

Environmentally friendly methods for forest pest control: prevention is better than cure



Hervé Jactel (INRA)

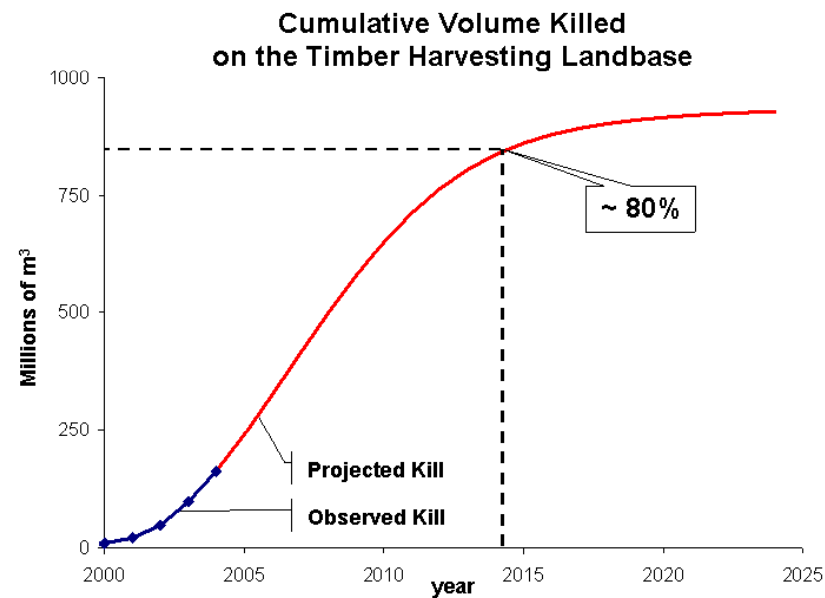
EFIMED - Scientific seminar - 14 - 16 April 2010, Antalya, Turkey
Knowledge based management of Mediterranean forest under climate change: the ways ahead

