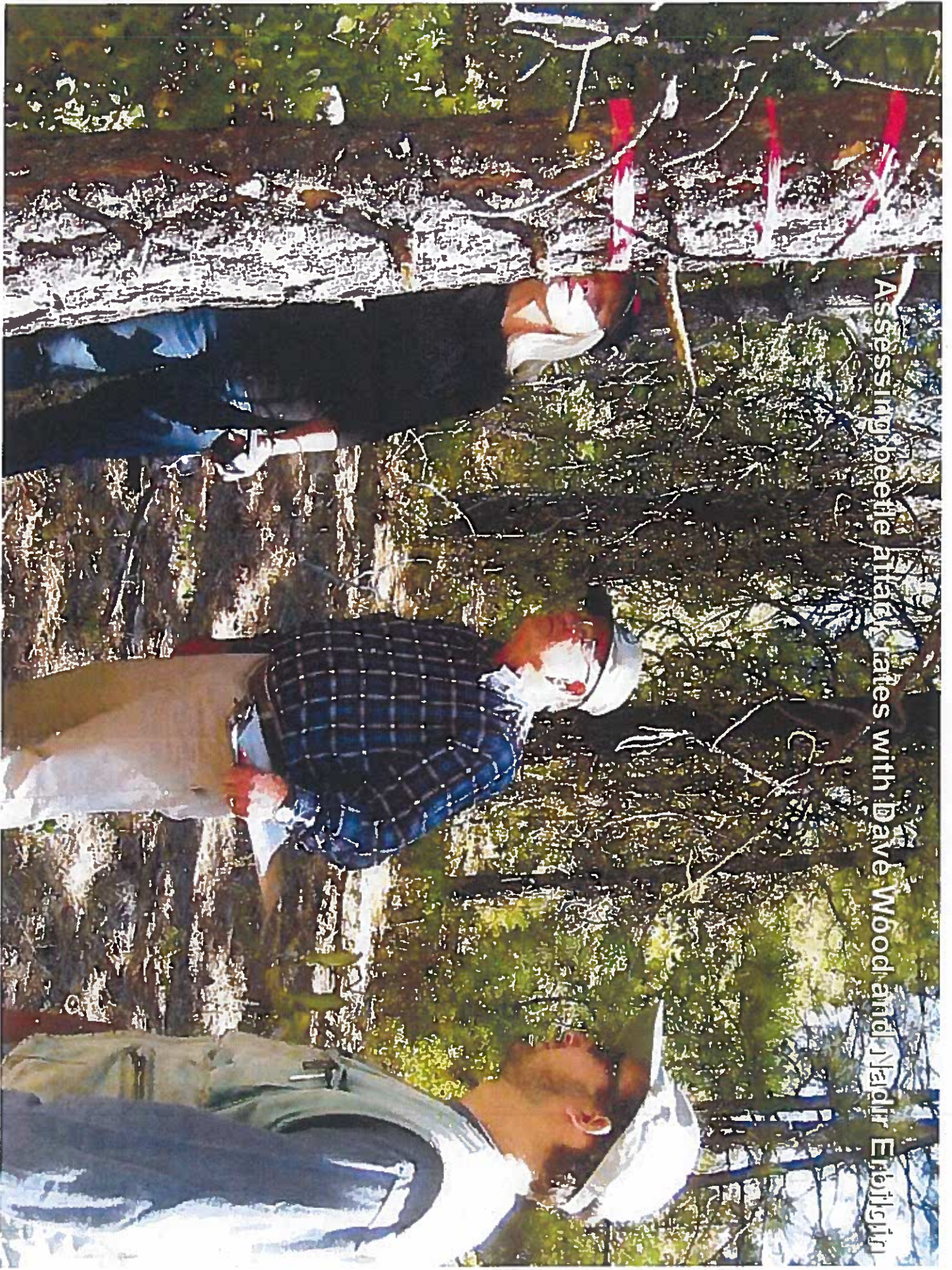
Simulated aerial application:

