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**Appendix A**  
**List of Pests Intercepted**  
**by Other Countries on Logs**  
**From the Soviet Union**

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**Insect Species Found in Log (With Bark) of *P. abies***  
**and *P. sylvestri* Imported From the Soviet Union to Sweden**

<u>Insect Species</u>	<u>State in Life Cycle</u>	<u>Number of Loads in Which Species Detected</u>
<b>Coleoptera</b>		
<b>Carabidae</b>		
<i>Trachypachus zetterstedti</i> (Gyllenhal)	I	1
<i>Bembidion guttula</i> (Fabricius)	I	2
<i>Bembidion grapii</i> Gyllenhal	I	1
<i>Dromius quadraticollis</i> Morawitz	I	1
<i>Trichocellus placidus</i> (Gyllenhal)	I	1
<i>Syntomus truncatellus</i> (Linnaeus)	I	1
<b>Hydrophilidae</b>		
<i>Cercyon analis</i> (Paykull)	I	1
<i>Helophorus granularis</i> (Linnaeus)	I	1
<b>Leiodidae</b>		
<i>Agathidium atrum</i> (Paykull)	I	1
<b>Staphylinidae</b>		
<i>Philonthus varians</i> (Paykull)	I	1
<i>Philonthus carbonarius</i> Gravenhorst	I	1
<i>Gabrius vernalis</i> (Gravenhorst)	I	1
<i>Gabrius toxotes</i> Joy	I	1
<i>Nudobius lentus</i> (Gravenhorst)	I	1
<i>Quedius mesomelius</i> (Marsham)	I	1
<i>Quedius boopoides</i> Munster	I	1
<i>Othius myrmecophilus</i> Kiesenwetter	I	1
<i>Megarthus sinuatocollis</i> Lacordaire	I	2
<i>Proteinus brachypterus</i> (Fabricius)	I	1
<i>Acrulia inflata</i> (Gyllenhal)	I	1
<i>Omalius rugatum</i> Mulsant & Rey	I	1
<i>Omalius excavatum</i> Stephens	I	1
<i>Omalius caesum</i> Gravenhorst	I	2
<i>Phloeonomus lapponicus</i> (Zetterstedt)	I	3
<i>Phloeonomus pusillus</i> (Gravenhorst)	I	3
<i>Acidota crenata</i> (Fabricius)	I	1
<i>Phloeocharis subtilissima</i> Mannerheim	I	1
<i>Anotylus rugosus</i> (Fabricius)	I	1
<i>Tricophya pilicornis</i> (Gyllenhal)	I	1
<i>Mycetoporus lepidus</i> (Gravenhorst)	I	1
<i>Mycetoporus rufescens</i> (Stephens)	I	1
<i>Lordithon trinotatus</i> (Erichson)	I	1
<i>Sepedophilus littoreus</i> (Linnaeus)	I	3
<i>Sepedophilus testaceus</i> (Fabricius)	I	1

<i>Sepedophilus constans</i> (Fowler)	I	1
<i>Tachyporus chrysomelinus</i> (Linnaeus)	I	1
<i>Oxypoda opaca</i> (Gravenhorst)	I	1
<i>Oxypoda umbrata</i> (Gyllenhal)	I	2
<i>Oxypoda skalitskyi</i> Bernhauer	I	1
<i>Oxypoda haemorrhoea</i> Mannerheim	I	1
<i>Phloeopora testacea</i> (Mannerheim)	I	2
<i>Geostiba circellaris</i> (Gravenhorst)	I	1
<i>Atheta melanocera</i> (Thomson)	I	1
<i>Atheta fungi</i> (Gravenhorst)	I	2
<i>Atheta sodalis</i> (Erichson)	I	2
<i>Atheta trinotata</i> (Kraatz)	I	1
<i>Atheta atramentaria</i> (Gyllenhal)	I	2
<i>Atheta hypnorum</i> (Kiesenwetter)	I	1
<i>Atheta graminicola</i> (Gravenhorst)	I	1
<i>Atheta pygmaea</i> (Gravenhorst)	I	1
<i>Atheta obfuscata</i> (Gravenhorst)	I	1
<i>Atheta parens</i> (Mulsant & Rey)	I	1
<i>Atheta deformis</i> (Kraatz)	I	1
<i>Atheta nigra</i> (Kraatz)	I	1
<i>Atheta myrmecobia</i> (Kraatz)	I	1
<i>Atheta laticollis</i> (Stephens)	I	1
<i>Atheta lateralis</i> (Mannerheim)	I	1
<i>Atheta pertyi</i> (Heer)	I	1
<i>Atheta sordida</i> (Marsham)	I	1
<i>Atheta aterrima</i> (Gravenhorst)	I	1
<i>Dinaraea aequata</i> (Erichson)	I	2
<i>Dinaraea linearis</i> (Gravenhorst)	I	1
<i>Amischa analis</i> (Gravenhorst)	I	1
<i>Drusilla canaliculatus</i> (Fabricius)	I	1
<i>Leptusa pulchella</i> (Mannerheim)	I	1
<i>Pachygluta ruficollis</i> (Erichson)	I	1
<i>Anomognathus cuspidatus</i> (Erichson)	I	1
<i>Homalota plana</i> (Gyllenhal)	I	1
<i>Placusa complanata</i> Erichson	I	3
<i>Placusa tachyporoides</i> Waltl	I	1
<i>Placusa depressa</i> Mäklin	I	1
<i>Placusa incompleta</i> Sjöberg	I	2
<i>Placusa atrata</i> (Sahlberg)	I	2
<i>Stenus clavicornis</i> (Scopoli)	I	1
<i>Stenus humilis</i> Erichson	I	1
<i>Bryaxis puncticollis</i> (Denny)	I	1
Pselaphidae		
<i>Euplectus karsteni</i> (Reichenbach)	I	1
Histeridae		
<i>Plegaderus vulneratus</i> (Panzer)	I	1
Helodidae		
<i>Cyphon variabilis</i> (Thunberg)	I	1
<i>Cyphon pubescens</i> (Fabricius)	I	1
Elateridae		
<i>Athous subfuscus</i> (Müller)	I	1
Cleridae		
<i>Thanasimus formicarius</i> (Linnaeus)	I	1

Nitidulidae		
<i>Melighetes aeneus</i> (Fabricius)	I	1
<i>Epuraea boreella</i> (Zetterstedt)	I	1
<i>Epuraea unicolor</i> (Olivier)	I	2
<i>Epuraea rufomarginata</i> (Stephens)	I	3
<i>Epuraea abetina</i> J. Sahlberg	I	1
<i>Epuraea bickhardti</i> Saint-Claire Deville	I	2
<i>Epuraea pygmaea</i> (Gyllenhal)	I	2
<i>Glischrochilus quadripunctatus</i> (Linnaeus)	I	2
<i>Pityophagus ferrugineus</i> (Linnaeus)	I	1
Rhizophagidae		
<i>Rhizophagus bipustulatus</i> (Fabricius)	I	1
Monotomidae		
<i>Monotoma longicollis</i> (Gyllenhal)	I	1
Cucujidae		
<i>Dendrophagus crenatus</i> (Paykull)	I	1
<i>Silvanus bidentatus</i> (Olivier)	I	3
<i>Silvanoprus fagi</i> (Guerin-Meneville)	I	2
* <i>Uleiota planata</i> (Linnaeus)	I	1
Cryptophagidae		
<i>Cryptophagus abietis</i> (Paykull)	I	1
<i>Cryptophagus dentatus</i> (Herbst)	I	3
<i>Cryptophagus dorsalis</i> Sahlberg	I	1
<i>Atomaria procerula</i> Erichson	I	3
<i>Atomaria peltata</i> Kraatz	I	1
<i>Atomaria fuscata</i> (Schönherr)	I	1
<i>Atomaria lewisi</i> Reitter	I	2
<i>Atomaria beroliensis</i> Kraatz	I	1
<i>Atomaria pulchra</i> Erichson	I	1
<i>Atomaria atrata</i> Reitter	I	1
Cerylonidae		
<i>Cerylon deplanatum</i> Gyllenhal	I	1
Corylophidae		
<i>Sacium pusillum</i> (Gyllenhal)	I	2
<i>Orthoperus mundus</i> Matthews	I	1
Latridiidae		
<i>Enicmus transversus</i> (Olivier)	I	1
<i>Enicmus histrio</i> Joy & Tomlin	I	1
<i>Aridius nodifer</i> Westwood	I	1
<i>Corticaria rubripes</i> Mannerheim	I	2
<i>Corticaria pubescens</i> (Gyllenhal)	I	1
<i>Corticaria lateritia</i> Mannerheim	I	1
<i>Corticarina fuscula</i> (Gyllenhal)	I	1
Colydiidae		
<i>Lasconotus jelskii</i> (Wankowicz)	I	1
Mycetophagidae		
<i>Litargus connexus</i> Fourcroy	I	2
* <i>Mycetophagus salicis</i> Brisout de Barneville	I	1
Pythidae		
<i>Pytho depressus</i> (Linnaeus)	L,I	1
Tenebrionidae		
<i>Corticeus suturalis</i> Paykull	I	1
<i>Corticeus linearis</i> Fabricius	I	1