A rise of threats to forests

Climate change

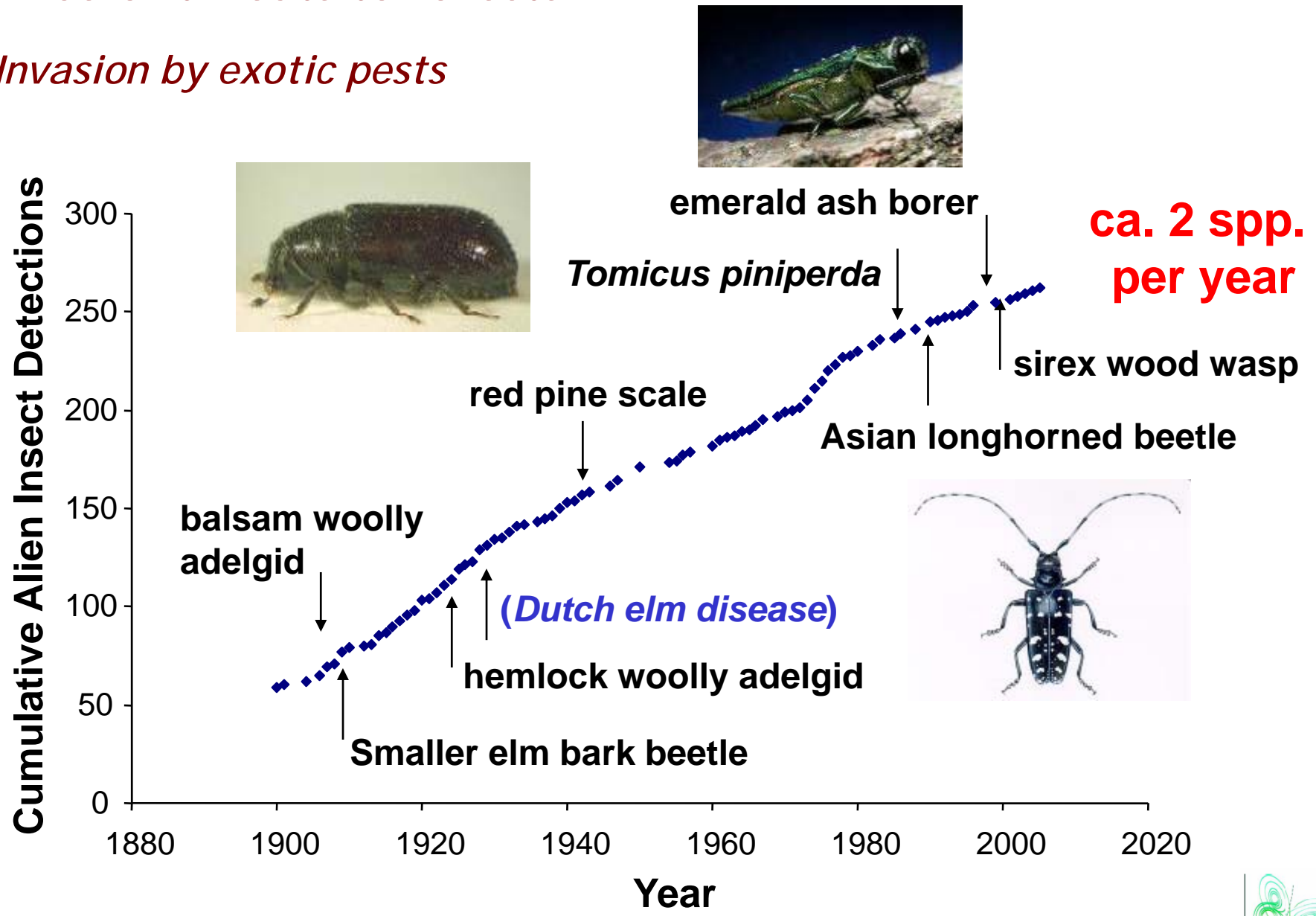


Mountain pine beetle *Dendroctonus ponderosae* outbreak in British Columbia, Canada



A rise of threats to forests

Invasion by exotic pests



The use of insecticides to control forest pest insects



Advantages

- fast and easy to apply
- knock down effect

- mainly to control defoliators or leaf aphids
e.g. diflubenzuron (urea) vs. pine processionary moth

Drawbacks

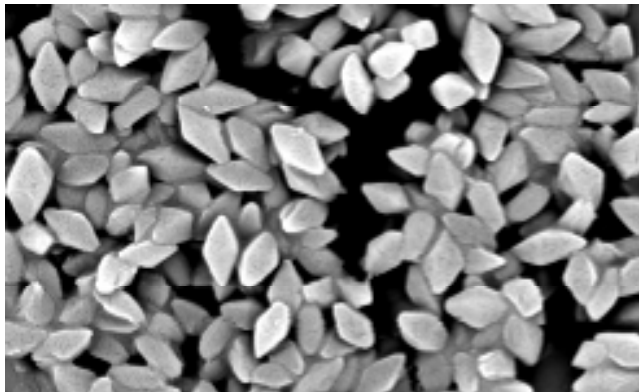
- lack of effectiveness
 - cryptic species (feeding in tree tissues)
 - tall trees
- lack of specificity
 - broad-spectrum: collateral damage on non target species incl. natural enemies
 - narrow-spectrum: commercially unattractive
- selection for pest resistance by removing susceptible individuals

Costly, not very effective, not environmentally friendly ☹️

Other curative methods of forest pest control

1. Microbial control

- toxin of *Bacillus thuringiensis* (*Bt*)
- vs. defoliator (Pine processionary moth, Gypsy moth)
- effective, narrow spectrum, cost effective



JC Martin

2. Mechanical removal of infested trees

- mainly sanitary thinnings or salvage harvesting vs. bark beetles



Other curative methods of forest pest control

3. Semiochemical

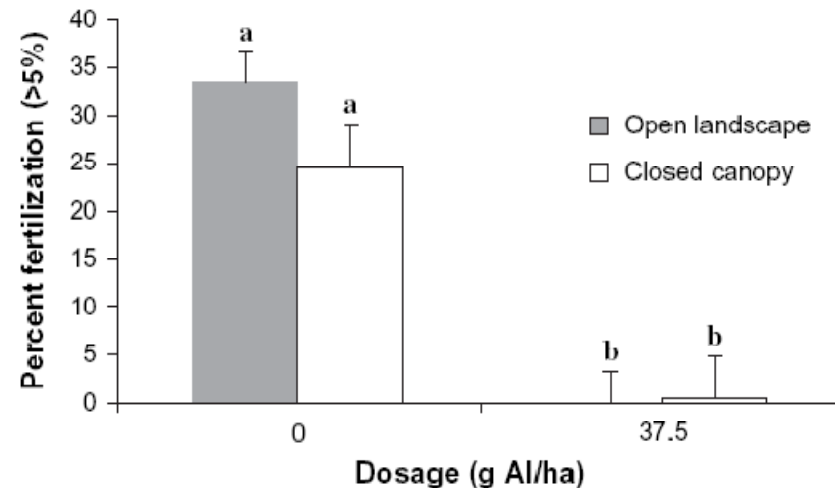
- Pheromones (volatile compounds released by individuals to impact the behavior of individuals from the same species)
 - Aggregation pheromone in bark beetles: mass trapping → not effective
 - Sex pheromone in defoliators: mating disruption → promising