Flakes on ground following application



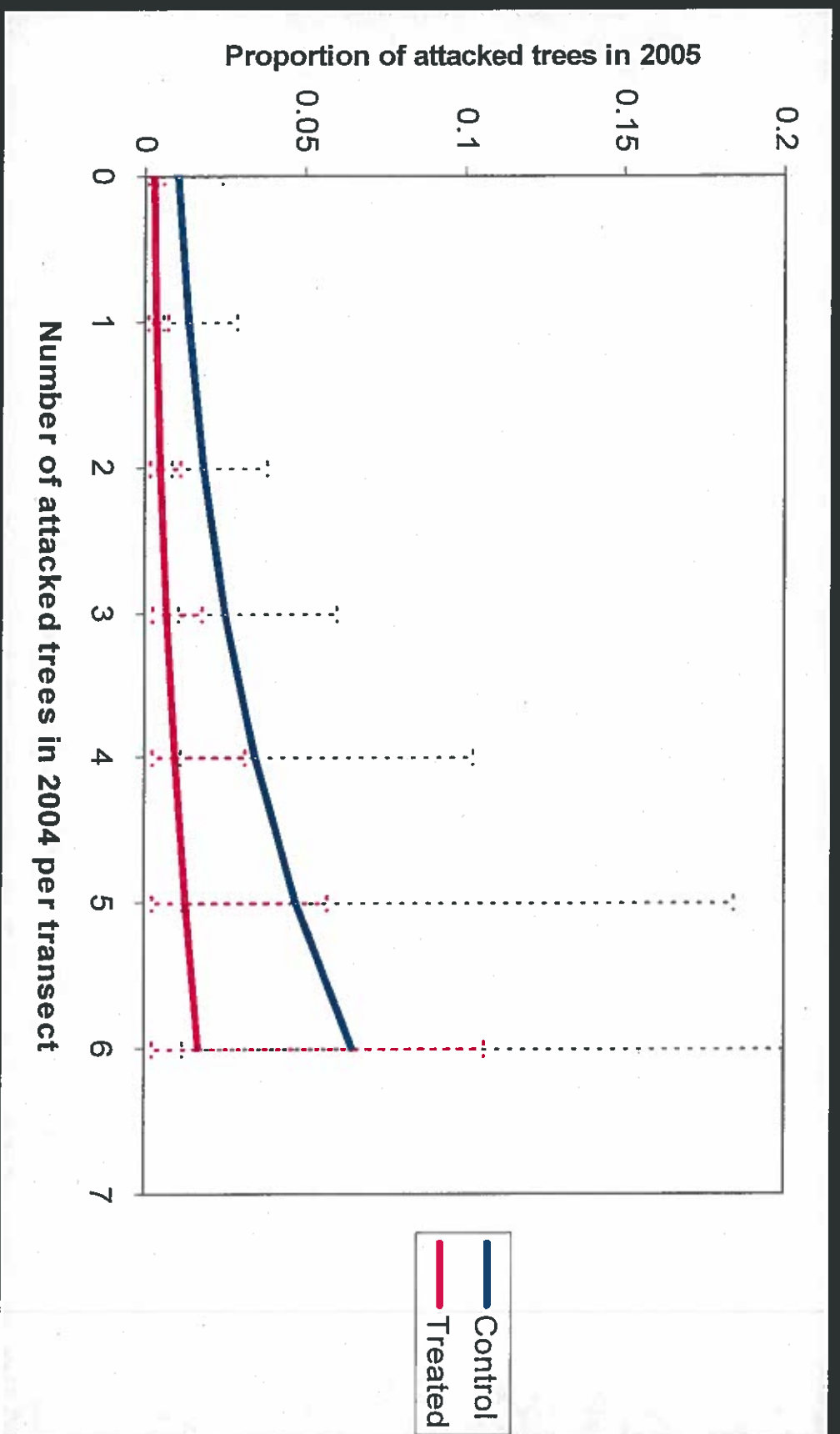
Assessment of stand conditions and treatment effects

- Stand basal area
- Target tree basal area
- Target tree mean DBH
- Previous year beetle infestation rate
- Current year beetle infestation rate