<b>Anaspidae</b>		
<i>Anaspis rufilabris</i> (Gyllenhal)	I	1
<b>Tetratomidae</b>		
<i>Tetratoma ancora</i> Fabricius	I	1
<b>Cerambycidae</b>		
<i>Tetropium castaneum</i> (Linnaeus)	L,I	2
<i>Callidium coriaceum</i> (Paykull)	I	2
<i>Monochamus galloprovincialis</i> (Olivier)	I	1
<i>Monochamus sutor</i> (Linnaeus)	L,I	2
<i>Acanthocinus aedilis</i> (Linnaeus)	I	1
<i>Acanthocinus griseus</i> (Fabricius)	I	1
<b>Chrysomelidae</b>		
<i>Hydrothassa marginella</i> (Linnaeus)	I	1
<i>Chaetocnema concinna</i> (Marsham)	I	1
<b>Curculionidae</b>		
<i>Anthonomus pinivorex</i> Silverberg	I	1
<b>Scolytidae</b>		
<i>Tomicus piniperda</i> (Linnaeus)	I	3
<i>Hylurgops palliatus</i> (Gyllenhal)	L,I	5
<i>Hylurgops glabratus</i> (Zetterstedt)	L,I	2
<i>Hylastes brunneus</i> Erichson	I	1
<i>Hylastes cunicularius</i> Erichson	I	1
<i>Hylastes opacus</i> Erichson	I	1
<i>Pityogenes chalcographus</i> (Linnaeus)	L,I	5
<i>Orthotomicus proximus</i> (Eichhoff)	L,I	4
<i>Orthotomicus suturalis</i> (Gyllenhal)	L,I	4
<i>Xylechinus pilosus</i> (Ratzeburg)	I	1
<i>Polygraphus subopacus</i> Thomson	I	1
<i>Carphoborus rossicus</i> Semenov	I	1
<i>Crypturgus pusillus</i> (Gyllenhal)	I	2
<i>Crypturgus cinereus</i> (Herbst)	I	1
<i>Dryocoetus autographus</i> (Ratzeburg)	I	1
<i>Dryocoetus hectographus</i> (Reitter)	L,I	1
<i>Trypodendron lineatum</i> (Olivier)	I	3
<i>Ips duplicatus</i> (Sahlberg)	L,I	4
<i>Ips typographus</i> (Linnaeus)	L,I	4

## Hemiptera

<i>Dufouriellus ater</i> (Dufour)	I	1
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Notes: Six different shipments were inspected.

L = larvae/pupae, I = adults, \* = not indigenous to Sweden.

### Lists of Pests Intercepted on Logs Imported From the U.S.S.R. Into China (Reported by Department of Pest Quarantine, Peoples Republic of China)

*Blastophagus* spp. (pine bark beetles)  
*Hemiberlesia pitysofila* Takagi (pine stem scale)  
*Hyphantria cunea* (Drury) (American White Moth)  
*Ips typographus* L. (spruce bark beetles)  
*Monochamus alternatus* Hope (pine black ink wood borer)  
*Pissodes nitidus* Roelofs (red wood weevil)

*Pityogenes bistridentatus* Eichh (Russian pityogenese bark beetles)  
*Pityogenes bidentatus* Herbst. (two-teeth Pityogenes bark beetles)  
*Pityogenes bidentatus* Herbst.  
*Polygraphus sachalinensis* Egger  
*Pteleobius uittatus* F. (elm xylem bark beetles)  
*Scolytus multistriatus* (Marsham) (European elm bark beetles)  
*Scolytus ratzeburgi* Janson (birch phloem bark beetles)  
*Scolytus scolytus* Fabricius (European elm small bark beetles)  
*Bursaphelenchus xylophilus* (Steimenter & Buhrar) Nickle (pine nematode wilt)  
*Ceratocystis fagacearum* (Bretz) Hunt (oak wilt)  
*Ceratocystic ulmi* (Buisman) Moreall (Dutch elm disease)

### Bark Beetles Found on Soviet Timber Imported Into Japan

#### **Larix**

*Cryphalus latus* Eggers  
*Dryocoetes baicalicus* Reitter  
*Ips cembrae* (Heer)  
*Orthotomicus laricis* (Gyllenhal)

#### **Picea**

*Hylurgops glabratus* (Zetterstedt)  
*Hylurgops palliatus* (Gyllenhal)  
*Hylurgops transbaicalicus* Eggers  
*Polygraphus gracilis* Niijima  
*Polygraphus jezoensis* Niijima  
*Polygraphus subopacus* Thomson  
*Carphoborus teplouchovi* Spessivtseff  
*Dendroctonus micans* (Kugelann)  
*Crypturgus pusillus* (Gyllenhal)  
*Crypturgus tuberosus* Niijima  
*Dryocoetes autographus* (Ratzeburg)  
*Dryocoetes hectographus* Reitter  
*Dryocoetes rugicollis* Eggers  
*Pityogenes chalcographus* (L.)  
*Ips acuminatus* (Gyllenhal)  
*Ips duplicatus* (Sahlberg)  
*Ips typographus* (L.)  
*Orthotomicus suturalis* (Gyllenhal)  
*Orthotomicus golovjankoi* Pjatnitzky  
*Trypodendron lineatum* (Olivier)  
*Xyleborus pfilii* (Ratzeburg)

Note: *Trypodendron lineatum* (Olivier) and *Xyleborus pfilii* (Ratzeburg) are xylomycetophagous ambrosia beetles and others are phloeophagous bark beetles.

#### **Abies**

*Hylurgops glabratus* (Zetterstedt)  
*Polygraphus oblongus* Blandford  
*Xylechinus pilosus* (Ratzeburg)

*Dryocoetes striatus* Eggers  
*Dryocoetes hectographus* Reitter  
*Dryocoetes rugicollis* Eggers

#### Pinus

*Hylurgops interstitialis* (Chapuis)  
*Hylurgops spessiwezefi* Eggers  
*Ips acuminatus* (Gyllenhal)  
*Ips duplicatus* (Saahlberg)  
*Ips sexdentatus* (Boerner)  
*Trypodendron lineatum* (Olivier)

Notes: Abundant species are *Ips typographus*, *Pityogenes charchographus*, *Orthotomicus golovjankoi*, and *Polygraphus jezoensis* in *Picea*; *Polygraphus proximus* in *Abies*; *Ips cembrae* and *Dryocoetes baicalicus* in *Larix*; and *Ips acuminatus* in *Pinus*.

The most important bark beetles are *Ips typographus* in *Picea*; *Polygraphus proximus* in *Abies*; *Ips cembrae* in *Larix*; and *Ips acuminatus* in *Pinus*.

#### Scolytidae Found in Siberian Timber

*Scolytus ratzeburgi* Janson  
*Hylurgops glabaratus* (Zetterstedt)  
*Hylurgops interstitialis* (Chapuis)  
*Hylurgops palliatus* (Gyllenhal)  
*Hylurgops spessiwezefi* Eggers  
*Hylurgops transbaicalicus* Eggers  
*Polygraphus gracilis* Niiijima  
*P. jezoensis* Niiijima  
*P. proximus* Blandford  
*P. subopacus* Thomson  
*Carphoborus teplouchovi* Spessivtseff  
*Xylechinus pilosus* (Ratzeburg)  
*Dendroctonus micans* (Kugelann)  
*Blastophagus minor* (Hartig)  
*Cryphalus latus* Eggers  
*Crypturgus pusillus* (Gyllenhal)  
*C. tuberosus* Niiijima  
*Dryocoetes autographus* (Ratzeburg)  
*D. striatus* Eggers  
*D. baikalicus* Reitter  
*D. hectographus* Reitter  
*D. rugicollis* Eggers  
*Pityogenes chalcographus* (Linne.)  
*Ips acuminatus* (Gyllenhal)  
*Ips duplicatus* (Sahlberg)  
*Ips typographus* (Linne.)  
*Ips cembrae* (Heer)  
*Ips sexdentatus* (Boerner)  
*Orthotomicus suturalis* (Gyllenhal)  
*O. larcis* (Gyllenhal)

*O. golovjankoi* Pjatnitzky  
*Trypodendron lineatum* (Olivier)  
*Xyleborus pfilii* (Ratzeburg)

**List of Pests Intercepted on Siberian Timber in Korea**

*Asemum striatum*  
*Leiopus stillatus*  
*Tetropium castaneum*  
*Ips acuminatus*  
*Ips sexdentatus*  
*Ips cembrae*  
*Scolytus ratzeburgi*  
*Hylurgops interstitialis*  
*Pityogenes seirindensis*



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**Appendix B**  
**Letters of Correspondence Between**  
**APHIS and the Forest Service**

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United States  
Department of  
Agriculture

Forest  
Service

Washington  
Office

14th & Independence SW  
P.O. Box 96090  
Washington, DC 20090-6090

Reply To: 3400

Date: OCT 5 1990

Dr. James W. Glosser  
Administrator  
Animal and Plant Health Inspection Service  
U.S. Department of Agriculture  
Washington, DC 20250

Dear Dr. Glosser:

As you know, California and the Pacific Northwest forest industries are seeking alternative sources of sawtimber to offset expected harvest reductions from Federal lands. Considerable interest is being expressed in importing pine and larch logs from the Siberian forests of the USSR. We know of at least two trial shipments of Scots pine that entered through California. Those shipments were embargoed by the California Department of Agriculture and fumigated before proceeding to their destination. Much of our information on this activity came to us through the cooperative efforts of your State and National Headquarters' staffs.