Agricultural and Forest Entomology (2008), 10, 175–179

DOI: 10.1111/j.1461-9563.2008.00375.x

Gypsy moth mating disruption in open landscapes

Ksenia S. (Tcheslavskaja) Onufrieva, Kevin W. Thorpe*, Andrea D. Hickman†, Donna S. Leonard‡, Victor C. Mastro§ and E. Anderson Roberts



Aerial application of flake formulation of disparlure achieved > 99% reduction of mating among females on isolated trees



Other curative methods of forest pest control

3. Semiochemical

- Allomones (volatile compounds released by one species that impacts the behavior of individuals from other species to the benefit of the emitter)
 - Antiaggregation pheromone (verbenone) vs. bark beetles → promising

Forest Ecology and Management 257 (2009) 1405–1412

Aerially applied verbenone-releasing laminated flakes protect *Pinus contorta* stands from attack by *Dendroctonus ponderosae* in California and Idaho

N.E. Gillette^{a,*}, N. Erbilgin^{b,h}, J.N. Webster^c, L. Pederson^d, S.R. Mori^a, J.D. Stein^{e,1}, D.R. Owen^f, K.M. Bischel^{g,h}, D.L. Wood^h

2.5 kg verbenone/ha

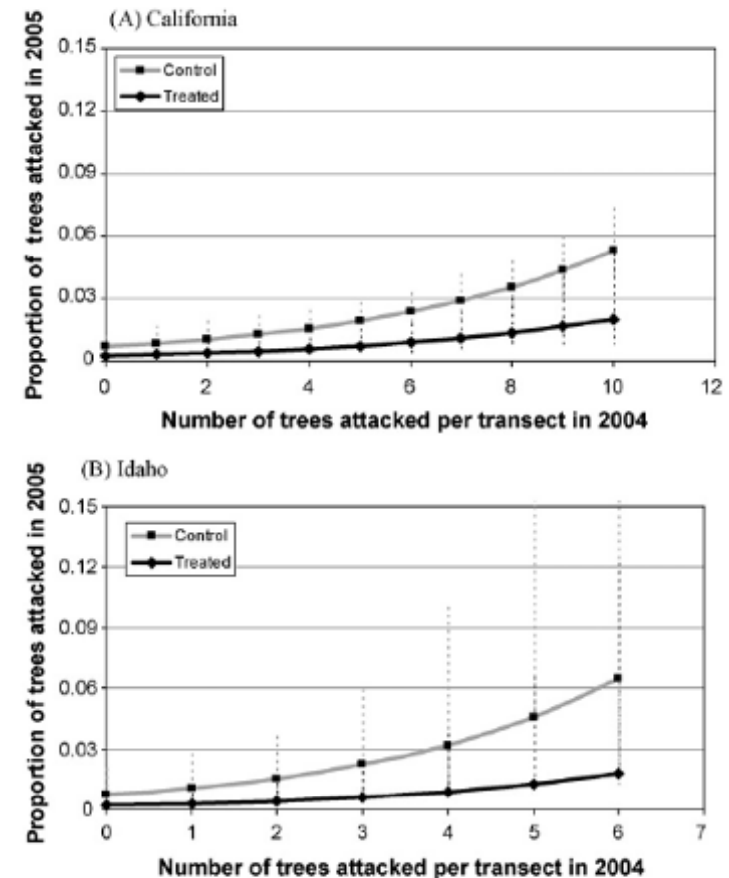
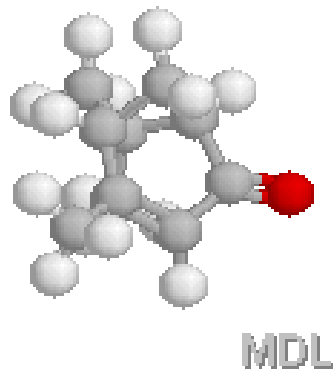


Fig. 3. Attack rate in 2005 (with 95% CI) in California and Idaho as function of 2004 *D. ponderosae* attack rates, with 95% confidence intervals shown as dashed lines.