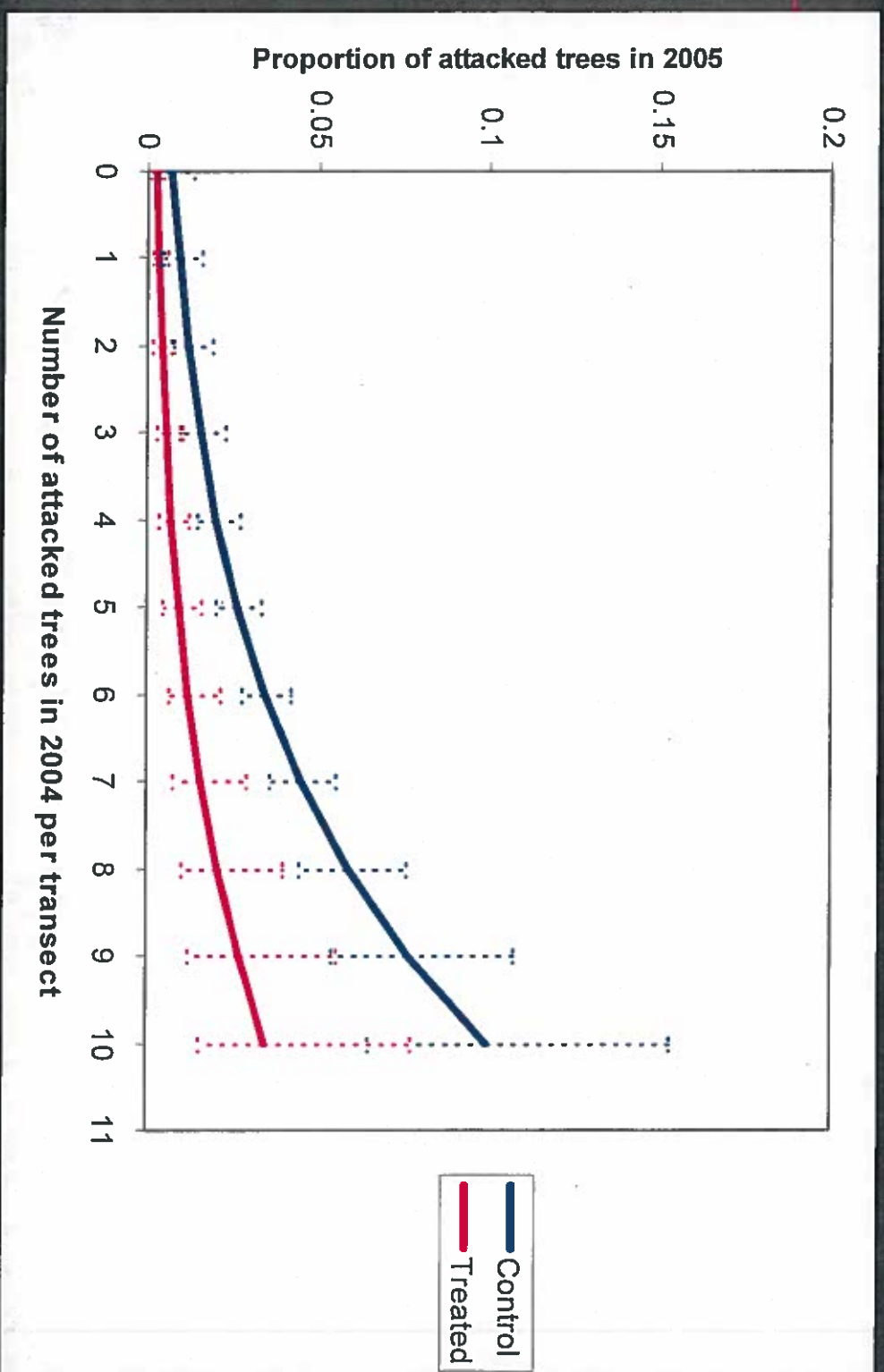
Assessing beetle attack rates with Dave Wood and Naldir Erbilgin