While the Forest Service supports forest industry efforts to locate new supplies of raw materials, we are concerned about the potential for the introduction of exotic forest pests. Forest Service scientists who have traveled extensively throughout the USSR warn us that prospects are excellent for successful introduction and establishment of pests originating from that area into North America, since we have similarities in host species and pest genera.

We anticipate strong, continued interest by the forest industry in importing logs from Siberia and possibly other regions of the Soviet Union. We are requesting that APHIS proceed with the development of regulations to minimize the risk of introducing exotic forest pests as a result of this activity. Forest Service research scientists and pest management specialists are available to provide information and to help develop the necessary regulations. Dr. Kenneth Knauer, Assistant Director, Forest Pest Management, will coordinate our participation in this effort. He can be reached at FTS 453-9600.

Sincerely,

  
F. DALE ROBERTSON  
Chief



Caring for the Land and Serving People

FS-6200-286(4/88)



United States  
Department of  
Agriculture

Animal and  
Plant Health  
Inspection  
Service

Subject: Importation of Siberian Logs from Soviet Siberia

Date: DEC 05 1990

To: Kenneth Knauer, Assistant Director  
Forest Pest Management  
Forest Service  
Auditors Building, 2S  
Washington, D.C. 20250

As indicated in our memorandum dated November 20 to F. Dale Robertson, we are providing further information concerning the subject issue.

APHIS developed a provisional assessment for use in current efforts by a team of State and Federal regulatory and forestry agencies developing a management strategy for the importation of Siberian logs. Ongoing active involvement by your Agency is crucial to the success of this team. We view this team's efforts as the initial step toward resolving the larger issue of importation of logs. The team has determined that an expanded technical assessment is required. Because of the recognized leadership and technical credibility of the Forest Service, we request that your Agency take the lead in development of this assessment.

Discussions to this point have identified the following risk communication requirements of such a document:

- o Identify the exotic organisms with potential to be pests that may move with forest products from Siberia.
- o Assess the potential of colonization of groups or individual pests during the process of importing, processing, and utilizing logs.
- o Assess the relative potential impacts of organisms identified should they become established.

As you are aware, there is considerable interest within the technical community in this issue as well as a wide array of individuals who could contribute in this effort. We would like to meet with you at your earliest convenience to determine the scope and plan of action for this effort. Please contact Michael J. Shannon, Chief Operations Officer of our Planning and Design staff, at 436-8716.

B. Glen Lee  
Deputy Administrator  
Plant Protection and Quarantine





United States  
Department of  
Agriculture

Animal and  
Plant Health  
Inspection  
Service

Washington, DC 20090-6464

Subject: Importation of Siberian Logs from Soviet Siberia

To: F. Dale Robertson, Chief  
Forest Service

Date: CV 2

This is in response to your timely letter of October 5 expressing concern about the potential pest hazards associated with the importation of logs from Soviet Siberia. It is important that the Animal and Plant Health Inspection Service (APHIS) react in a judicious manner to this new avenue of risk to American forestry. We appreciate the opportunity to work with your staff in addressing this important issue.

APHIS and the Forest Service have worked together on this issue before. In 1983, an assessment was made of the exotic pest threat associated with wood products. One outcome of this effort was a proposal for regulating various types of wood products, including logs from temperate areas of the world. At that time such imports were rare. Now that trade patterns have changed, it is appropriate that we reexamine the need for such regulation. This matter was discussed at the October 1990 meeting of the North American Forestry Commission where interest and concern were expressed by the Canadian, Mexican, and U.S. participants. It would be appropriate to seek solutions to this problem cooperatively with Mexico and Canada.

APHIS conducted a meeting on November 6 in San Francisco to evaluate alternatives for importation of Siberian logs which would minimize the risk of introducing exotic pests. Participants included representatives from APHIS headquarters and field units, Forest Service, State regulatory agencies, Agriculture Canada, and various industries. In the process of developing an approach to managing the hazards associated with Siberian logs, we will address the need for and probable content of a Federal regulation.

We will contact Dr. Knauer of your Forest Pest Management staff to begin developing a joint position addressing this issue of mutual concern. We appreciate the opportunity to work with your scientists and technical specialists in resolving this issue.

James W. Glosser  
Administrator

cc:  
K. Knauer, FS, Washington, DC



APHIS—Protecting American Agriculture



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## Appendix C Estimated Potential Volume of Soviet Log Imports to the United States

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### Summary

The following estimations of potential Soviet log imports to the United States are based upon University of Washington (CINTRAFOR) publications; discussions with Dr. Thomas Waggener, University of Washington; and data gathered from a survey of timber companies and trading companies negotiating with the Soviet Union for trade in forest products. Survey data were gathered in confidence and can only be shared in the aggregate at this time. The purpose of estimations of potential imports is for use by the U.S. Department of Agriculture Pest Risk Assessment Team to better understand the potential scope of importation of logs from the Soviet Union. An interesting caveat arises from one assumption in particular. The assumption that Soviet economic and political changes will stay on course implies that Soviet and American intentions in forest products trade will proceed to conclusion. However, if Soviet changes do stay on course, one may conclude that a free market system with a real pricing mechanism would be established and that the ruble would become convertible on the world market. If this happens, predictions about Soviet forest products trade with the West would become difficult because no historical background exists for the transformation of command economies to free market economies.

### Assumptions

Estimates given in this appendix are based on the following assumptions:

- Volume estimates assume no significant capital investment in Soviet forest industry infrastructure.
- All U.S. imports would be in log form.
- No significant changes would occur in labor structure of the Soviet Far East and Siberia.
- No significant barriers to importation instituted by the United States.
- "Bonafide" U.S. companies would be successful in negotiations for timber contracts with the Soviet Union.
- Survey data are assumed to be accurate (company import target variations = 0).
- No unsurveyed companies are included (100 percent survey).
- Stated intentions of companies are true for the short run.
- For companies unable or unwilling to estimate volumes for U.S. import, a value of zero was used (assumes negative correlation between no volume estimates and "bonafide" company).
- Soviet economic and political changes would stay on course.

## Estimations of Soviet Timber Imports to the United States

### CINTRAFOR Studies

#### Soviet Far East (year 2000):

Potential increased output .....	800-1,200 mmbf/yr
Potential percent imported by the U.S. ....	5-10 percent/yr
Potential volume imported by the U.S. from Soviet Far East .....	40-120 mmbf/yr
Above considers problems of:	
	infrastructure constraints
	environmental & ecological constraints
	labor & capital constraints
	physical factors
	economics

#### Eastern Siberia:

No current estimates. Currently under study by CINTRAFOR .....	Xmmbf/yr
Total CINTRAFOR estimates for all U.S.S.R. ....	40-120 mmbf + Xmmbf/yr

### Industry Survey

#### Soviet Far East (6 months or more):

Potential aggregate volume imported by the U.S. from U.S.S.R. ....	200 mmbf/yr
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#### Eastern Siberia (18 months to 5 years):

Potential aggregate volume imported by the U.S. from U.S.S.R. ....	225 mmbf/yr
Total industry estimates for all U.S.S.R. ....	425 mmbf/yr

### Range Estimation

Soviet Far East (CINTRAFOR) + Eastern Siberia (Industry) = Total

40-120 mmbf + 225 mmbf = 265-345 mmbf/yr

Soviet Far East (Industry) + 225 mmbf = 425 mmbf/yr

Potential annual volume imported by the U.S. from U.S.S.R. .... 265-425 mmbf/yr

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## Appendix D Soviet Forest Resources and Host Timber Species Profiles