Other curative methods of forest pest control

4. Biological control

- Use of natural enemies to reduce pest population density
- Natural enemies: predators (feed on a prey), parasitoids (live within a host which they ultimately kill)
- More effective vs. exotic, invasive insects
- Augmentation (release from mass-rearing) or introduction

Rhyzophagus grandis preys on *Dendroctonus micans* at the front edge of the invasion



Cyzenis albicans (Tachinid fly) and *Agrypon flaveolatum* (Ichneumonid wasp) parasitize winter moth (*Operophtera brumata*), introduced to Canada



Preventive methods of forest pest control

Principle

- ability of forest ecosystems to defend themselves
- good silvicultural practices reduce
 - likelihood of insect attacks
 - and susceptibility of trees

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© INRA, EDP Sciences, 2009
DOI: [10.1051/forest/2009054](https://doi.org/10.1051/forest/2009054)

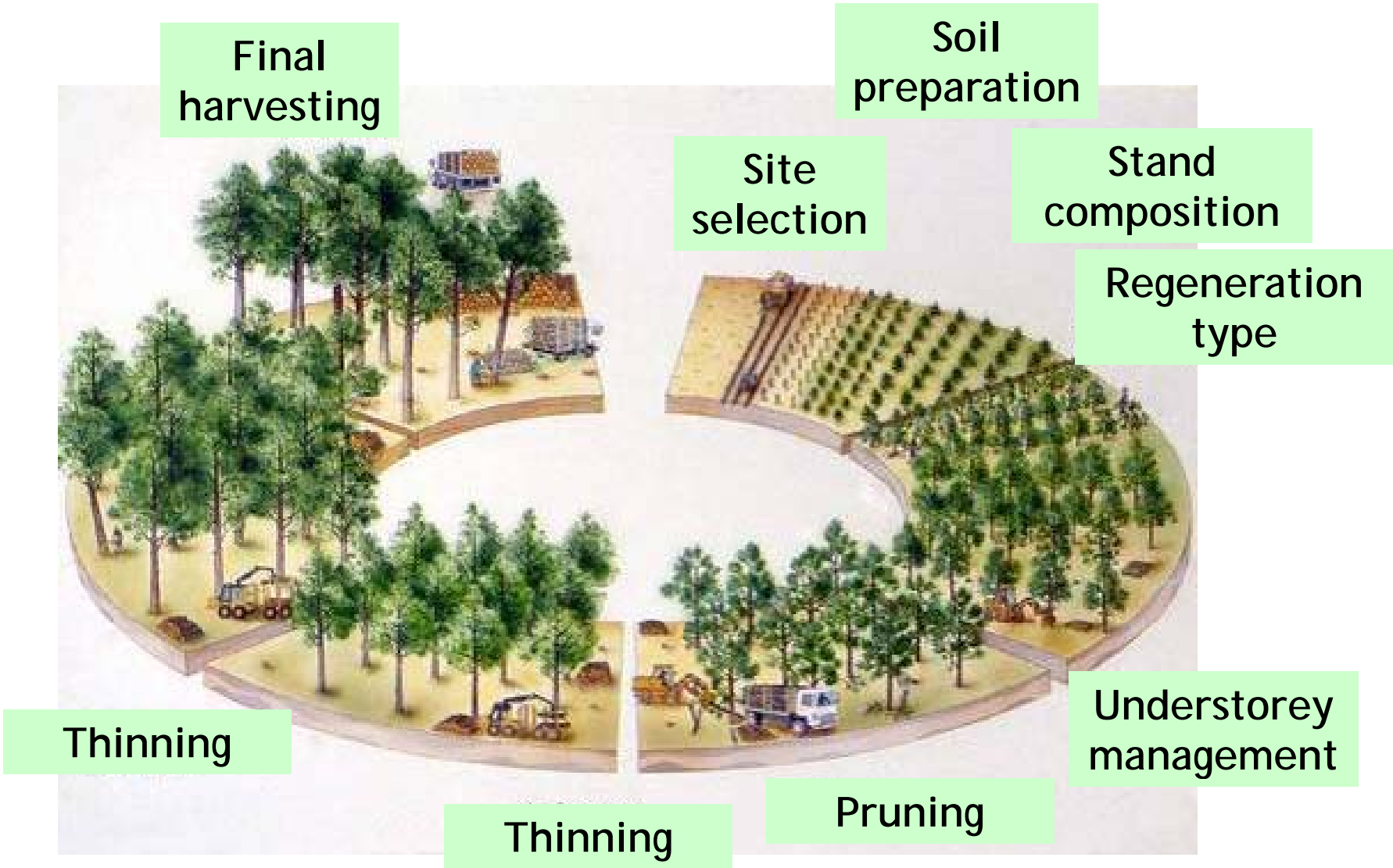
Available online at:
www.afs-journal.org