Verbenone flakes, MPPB/LPP, Idaho 2005



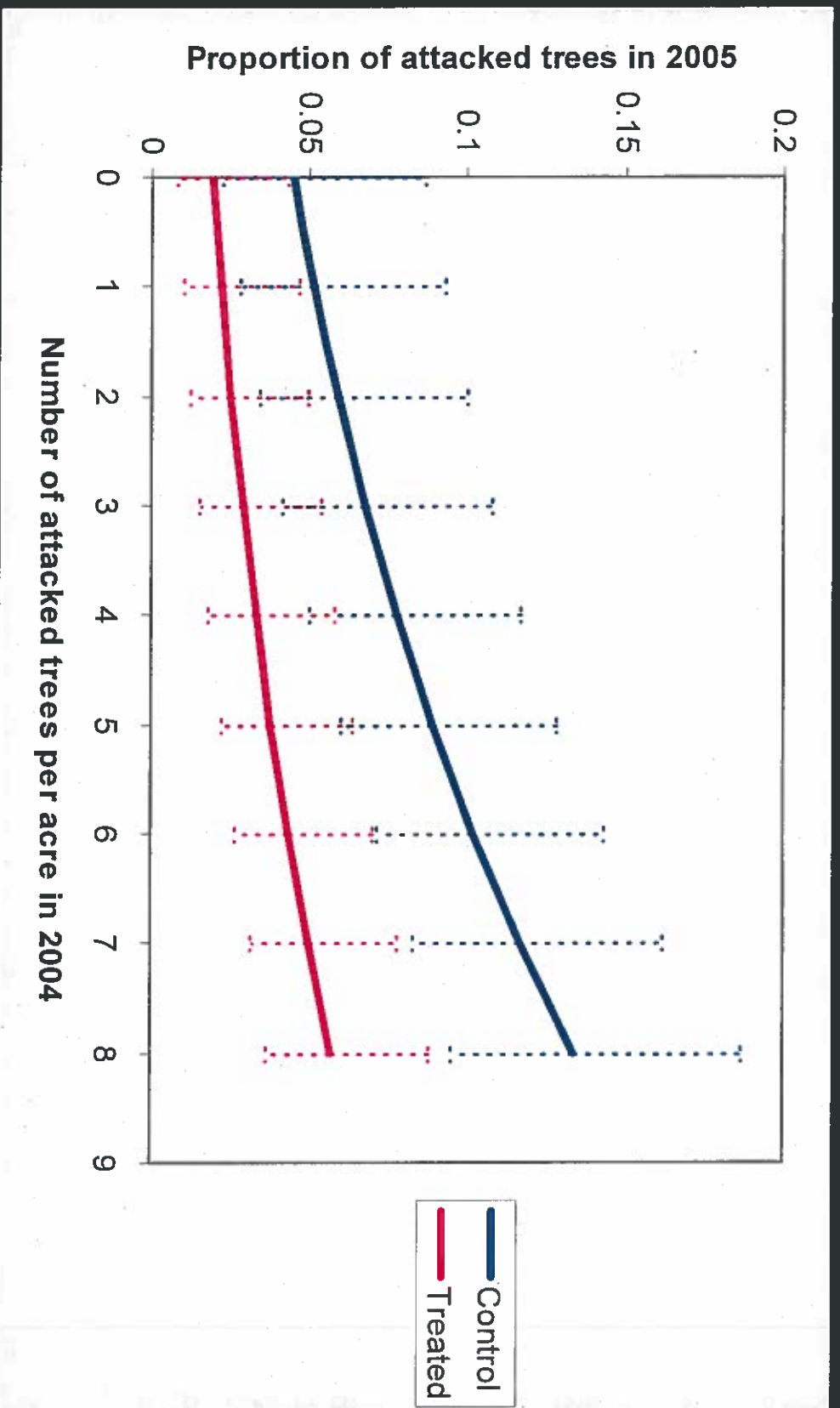
Gillette, N.E., N. Erbilgin J.N. Webster, L. Pederson, S.R. Mori, J.D. Stein, D.R. Owen, K. M. Bischel, and D.L. Wood. In press. Aerially applied verbenone-releasing laminated flakes protect *Pinus contorta* stands from attack by *Dendroctonus ponderosae* in California and Idaho. Forest Ecology and Management.