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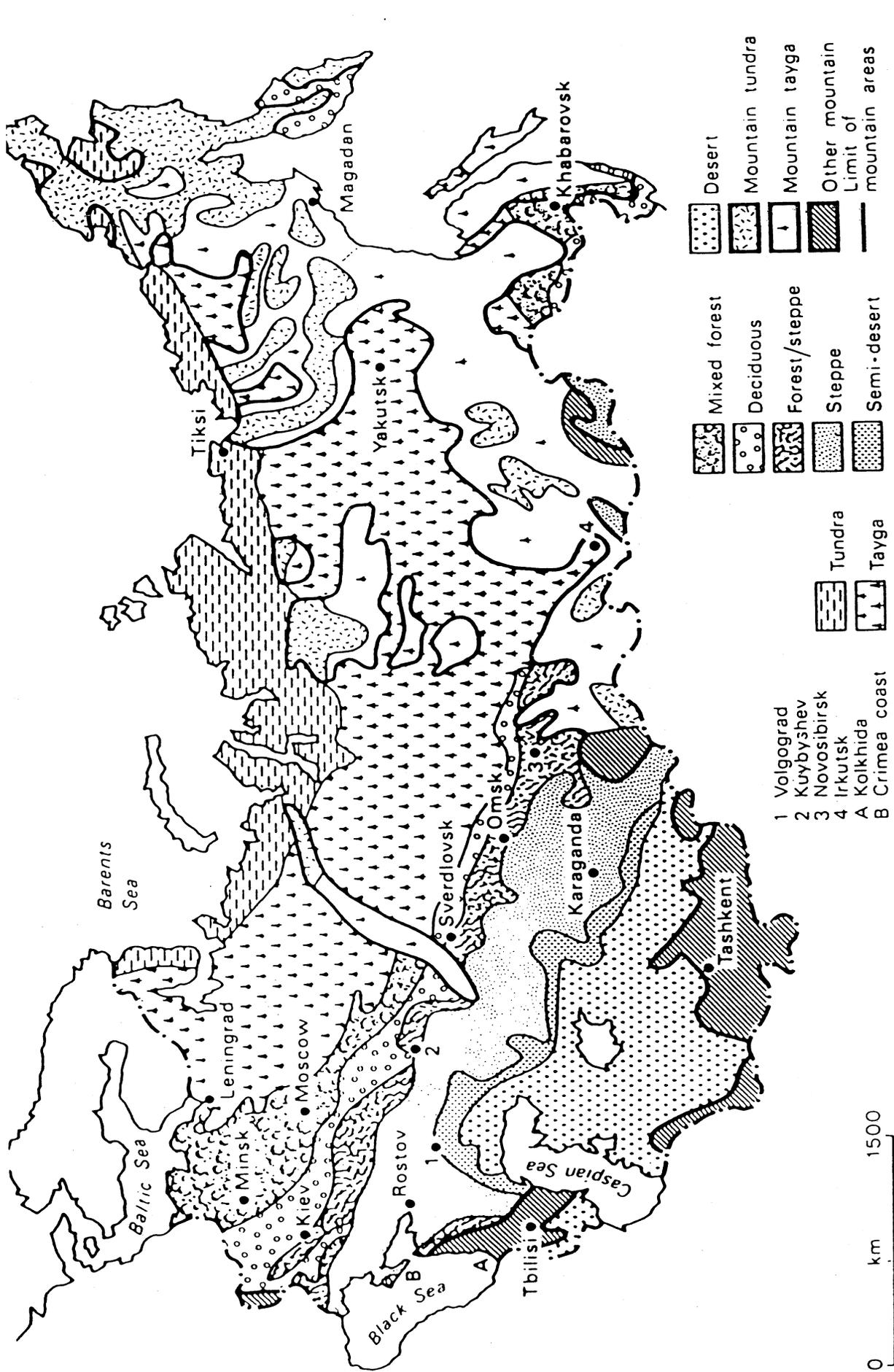
### Soviet Forest Resources

The Soviet Union has the largest forest resources, by far, of any country in the world. Altogether the Soviet Union has approximately 1,259.4 million hectares of forested land. This represents about 56 percent of the country's area. Stocked productive land accounts for 810.9 million hectares or more than 36 percent of the total area of the Soviet Union. This represents 22 percent of the world's total forest resource and more than 53 percent of the world's coniferous reserves (Holowacz, 1985). Therefore, the management and rational use of this enormous resource are increasingly becoming a matter of concern in the Soviet Union and abroad.

Although a detailed description of the vegetative zones and physiographic regions of the Soviet Union are beyond the scope of this assessment, it is useful to show the areal extent of the coniferous forest zone in order to understand the magnitude of Soviet timber resources (See figures D-1 and D-2). Generally speaking, the coniferous forest or taiga extends from the Finnish border in the west to the Pacific coast in the Far East. It extends southward into other zones of vegetation along mountain ranges, as in the Southern Urals, and in Siberia and the Far East mainly due to the effects of continentality. Coniferous species also appear in isolated mountain regions to the south, such as the Caucasus and Carpathian ranges of the European U.S.S.R.

The forest resources of the Soviet Union are unevenly distributed throughout the country. The Russian Soviet Federated Socialist Republic (R.S.F.S.R.) alone contains 94.7 percent of the forested land (Kalinin et al., 1985). This distribution has given rise to two distinct timber economies. The first, often referred to as the European-Uralian reserves, is located primarily in the most developed and populated regions of the European U.S.S.R. and West Siberia. These more productive and accessible forests have been utilized for many years, which has led to severely diminished stocking levels. Products from this region are destined for European markets and used in the national economy. In contrast, the second timber economy of the eastern forests of Siberia and the Far East is located in a sparsely populated region of the country. This region is relatively undeveloped, making the forests, for the most part, large untapped reserves. This region accounts for 33.5 percent of the Soviet forested land, 31.4 percent of the mature coniferous growing stock and nearly 25 years of exploitable hardwood resources (Barr and Braden, 1988). Products from this region are exported mainly to Japan and China and used regionally due to excessive transport costs.

The land supporting valuable stand-forming species covers 688.8 hectares; conifers account for 78.2 percent of this, tolerant hardwoods 5 percent, and intolerant hardwoods 16.8 percent. Approximately 55 percent of the Soviet mature timber volume is classified as potentially accessible forests; of that, 87 percent is made up of degraded European-Uralian growing stock, and only 48 percent of that stock is in the Asian part of the R.S.F.S.R. Nearly 40 percent of Soviet forests are mountainous or "gorniye lesa," with most land sloped greater than 30 percent (Backman and Waggener, 1990). Forty-two percent of the calculated allowable harvest east of the Urals consists of accessible coniferous forests.



Natural zones of the USSR  
 Source: Based on *Geograficheskiy atlas SSSR dlya 7-8 klassov*, Moscow 1966, pp. 6-7

Figure D-1. Natural Zones of the U.S.S.R.