Review article

The influences of forest stand management on biotic and abiotic risks of damage

Hervé JACTEL^{1*}, Bruce C. NICOLL², Manuela BRANCO³, José Ramon GONZALEZ-OLABARRIA^{4,5},
Wojciech GRODZKI⁶, Bo LÅNGSTRÖM⁷, Francisco MOREIRA⁸, Sigrid NETHERER⁹,
Christophe ORAZIO^{1,10,11}, Dominique PIOUS¹², Helena SANTOS³, Mart Jan SCHELHAAS¹³,
Karl TOJIC¹⁴, Floor VODDE¹

530 references!



1. Site selection

- microclimatic conditions

high temperatures benefit *Ips typographus*, *Lymantria dispar*, *Thaumetopoea pityocampa*

low temperatures benefit larch bud moth (*Zeiraphera diniana*)



- soil conditions

dry conditions may trigger bark beetle outbreaks (*Ips sexdentatus*)

wet soils increase mortality of defoliator pupae (*T. pityocampa*)



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2. Soil preparation

- ploughing and stump removal

→ reduce infestation by pine weevils *Hylobius abietis*



- brash removal or prescribed burning

→ reduce infestation by bark beetles (breeding material)
Ips pini, *Hylastes angustatus*, *Pityogenes chalcographus*



- Nitrogen fertilization

→ contradictory effects

(+) pine tip moth (*Rhyacionia frustrana*)

(-) leaf chewers (*Neodiprion sertifer*, *Chrysomela tremulae*)



3. Stand composition: pure vs. mixed forests

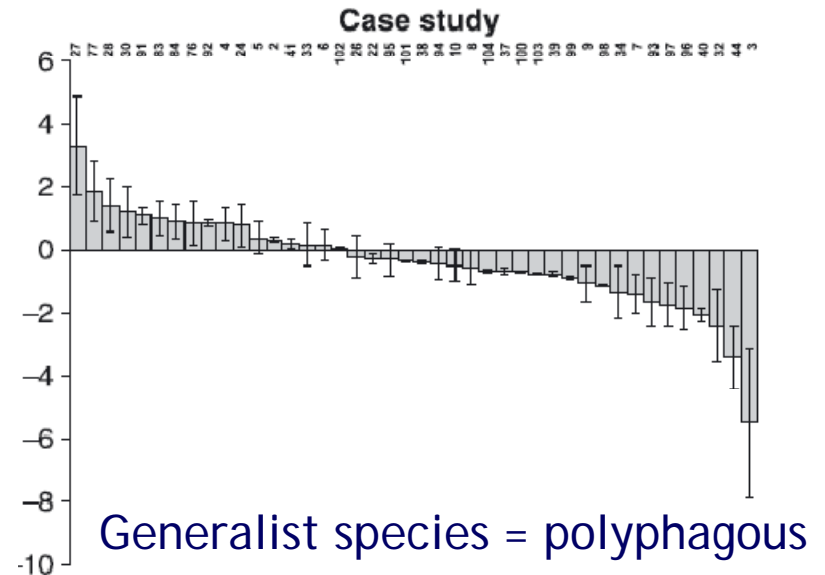
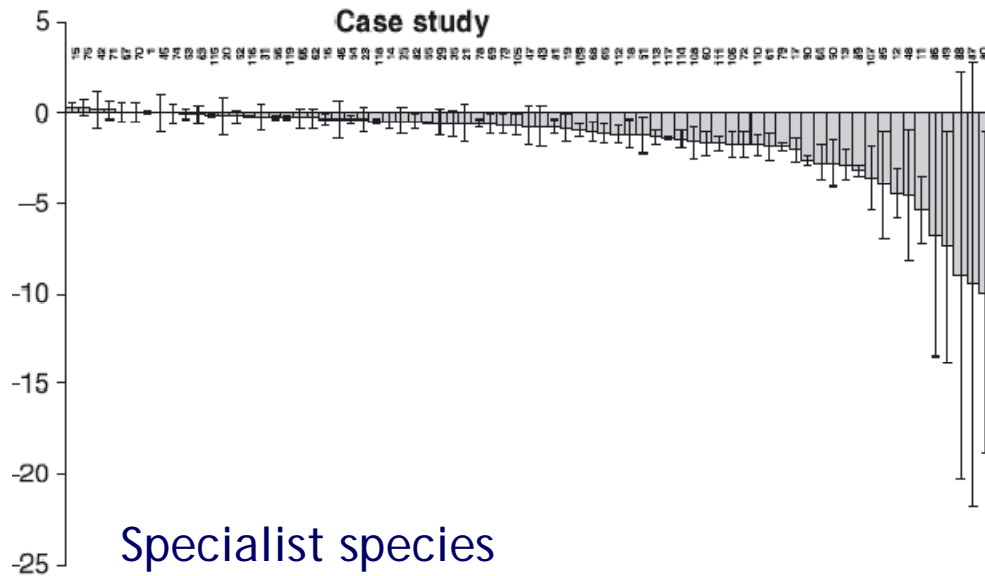
Ecology Letters, (2007) 10: 835–848