Verbenone flakes, MPPB/LPP, Calif. 2005



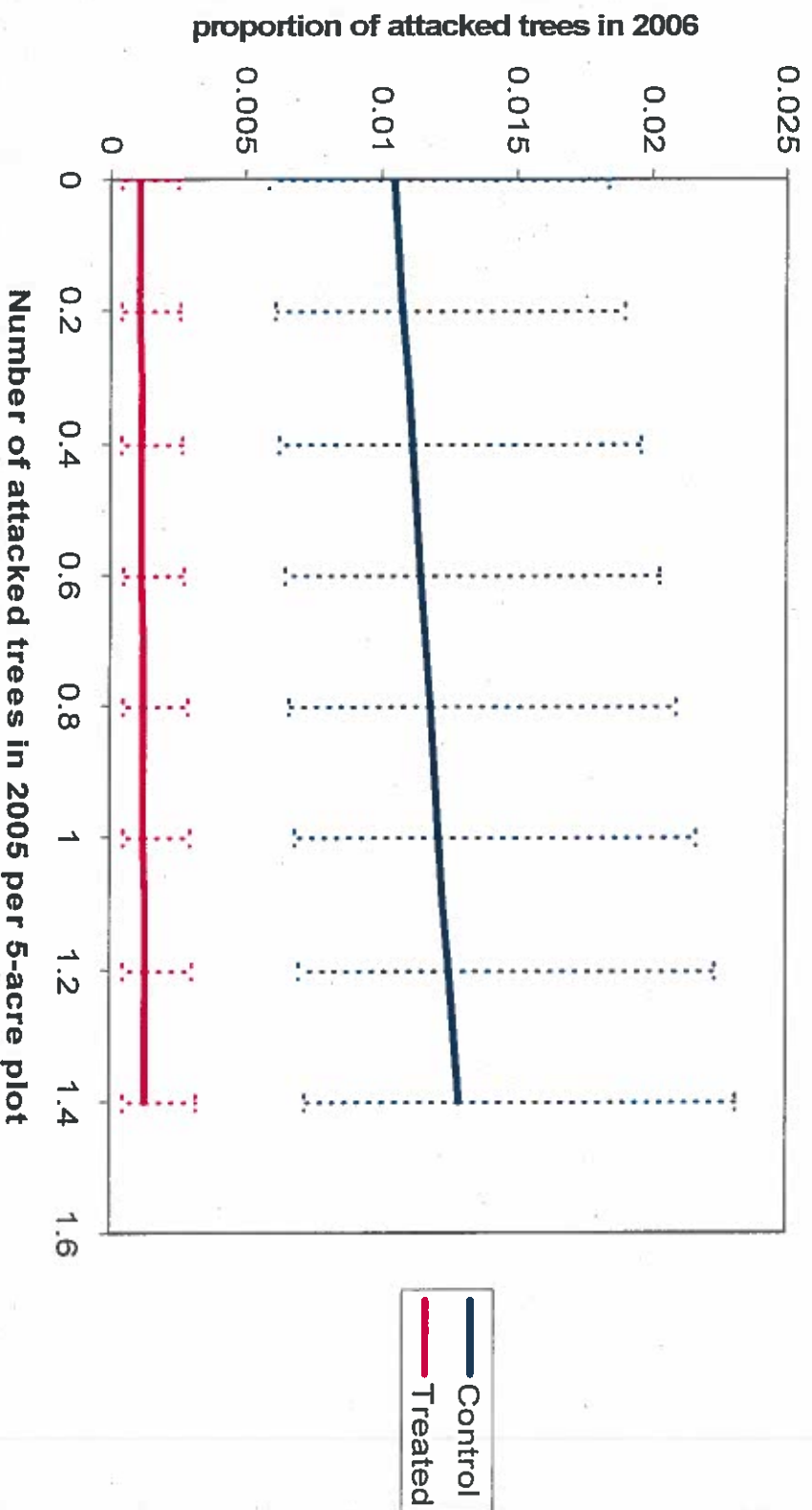
Gillette, N.E., N. Erbilgin J.N. Webster, L. Pederson, S.R. Mori, J.D. Stein, D.R. Owen, K. M. Bischel, and D.L. Wood. In press. Aerially applied verbenone-releasing laminated flakes protect *Pinus contorta* stands from attack by *Dendroctonus ponderosae* in California and Idaho. Forest Ecology and Management.

Verbenone flakes, MPPB/WBP, WY 2005



Gillette, N.E., Hansen, E.M. Mori, S.R., Webster, J.N., and Stein, J.D. In prep. Area-wide applications of verbenone-releasing flakes protect *Pinus albicaulis*, from attack by *Dendroctonus ponderosae* (Coleoptera: Curculionidae, Scolytinae)