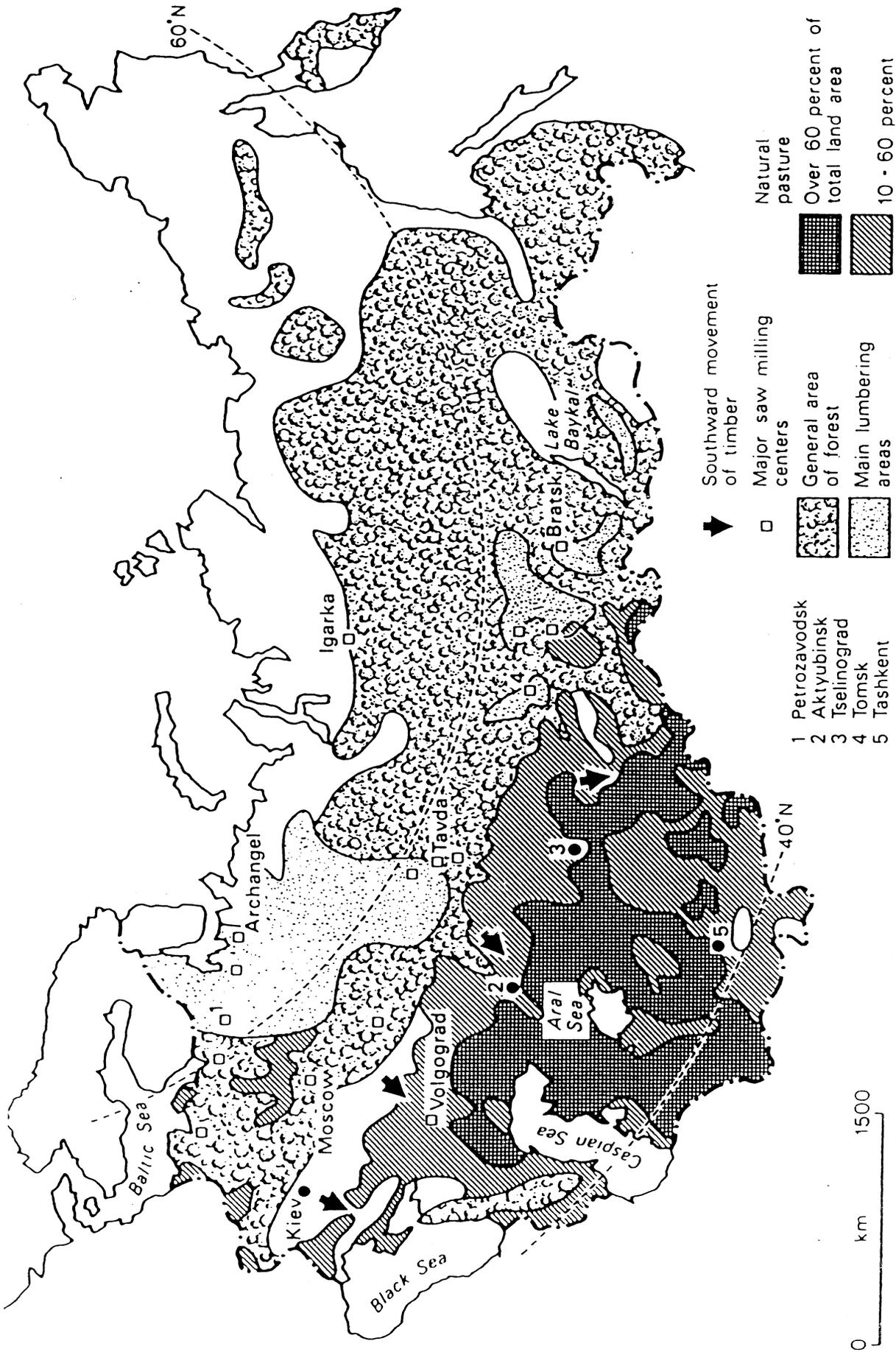


Figure D-2. Natural Pasture and Forestry

## Species Distribution

Because of its size and location, the Soviet Union has a wealth of arboreal and floristic diversity. Of the 570 recognized timber species in the U.S.S.R., only 30 are economically significant. Although the hardwood species are important components of the forest inventory, most commercial timber is of a coniferous species generally restricted to the family Pinaceae. Thirty-five members of the family Pinaceae are represented in the Soviet Union. More than 24 species are found in Siberia and the Far Eastern territories of the Russian Republic. Of these, at least 14 are major commercial species that have potential value as exports to the Pacific Northwest (Holowacz, 1985).

The coniferous zone of Siberia and the Far East is characterized by four main genera: *Abies*, *Larix*, *Picea*, and *Pinus*, which are further divided along forest types and densities. The dark taiga or "dark conifers" consist of the various spruce-fir associations and stone pine as opposed to the "light conifers" that consist of larch and pines. The "white taiga" often refers to a mixed-wood forest that develops after a disturbance, such as fire or logging. This forest is characterized by a strong component of birch and other early successional hardwoods.

## Problems of Development

Despite seemingly inexhaustible timber reserves, the Soviet forest products industry lags disproportionately behind other timber producing countries in the West (notably the United States, Canada, Finland, and Sweden) in both the production and use of forest resources. Moreover, the Soviet forest products industry is not proportionate to the size and quality of the country's timber resources and plays an insignificant role in the national economy as compared to other industrialized nations (Barr and Braden, 1988).

Many problems exist in the Soviet forest products industry, particularly as they relate to the development of the forest resources in East Siberia and the Soviet Far East. Among the more exigent problems limiting the development of the forest products industry in Siberia and the Far East are the accessibility of timber stands, the lack of adequate infrastructure, the low level of harvesting and manufacturing technology, and the chronic labor shortages of the region. Add this to the inherent costs and problems of working in the extreme climatic conditions of the region and timber harvesting becomes a difficult and often economically unfeasible operation.

During the past decade the central government has encouraged intensive development of the timber economy in an effort to reduce wastes and increase overall production. However, up to this time the Soviet government has been unable to sufficiently direct investment into the forestry sector. This is manifested in the sector's inability to manufacture value-added timber products that meet world market standards. As a result, more than 95 percent of the timber exported from the Far East is in round or raw material form (that is, non-value added), whereas forest products exports of other major timber producing countries show an average of about 12 percent roundwood and raw material exports (Grabovskiy, 1988).

## Logging Techniques

Approximately 50 percent of the timber logged annually in the Soviet Union is harvested in the 4 months from December to March (Varaksin, 1971). This is because of the inferior quality of the road surfaces from the upper landings to the lower landings. These roads are most suitable for transport during the heavy frosts of winter. In contrast, during the spring thaw and the wet autumn periods, logging productivity is greatly reduced due to poor soil conditions. However, logs may be stored at upper and lower landings for a considerable period of time until transportation to a processing facility becomes available (Blandon, 1983).

Logging technology in the Soviet Union can be classified into two techniques: (1) conventional logging (felling by chain saw, delimiting by axe, choker, and skidding by tracked vehicle using some log winches), and (2) mechanized logging (feller-buncher/grapple skidder system). In recent years, conventional logging practices have come under attack from the central government. This method produces excessive wastes and is labor intensive. On the other hand, the Soviets have been unable to significantly increase the level of mechanization

in the forest products industry. It is assumed that foreign technology will play a large role in the future modernization of the industry. Table D-1 shows the variations in logging operations according to the types of activities performed on sites during the logging process. The method used depends on the location and accessibility of the timber being harvested and the available equipment and technology.

### **Transportation**

The future development of timber resources in East Siberia and the Soviet Far East is closely tied to the transportation networks of the region—namely the railroads (see figure D-3) and, to a lesser degree, the highways. There are two major railroads in the Eastern Soviet Union. One, the Trans-Siberian line, completed in the early 1900's, has been essential to the early development of the eastern regions. The second, the recently constructed Baykal-Amur Mainline (BAM) is another important part in the current and future development plans of the region. Indeed, recent logging expansion has occurred in areas adjacent to the BAM. Table D-2 presents data on the basic forest resources of this region and their current use. In addition, many other natural resources (coal, gold, diamonds, and so forth) are found throughout the region.

Another railroad, the Amur-Yakutsk Mainline is currently under construction. It will extend from the city of Tynda in Amur Oblast to the northern city of Yakutsk. Only about one-third of the distance has been covered to date (Cardellichio et al., 1989). This railroad will open up large tracts of previously untapped larch reserves north of current logging operations in the Yakutsk A.S.S.R.

The primary railheads in Siberia and the Far East where logs are loaded onto trains and transported to the coast are in the cities of Krasnoyarsk, Irkutsk, Ulan-Ude, Chita, Tynda, and Khabarovsk. Undoubtedly, other railheads will be designated as new logging sites are developed and as rail links are expanded into remote regions.

### **Soviet Forest Classification**

The forests of the Soviet Union are divided into three groups for managing and regulating timber production and forest use. This tripartite classification scheme has been in effect since April 1943 and categorizes forests according to their significance in the national economy. In general, Group 1 and 2 forests are managed for resource conservation and environmental protection and Group 3 forests are used by the timber industry. Group 1 forests currently represent about 20 percent of the total forested area. This group is the most protected of the forested areas. All of Group 1 forests are considered nonexploitable; however, some sanitary and selective cutting is permitted.

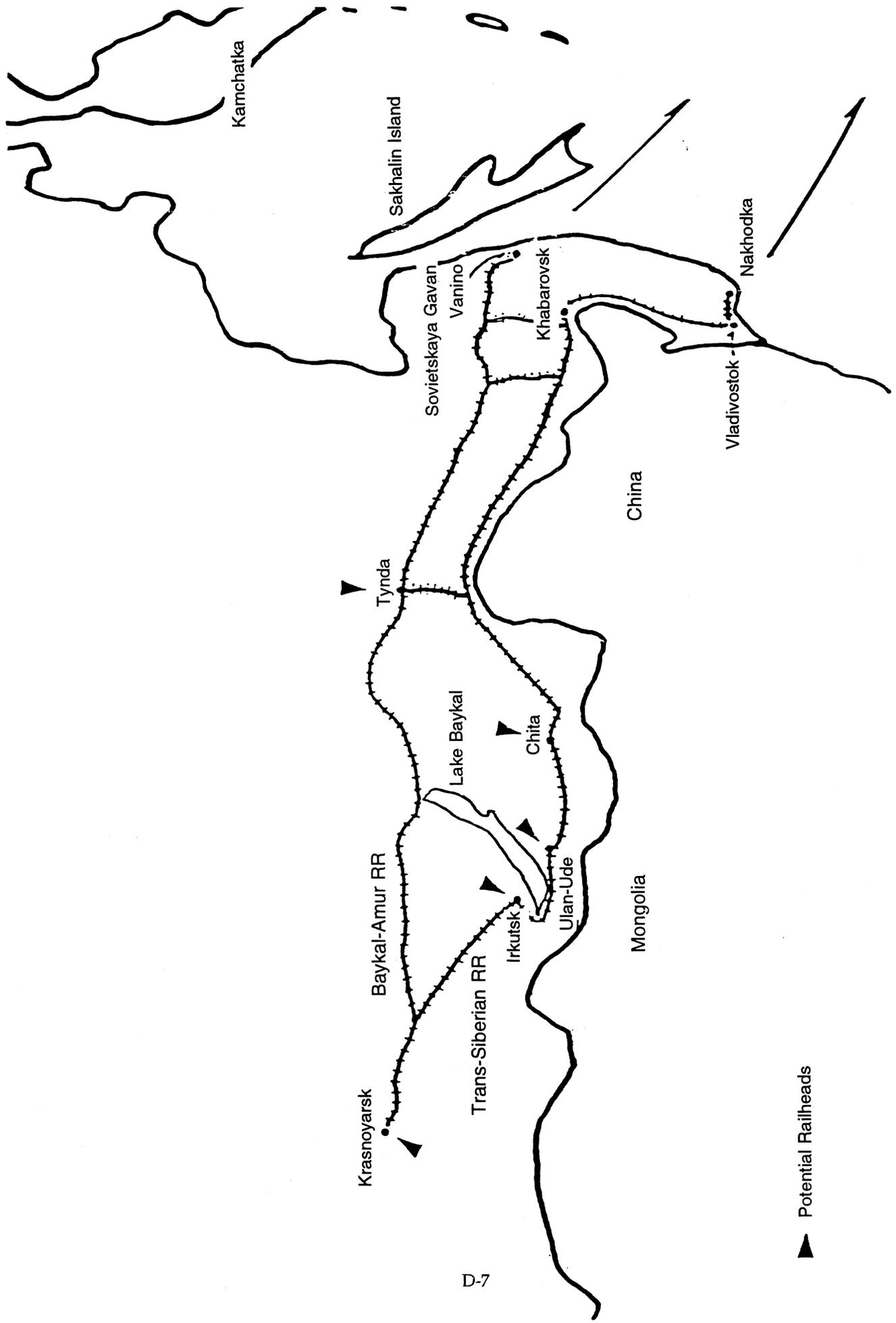
Group 2 forests occupy approximately 7 percent of the forested area. This management group includes restricted forests where some degree of regulated harvesting is allowed (Cardellichio et al., 1989). The remainder of Soviet forests are classified into Group 3. This makes up about 73 percent of the total forested area (Kalinin et al., 1985). These forests are suitable for commercial exploitation. Group 3 forests comprise 45 percent of the European state forest area and 84 percent of that in Asia (Barr and Braden, 1988). For a more complete discussion of this classification scheme, see Kalinin et al., 1985; Chapter 3, Barr and Braden, 1988; or the "Fundamental Forestry Legislation of the U.S.S.R. and Union Republics."