doi: 10.1111/j.1461-0248.2007.01073.x

LETTER

Tree diversity reduces herbivory by forest insects

Hervé Jactel^{1*} and Ekehard G.
Brockhoff²



3. Stand composition: pure vs. mixed forests

- reduced accessibility of host trees

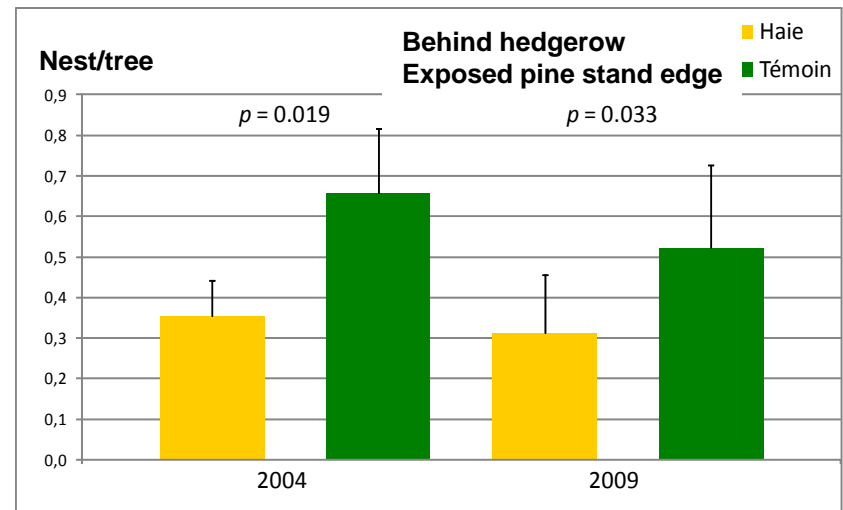
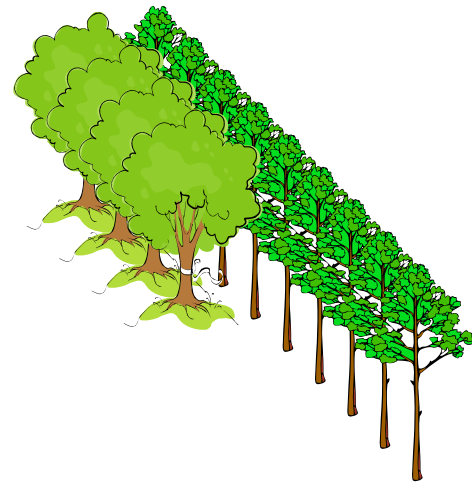
Pine processionary moth

Pine stand

Trees behind hedgerow

Trees on exposed edge

Deciduous hedgerow



3. Stand composition: pure vs. mixed forests

- reinforced control by natural enemies

Pine processionary moth



Hoopoe (*Upupa epops*)