MCH flakes, DFB/DB, WA 2006



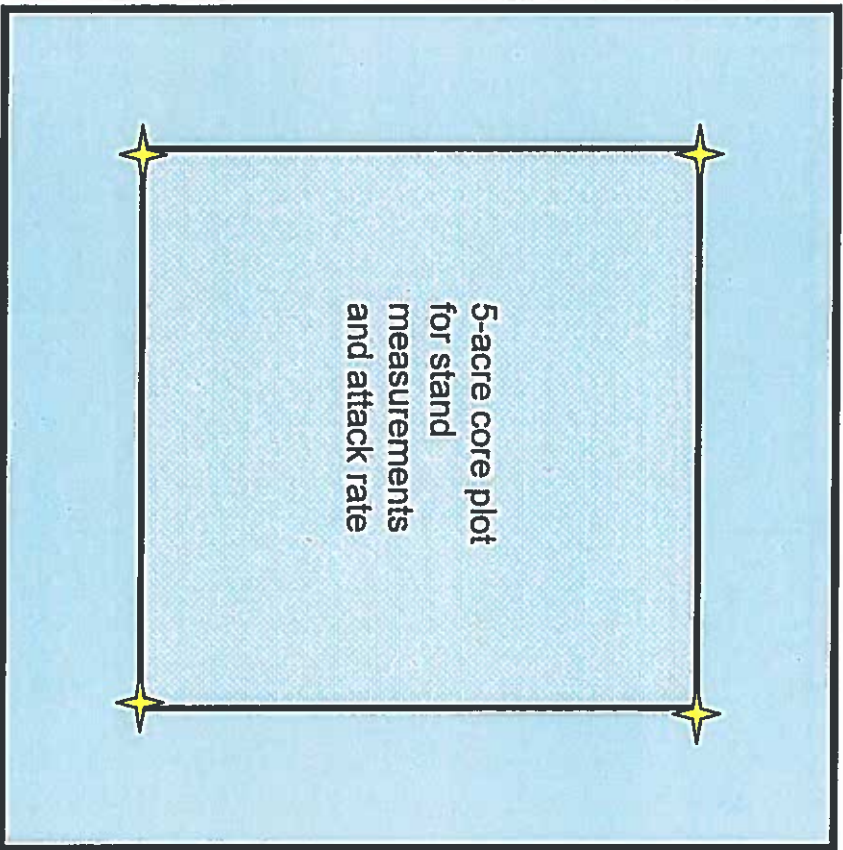
Gillette, N.E., Mehmehl, C.J., Erbilgin, N., Mori, S.R., Webster, J.N., Wood, D.L., Stein, J.D. In press. Aerially applied methylocyclohexenone-releasing flakes protect *Pseudotsuga menziesii* stands from attack by *Dendroctonus pseudotsugae*. Forest Ecology and Management.

Push-Pull Test, VBN in LPP, 2008

- PUSH: Verbenone flakes (antiaggregation pheromone) inside plots
- PULL: Traps baited with aggregation pheromone around the perimeter at 150-foot spacings

10-ACRE TREATED PLOT

 = trap w/ tree bait



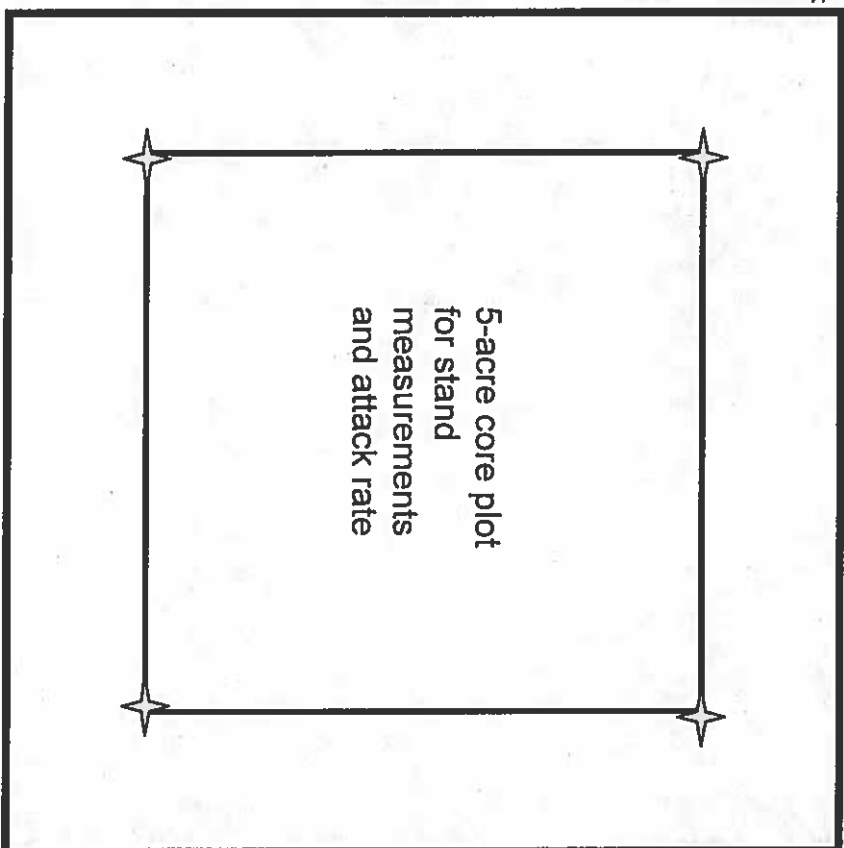
Push only: Flakes applied in center, no perimeter traps