Table D-1. Variations of the Logging Process in the U.S.S.R.

Operation	Skidding Whole Trees Hauling			Skidding Tree Length Hauling			Skidding and Hauling	
	Whole Trees	Tree Length Logs	Length Assortment	Tree Length	Length Assortment	Length Assortment	Length Assortment	
Cutting unit								
Tree felling	+	+	+	+	+	+	+	+
Limbing	-	-	-	-	-	-	-	-
Bucking	-	-	-	-	-	-	-	-
Skidding	+	+	+	+	+	+	+	+
Upper landing								
Limbing	-	+	+	-	-	-	-	-
Bucking	-	-	+	-	-	-	-	-
Sorting of roundwood	-	-	+	-	-	-	-	-
Decking	+	+	+	+	+	+	+	+
Loading	+	+	+	+	+	+	+	+
Hauling on forest roads	+	+	+	+	+	+	+	+
Lower landing								
Unloading	+	+	+	+	+	+	+	+
Limbing	+	-	-	-	-	-	-	-
Bucking	+	+	-	+	+	+	+	+
Sorting of roundwood	+	+	-	+	+	+	+	+
Loading on train or water transport	+	+	+	+	+	+	+	+

Note: + = does occur during harvesting.  
 - = does not occur during harvesting.

Source: Gorunov and Sadovnichii, 1985.



D-7

Figure D-3. Potential Flow of Timber for Export to the United States

**Table D-2. Forest Resources in the Baykal-Amur Mainline Zone and Their Use**

Republics, Oblasts and Krays	Mature and Overmature Stands		Marketable Volume, (billions m <sup>3</sup> )	Calculated Allowable Cut, Million m <sup>3</sup>		Current Volume Logging (million m <sup>3</sup> )
	Area in (million ha)	Reserves in (billions m <sup>3</sup> )		Total	Incl. Conifer Stocks	
Irkutsk Oblast	11.2	2.0	1.6	29.3	25.5	2.4
Buryat A.S.S.R.	3.3	0.4	0.2	7.6	7.4	0.8
Chita Oblast	4.8	0.5	0.4	5.4	5.4	--
Amur Oblast	6.4	0.8	0.6	18.6	15.1	2.5
Yakutsk A.S.S.R.	22.1	2.9	2.0	35.2	34.8	1.0
Khabarovsk Kray	11.0	2.1	1.5	36.3	31.7	9.8
<b>Total</b>	<b>58.8</b>	<b>8.7</b>	<b>6.3</b>	<b>132.4</b>	<b>119.9</b>	<b>16.5</b>

Note: -- Not available.

Source: Kiryukhin and Loginov, 1986.

### Forest Zonation of the Coniferous Taiga

The boreal coniferous forest zone or taiga is characterized by four subzones distinguished by spatial distribution and the flora. Except for the extreme maritime regions, forest productivity and species diversity are a direct function of latitudinal gradient and elevation (Kurnayev, 1973). The taiga consists of the following subzones:

- **Pretundra Sparse or Spacious Taiga Subzone**—A transitional area from tundra to forest that is characterized by sparse stands of extremely low productivity and tundra-like ground cover. Permafrost and gley podzolic soils are dominant in this region.
- **Northern Taiga Subzone**—This subzone consists of somewhat denser but still quite dispersed conifer forests. The ground cover consists of mosses or lichens on the frozen soil. Numerous herbaceous species and heaths such as crowberry, bog-bilberry, and ledum grow in marshy areas of the more southern subzones.
- **Central Taiga Subzone**—This area is covered by dense conifer stands of somewhat higher productivity class III. Green moss, principally whortleberry, dominates the understory, and the soils are typical podzols.
- **Southern Taiga Subzone**—Commercially important conifer stands of high productivity (classes I and II) are typical of this zone. There is a well-developed grassy ground cover of boreal, nemoral species, and weakly developed mosses. The grasses are almost steppe-like and present a fire hazard in the fall. Deciduous forest zones with a narrow-leaved overstory and broad-leaved understory begin at the southern end of the subzone. The soils are of the old sod-podzol classification.

The following criteria were used for selecting conifer species in these profiles. Tree species profiled are located in the Soviet Far East or Eastern Siberia. Because of economic considerations, timber exported to the Western United States is expected to come only from these areas of the Soviet Union.

In addition to the genus *Larix* spp., the following are the primary export species (listed by genera): *Abies* spp., *Picea* spp., and *Pinus* spp. Profiles of *Larix* spp. are followed by *Pinus* spp., *Abies* spp., and *Picea* spp. respectively. For simplification of the risk assessment process, closely related species may be grouped together under their appropriate genera. However, representative species were selected for some genera because their host infestations are species specific. These genera were selected by industry, university, and government representatives because of their high potential for export to the United States.

### Host Timber Profile

#### Family Pinaceae Lindl. Genus *Larix* Mill.—Larch

Most Soviet exports to the Pacific Northwest will be *Larix* spp., or larch, from the relatively untapped boreal reserves in Eastern Siberia and the Far East. Therefore, the first profile presented focuses on the genus *Larix*. Other potential host species, from the genera *Abies*, *Picea*, and *Pinus* are listed after the *Larix* spp. in this appendix.

The genus *Larix* reaches its greatest global concentration and diversity in the Soviet Far East. More than half the world's larch species grow in the U.S.S.R. Larch forests cover vast areas; more than 40 percent of the commercial timberlands in the U.S.S.R. are larch. The greatest distribution of larch forest occurs in Eastern Siberia and the Far East region, accounting for almost 50 percent of the forest resources (Barr and Braden, 1988). Larch forests in the U.S.S.R. exceed 274 billion hectares, with wood reserves of more than 28 million cubic meters (m<sup>3</sup>). The largest larch forests are found in Eastern Siberia (78.6 percent) and in the Far East (19.4 percent) (Tsepilyayev, 1965).

Depending on the taxonomic sources (Sokolov et al., 1977), most references cite 11 larch species in the U.S.S.R., with 9 occurring in Siberia and the Far East. Larch species are geographically distributed as follows:

#### European-Uralian Soviet Union and Western Siberia:

- L. decidua* Mill ssp. *polonica* Racib.—European or Polish larch
- L. sibirica* Ledeb.—Siberian larch
- L. sukaczewii* Djil. Dyl.—Sukachev's larch

#### Eastern Siberian and Far Eastern Soviet Union.

- L. amurensis* B. Kolesn.—Amur larch
- L. czekanowskii* Szaf.—Czekanowskii larch
- L. gmelinii* (Rupr.) or *L. dahurica* Turcz. et Trautv.—Daur larch
- L. kurilensis* Mayr.—Kuril larch
- L. lubarskii* Sukacz.—Lubarski larch
- L. maritima* Sukacz.—Maritime larch
- L. ochotensis* B. Kolleen—Okhotskaya larch
- L. olgensis* A. Henry—Olgenskaya larch

Most of these species are limited in their range and economic importance. Larch appears in many varieties and ecotypes that are not different morphologically, but differ considerably in tolerance to unfavorable soil and temperature conditions. Because of their geographic distribution and accessibility, three tree species are commercially important and represent the most likely exports to U.S. markets. These major species, *Larix sibirica*, *Larix gmelinii* (*dahurica*), and *Larix amurensis* are indistinguishable from other local larch species.