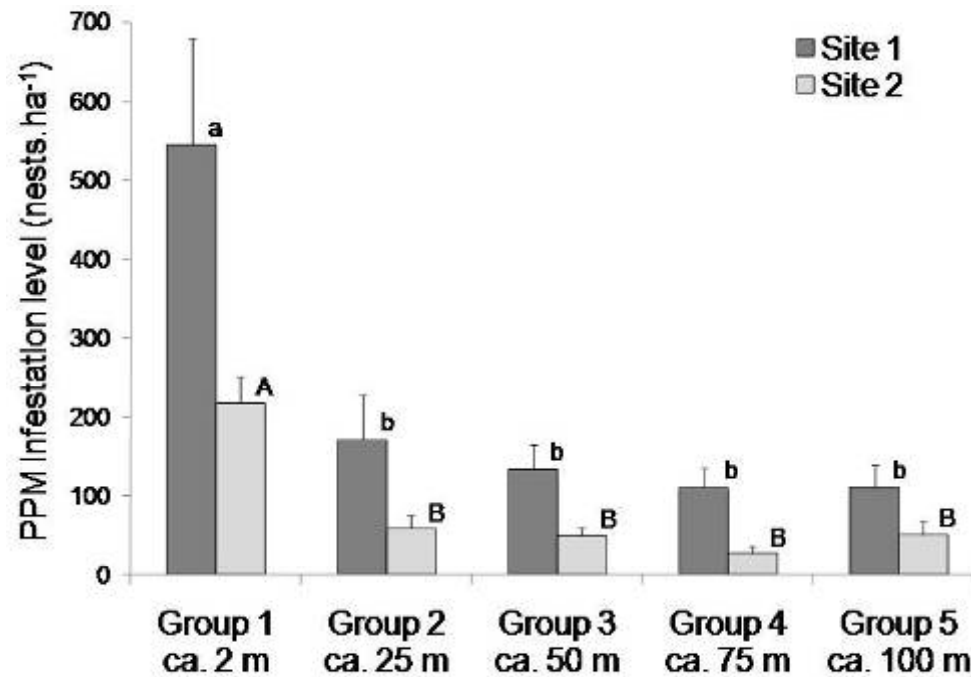
PPM exuviae

- Mature pine: resources
- Forest tracks: foraging
- Broadleaved woodland: nesting



4. Regeneration

- even-aged vs. uneven-aged ???
- low density plantation, sharp edges
→ benefit pine processionary moth



5. Understorey management

- dense understorey vegetation
→ hide trees from pine tip moth attacks



- diverse understorey vegetation
→ provide natural enemies with habitat or resources
e.g. parasitoids of pine tip moth



6. Thinning & Pruning

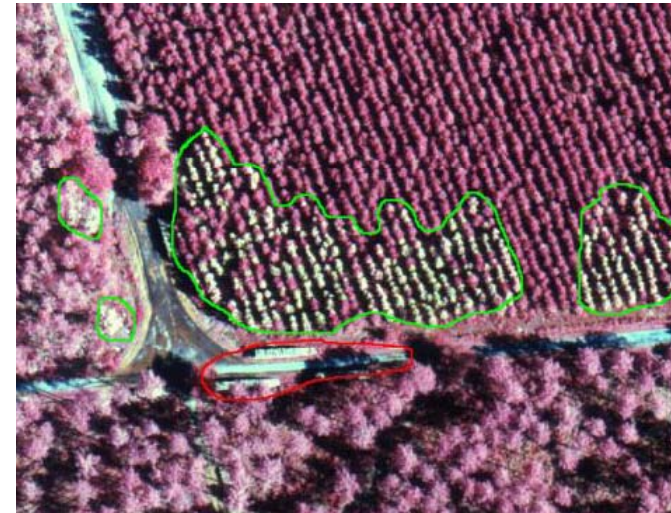
- release of volatiles
 - attractants for pine stem borer (*Dioryctria sylvestrella*) bark beetles (*Dendroctonus micans*)
- improve individual tree vigor
 - Higher resistance to bark beetles (secondary pests)