tree

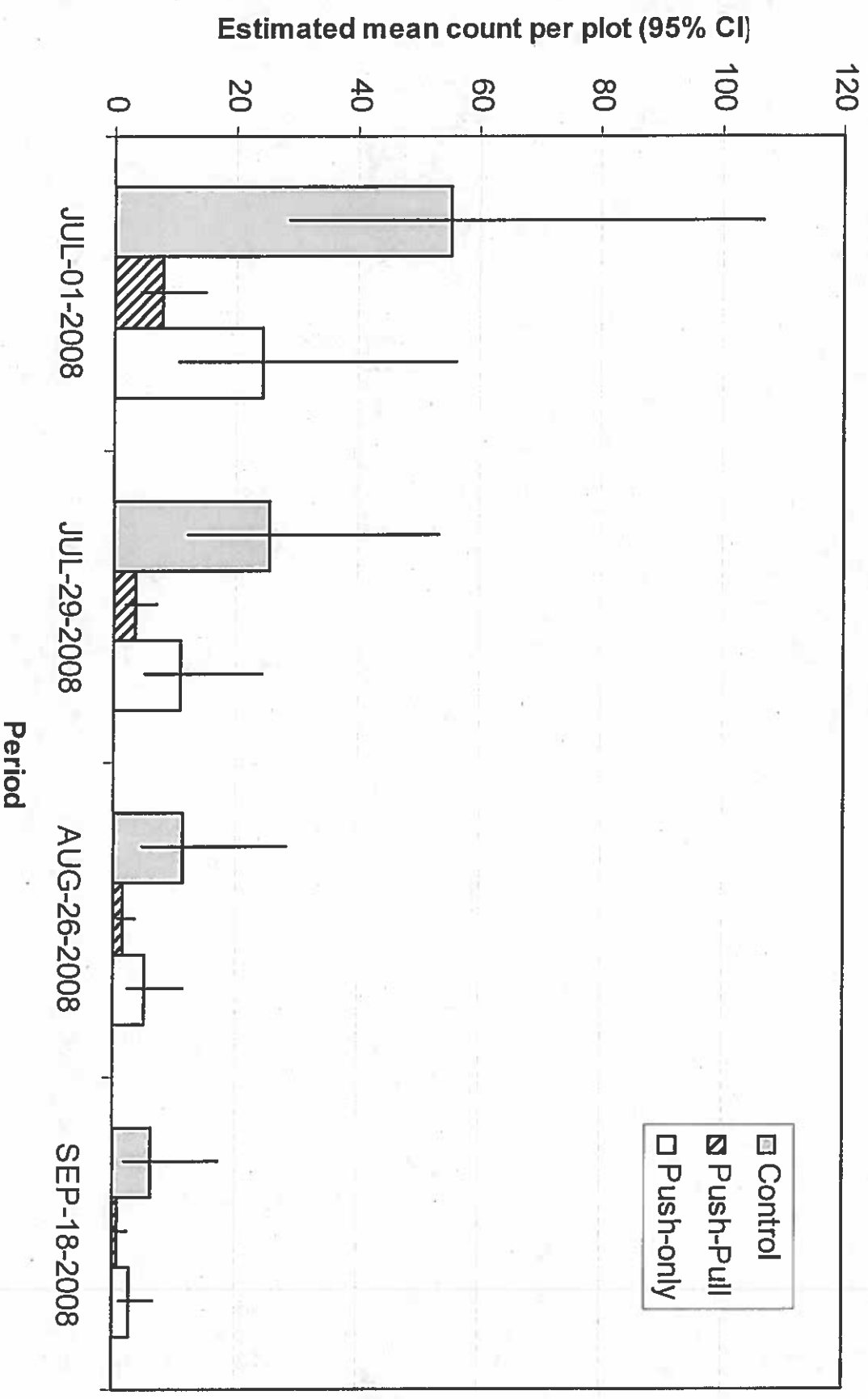
Control plots: No flakes, no perimeter traps