***Larix sibirica*—Siberian larch—Listvennitsa sibirskaya**

**Range:** Siberian larch grows mostly in Western Siberia, where it occupies significant areas; from the permafrost limits on the northern border to the edge of the semi-desert in the south (Kalinin et al., 1985). The range of Siberian larch extends east into the northeastern European U.S.S.R., east into the western half of Siberia, north to the lower reaches of the Yenisey River (69° 40') and Pyasina River (70° 15'), and south to the western foothills of the Altay, Saur, and Tarbagatay ranges (47° north latitude). Larch grows at elevations of up to 2,500 meters in the Saur mountains.

**Silvics:** Like North American larches, *L. sibirica* is a relatively fast growing, deciduous, and intolerant conifer. Siberian larch is often found in permanently frozen ground and frequently in deep organic soils or peat bogs. Siberian larch has more selective soil nutrient requirements, especially calcium, than other conifers. On deep, well-drained soils, larch develops a deep root system with strong lateral roots, but in areas with frozen soils, the root system is shallow and the tree is subject to windthrow.

Larch is found in pure stands and often in association with other boreal conifers such as *Picea obovata*, *Pinus sibirica*, *Abies sibirica*, and shade intolerant hardwoods. Natural regeneration through seeding on burned-over areas is common. However, on these areas, because of the less selective demands, former larch stands are replaced by pine. The typical successional pattern after disturbance is birch and aspen, followed by pine and larch.

Larch is monoecious, it flowers in the spring, and produces seeds at the age of 12 to 15 years in open stands. However, in closed stands, 20 to 50 years is more common. Large seed crops are produced at intervals of 3 to 5 years.

Growth rate:	age (years)	10	20	50	100	150
	height (meters)	2.8	7.8	17.6	27.0	32.7

Like all larches, Siberian larch is characterized by rapid, early growth and good form. Larch reaches a volume of 300 to 400 m<sup>3</sup> per hectare on only the best sites.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 40 to 45 meters

**Diameter:** Up to 1.5 meters

**Maximum Age:** 400 to 450 years (oldest documented tree—900 years)

<b>Wood Characteristics:</b>	Moisture content	Air dry
	Specific gravity	0.56
	psi MOR (Modulus of Rupture)	1,200
	psi MOE (Modulus of Elasticity)	1.45
	psi compression parallel	5,545

**Logging, Transport, and Storage:** Larch is generally harvested in the winter (skidded log or tree lengths) and processed on secondary landings, where it may be cold-decked in storage for up to 9 months or more (Gorunov and Sadovnichii, 1985). The heaviness of the wood prevents it from floating. Thus, transport to processing facilities depends on the railway system. Special procedures, such as hot water thawing before sawing, are used for larch and other boreal species.

Due to extreme butt flair or swelling (sometimes exceeding 50 to 70 centimeters), longer saws and felling time are required for logging. Sparse crowns make delimiting easier but also result in greater breakage,

particularly under extreme temperature conditions. Branches and tops of standing timber are brittle and create a safety hazard for loggers in the cold weather (Kalinin et al., 1985).

**Primary and Secondary Uses:** Larch is dense, heavy, durable, extremely strong, and resistant to decay. Siberian larch is used for poles, mine props, marine pilings, sawtimber, parquet, export logs, pulpwood, chips, and firewood. It is used in fine woodworking for beautifully textured decorative material (Kalinin et al., 1985). Larch bark is used for tanning and dyeing substances as well.

Although larch or tamarack is now regarded as a low-value softwood in other parts of the world, larchwood was so popular in the mid-19th century that a severe restriction on its use was imposed in the Russian Empire. During the past three centuries, larch was used in the construction of water works in St. Petersburg and Venice, in churches in Poland, and in barrel manufacturing in Germany. Larchwood was used for making the floors of the Kremlin in Moscow, the doors and windows at the Winter Palace in St. Petersburg, and for structural materials in building St. Basil's Cathedral (Exportles, 1986).

Unfortunately, larchwood has a high resin content that tends to degrade equipment and make harvesting larch unprofitable. In the mid-1980's, the Japanese industry made a technological breakthrough that led to moderate success in using larch for veneer to replace lauan in plywood (Barr and Braden, 1988).

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

*Larix dahurica* Turcs.—Daurian larch—Listvennitsa daurskaya

or

*Larix gmelinii* (Rupr.)—Gmelini larch—Listvennitsa gmelini

**Range:** The eastern boundary of the Siberian larch territory marks the transition to Daurian larch. There is some degree of hybridization at this interface zone that creates Czekanowskii larch (*L. czekanowskii* Szaf.) Daurian larch exceeds the range of *L. sibirica*. It is the dominant eastern larch species and is widespread in Eastern Siberia and the Soviet Far East. In the North, it grows throughout the Irkutsk Oblast to the northern edge of forest vegetation where it acquires shrub-like characteristics. It grows on a variety of sites from river bottoms to a maritime climate and at high elevations. Its southern range extends into Manchuria and Northern Japan.

There is some confusion over the taxonomic difference between Daurian and Gmelini larch. Although the two species are now classified as one, according to a personal communication with Elias, 1991, Gmelini larch does not appear in the south of the Kamchatka peninsula, although Daurian larch is present. Daurian larch is one of the most frost-tolerant species in the U.S.S.R., and that explains the widespread distribution of Daurian larch in extreme climates.

**Silvics:** Like Siberian larch, *L. gmelinii* is a relatively fast-growing, deciduous, and intolerant conifer. *L. gmelinii* is distinguished from *L. sibirica* by its mature cones that have smaller scales and fewer scales, smaller seeds, and shorter, lighter needles (Kalinin et. al, 1985). The height and diameter of this larch is less than *L. sibirica*. Otherwise, their phenological and silvical characteristics are similar.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 30 to 35 meters (4 to 6 meters on poor sites)

**Diameter:** 0.8 to 1.0 meters

**Maximum Age:** 400 to 450 years

**Wood Characteristics:** Moisture content kiln dry (10 to 15 percent, based on 1990 U.S. industry tests of Daurian larch harvested in the Irkutsk area).

Specific gravity	0.64
psi MOR	1,205.00
psi MOE	1.86
psi compression parallel	2,914.00

**Logging, Transport, and Storage:** The same logging methods and processing used for *L. sibirica* are used to harvest *L. gmelinii*. *L. gmelinii* is often susceptible to frost cracks on the bole that result in dangerous splintering of the main stem during felling operations.

**Primary and Secondary Uses:** Primary and secondary uses of *L. gmelinii* are the same as for *L. sibirica*. According to British sources, the quality of Daurian larch is outstanding and is used widely due to its moisture-resistant properties, as compared to a tropical hardwood such as greenheart (*Ocotea rodiaei*). Because of its slow growth cycle, the wood is extremely dense with as many as 25 to 30 rings per inch.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** High

*Larix amurensis*—Amur larch—Listvennitsa amurskaya

**Range:** *L. amurensis* has a limited range restricted to the southeastern corner of the Soviet Union, which consists of Amur Oblast, southern Khabarovsk Kray, and part of the Maritime Kray of the Far East. Although the Amur and Ussuri Rivers mark the southern boundary of the U.S.S.R., the range of *L. amurensis* extends into Northern Manchuria.

**Silvics:** Like other Soviet larches, *L. amurensis* grows fast and is tolerant of drought, frost, insects, disease, soil compaction, and fire (Tseplyayev, 1965). It does not require much moisture and prefers calcareous soils. Morphologically and taxonomically, *L. amurensis* is an extraordinary species, but its origin may be attributable to hybridizations with *L. gmelinii*, *L. maritima*, and *L. olgensis* (Sokolov et al., 1977). It is more sensitive to frost and grows poorly on boggy sites. It regenerates well in clearcuts and after prescribed burns. Because of its southern range, it can be found growing with Mongolian oak (*Quercus mongolica*) and other tolerant broad-leaved species on river terraces of the Amur River and its tributaries. *L. amurensis* is often found with other conifers of the Soviet Far East, such as *Pinus koraiensis*, *Picea ajanensis*, and *Abies nephrolepsis*.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 30 to 35 meters (4 to 6 meters on poor sites)

**Diameter:** 0.8 to 1.0 meters

**Maximum Age:** 400 to 450 years

<b>Wood Characteristics:</b>	Moisture content	Air dry
	Specific gravity	N/A
	psi MOR	N/A
	psi MOE	N/A
	psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** The same logging and processing methods used for *L. sibirica* and *L. gmelinii* are also used for *L. amurensis*. A somewhat milder climate and easier access to a port reduces the storage and transport time for *L. amurensis*, compared to *L. sibirica* and *L. gmelinii*.

**Primary and Secondary Uses:** *L. amurensis* has the same uses as *L. sibirica* and other larches.

**Importance to Soviet Timber Economy:** Important

**Potential Export Value to Pacific Northwest:** High

**Family Pinaceae Lindl. Genus *Pinus* L.—Pine**

Pines are some of the most valuable commercial tree species in the northern coniferous zone of the Soviet Union. Pines constitute 23.5 percent of the Soviet Union's total commercial timberland. Approximately 110 million hectares of pine are potentially exploitable, which represents a reserve of 15 billion m<sup>3</sup> (Tseplyayev, 1965).