7. Final harvesting

- Storage of logs

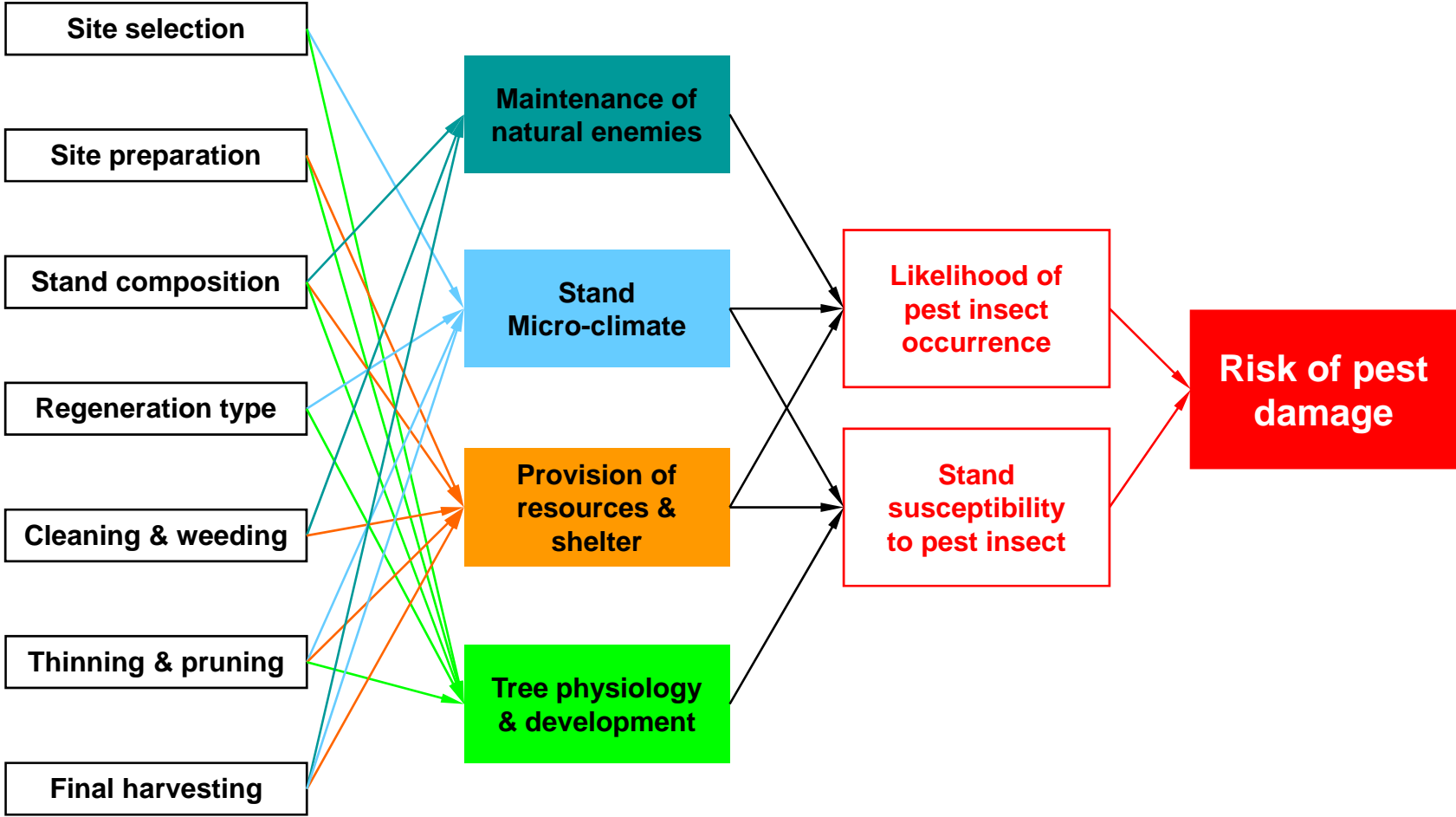
→ may trigger attacks by bark beetles (*Ips sexdentatus*)



- Rotation length

→ Short rotation forestry tends to reduce the risk of damage

Silviculture and forest pest control



Conclusions

Optimistic point of view

- many possible effective, environmentally friendly pest management methods
- incl. use of semiochemical, natural enemies, silviculture

Pessimistic point of view

- they don't work for any pest, in any conditions
- effectiveness varies w. feeding guild, primary vs. secondary, specialist vs. generalist

Realistic point of view

- improve knowledge on main threats, via monitoring of forest health
- prevent is better than cure
- develop species - oriented management strategies
 - Adapt silviculture for native pests
 - Use biological control for introduced pests
- **promote diversity**
 - **of tree species**
 - **of silvicultures**

Thank you for your attention !



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