10-ACRE CONTROL PLOT

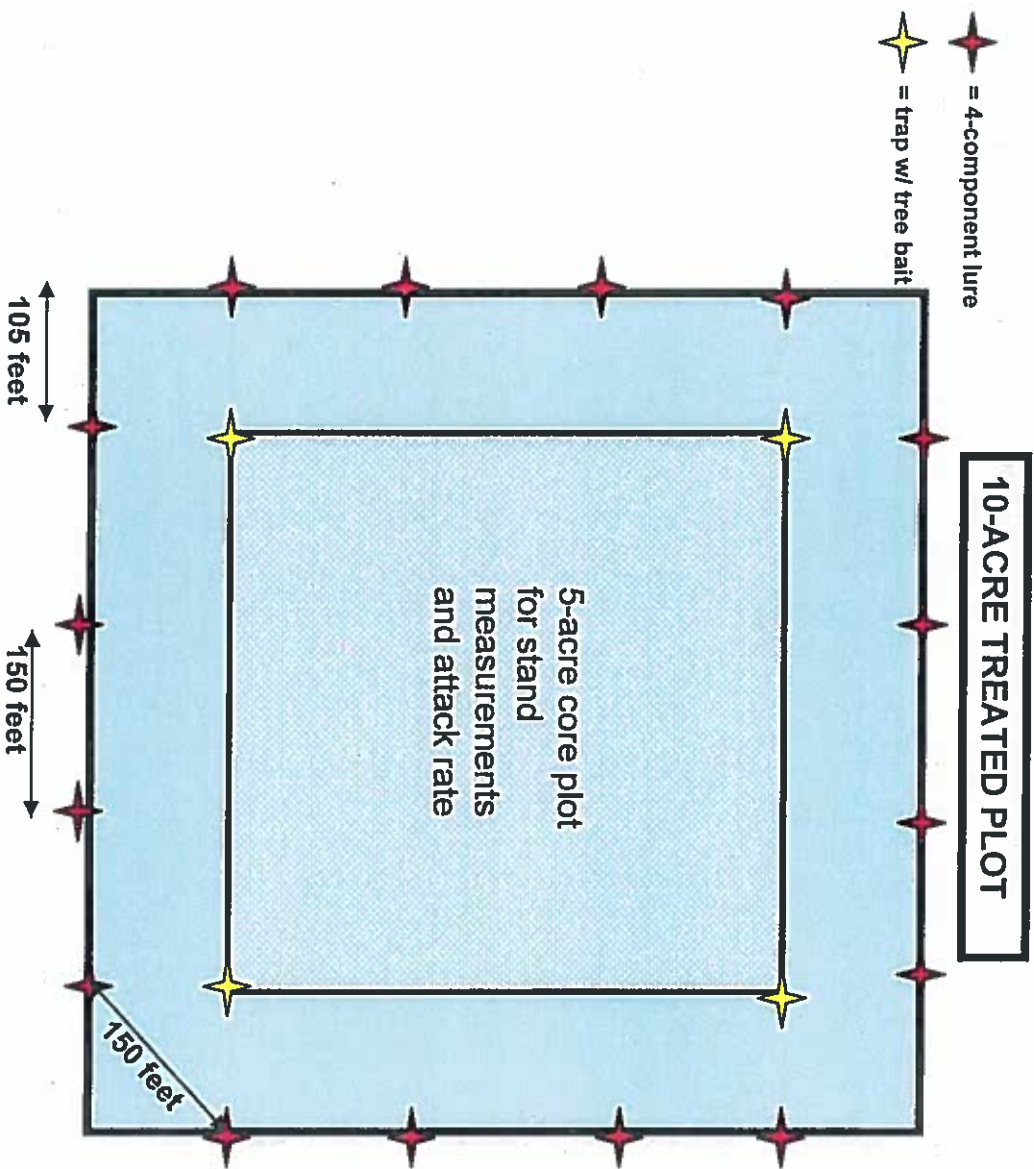
☆ = trap w/ tree bait



Verbenone Flakes, Push-Pull, 2008 (numbers of beetles trapped in monitoring traps)



Push-pull: Flakes in center, perimeter traps baited with aggregation pheromone



Conclusions

VBN flakes highly effective for individual tree protection of LPP from MPB attack

VBN flakes give area-wide protection of both LPP and WBP from MPB attack (may need higher rates or push-pull for larger beetle populations)

MCH flakes are very effective for area-wide control of DFB in DF stands (will test for individual trees)

Conclusions from push-pull test

- For high beetle populations, we should test:
 - Increased flake application rate OR
 - Increased number of perimeter traps OR
 - Removal of infested trees (sanitation salvage) OR
 - All of the above

THE END
(questions?)



Collaborators

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