The highest proportion of common, or Scots pine, stands (*P. sylvestris*) occurs in the Northwest and Western Siberia. Scots pine forests in the Transbaykal and Far East region are dense, slow-growing stands with low site quality. More than 2 million hectares of Aldan pinewoods in the Yakutsk Autonomous Soviet Socialist Republic (A.S.S.R.) and Khabarovsk Krai are of considerable economic significance and may be harvested for their export potential (Tseplyayev, 1965).

Of the 14 species of the genus *Pinus* native to Eurasia, 8 are indigenous to the Soviet Union, according to Sokolov et al. (1977). However, Tseplyayev (1965) has documented all 14 species present in the Soviet Union. Five *Pinus* species are present in Siberia and the Far East. Pine species are geographically distributed as follows and appear in order of economic importance:

European-Uralian Soviet Union and Western Siberia:

- P. sylvestris*—Scots pine, Scotch pine, red pine, common pine, redwood, Russian pine
- P. cembra*—European cedar pine
- P. brutia*—Calabrian pine
- P. pallasiana* D. Don—Crimean pine

Eastern Siberian and Far Eastern Soviet Union:

- P. sylvestris*—Scots pine, Scotch pine, red pine, common pine, redwood, Russian pine
- P. sibirica* Du Tour—stone pine, cedar, cedar pine
- P. koraiensis* Siebold et Zucc.—Korean cedar, Korean cedar pine, Manchurian cedar pine
- P. funebris* Kom. or *P. densiflora* Siebold et Zucc.—funeral pine
- P. pumila* (Pall.) Regel—Japanese stone pine

Of these, only two species, *Pinus sylvestris* and *Pinus sibirica* (which is restricted mainly to the Asian region), are commercially important. Korean pine, or as it is sometimes called, Manchurian cedar pine (*Pinus koraiensis*), is also of regional significance, but it is a slow-growing species and cutting is now banned in the Soviet Union.

***Pinus sylvestris* L.—Scots Pine, Scotch pine, red pine, redwood, common pine, Russian pine—Sosna obyknovennaya**

**Range:** The Scots pine has the widest range of any pine species in the world. It is found throughout the Soviet Union from the Kola Peninsula (70° N. latitude) and White Sea to the southern slopes of the

Verkhoyansk Range and the Sea of Okhotsk. Its territory includes the Altay mountain range and extends into Central Asia (as far south as 48° 20' N. latitude). The southern border of this pine's range in the European Soviet Union extends into southern Volyny and the Kiev Oblast through Dnepropetrovsk, Saratov, Kuybyshev, and the Chelyabinsk Oblasts. The Scots pine is also found in the eastern Crimea and Transcaucasia. It often grows in patches or strips referred to as a pine "bor."

**Silvics:** The silvics of Scots pine are well documented, because of its commercial importance in Western Europe and its cultural history of tree improvement. However, because of its large geographic range, the species is polymorphic and a number of distinct varieties or ecotypes are recognized; this may explain the discrepancy in the number of pine species in the Soviet Union. On dry sandy soils, considerable areas are covered with sparse pine stands of poor quality. Except for junipers, the understory is absent and the ground cover is an uninterrupted carpet of lichen and forest mosses. On sandy podzolized soils with more moisture, the growth is better. Podzolized soil with a neutral pH or podzolic soils with a hardpan (compacted soil layer) often have rich herbaceous flora. On such soils, pine is often found with other tree species, such as *Picea obovata*, *Larix* spp., *Pinus sibirica*, and *Abies sibirica*. Pine grows well on rich chernozem, cool sphagnum bogs, and areas of permanently frozen subsoil.

Scots pine is a two-needled, hard pine with a variable form and commercial value. Primeval forests of the northern taiga are growing with a clean bole and symmetrical crown with fine branches. Southern varieties grow faster, but are characterized by wider crowns and thick horizontal branches. However, open growth stands of Scots pine have knotty branches, deformed boles, and low commercial value. Natural regeneration of pine is prolific after fire; most of the mature even-aged stands were established as a result of forest fires. Scots pine begins to reproduce at 30 to 40 years, but reliable seed production only begins at 60 to 70 years. Small round cones, 2.5 to 7 cm in length, produce approximately 1,000 seeds at 3- to 5-year intervals, but this is dictated by climatic conditions. In northern regions, the interval between seed years may be as long as 10 to 30 years.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 20 to 40 meters

**Diameter:** Up to 1.0 meters

**Maximum Age:** 350 to 400 years

<b>Wood Characteristics:</b> Moisture content	12 percent
Specific gravity	0.46
psi MOR	1,290.00
psi MOE	1.45
psi compression parallel	6,875.00

**Logging, Transport, and Storage:** The Scots pine is generally harvested in the winter, skidded log or tree length, and processed on secondary landings, where it may be cold-decked in storage for 9 months or longer (Gorunov, 1985). Pine is almost as dense as larch (particularly the old growth), but it usually floats. Rail and water transport are used to bring the pine to market. The crown is more developed with longer branches on the south side of the tree. During severe cold, the tree trunk can split and splinter as far down as 1 to 1.5 meters off the ground. Brittle branches often break off and shatter when they hit the ground.

**Primary and Secondary Uses:** According to British sources (Bulkeley, 1978), the forests of the Krasnoyarsk region of Eastern Siberia produce the finest quality redwood in the world. The extreme climate of the central Siberian plateau causes the slow growth that results in beautifully textured, close-grained redwood (Angaa or kondo pine). Structural timber, poles, industrial cut stock, and pulpwood are the primary uses of Scots pine.

Pine supplies many chemical compounds and naval stores, such as turpentine, resin, pitch, rosin, and others. Pine needles are a source for chlorophyll-carotene, compounds for perfume, and wood meal for livestock or wood-concrete bricks (Kalinin et al., 1985). Naval stores and chemical products are extracted from the stumps for 10 to 15 years after the timber is harvested.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

***Pinus sibirica* Du Tour—Siberian pine, stone pine, cedar, cedar pine—*Sosna kedrovaya sibirskaya***

**Range:** Except for some areas in Northeastern European Russia, the range of *P. sibirica* is restricted to Asia. This pine is found throughout most of Siberia and occurs widely in the Urals. Its range extends throughout an area circumscribed by the upper reaches of Vychegda River, the northern Urals at 66° north latitude, the lower Ob and Yenisey (at 68° 12'), the upper reaches of the Aldan River, northern Mongolia, the Altay (48° 15') mountains, and the southeastern Urals (57° north latitude). The Siberian pine is found at elevations up to 2,500 meters.

**Silvics:** Stone pine forests occupy more than 23 million hectares in the Soviet Union. *P. sibirica* is a shade-tolerant, five-needle, soft pine that is often found growing with *Abies sibirica* and *Picea obovata*, making up the dark taiga. It also grows with various *Larix* spp. and shade-intolerant hardwoods. These large diameter, old-growth stands are partially protected against harvesting.

In its natural range, *P. sibirica* is found at mountaintops, along water courses, and in peat bogs along river valleys. *P. sibirica* is a tolerant species that grows on a variety of soils, but it grows best on level, deep, rich, and well-drained loams. In *sphagnum* bogs, it tolerates the excessive moisture and grows better than Scots pine. In the Soviet Far East, it grows on permafrost soils. It suffers catastrophic damage from forest fires and shows little or no ability to regenerate directly on burned areas. The natural regeneration of stone pine seems to be the most difficult silvicultural problem. This is accomplished most successfully through the predation and deposition of seed by birds and small mammals.

At maturity (plus or minus 50 years), *P. sibirica* flowers from May to June and the cones mature after 18 months. It produces seeds every 2 to 3 years and sometimes every 5 to 6 years. Although it produces fruit for as long as 250 to 300 years, its maximum fruiting occurs between 100 and 150 years (Kalinin, 1985).

**Insects and disease pathogens:** *Dendrolimus sibiricus*, the silkworm moth, is the most dangerous pest of *P. sibirica* in Siberia. See Appendix H for detailed descriptions of the pests of genus *Pinus* in the U.S.S.R.

**Height:** 40 to 45 meters

**Diameter:** 1 to 1.5 meters

**Maximum Age:** 500 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** Both rail and water transport are used to bring Siberian pine to market.

**Primary and Secondary Uses:** Siberian pine provides valuable timber for industrial cut stock, joinery, and the pencil industry. It has a fragrant, resinous odor, hence the common Russian misnomer of "cedar" or "cedar-pine." Its durable, soft wood is good for woodworking. The sapwood is yellowish-white and the heartwood is light pink (Kalinin et al., 1985).

The seeds and cones, or "nuts" as they are called locally, are collected by the Siberian population for human consumption and oil. From 1 hectare of old stone pine, 50 to 200 kilograms of nuts may be harvested. From 1 ton of nuts, 200 kilograms of oil or pine nut butter can be produced. The best crop yields are in open stands 80 to 150 years old.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

**Family Pinaceae Lindl. Genus *Abies* Mill.—True fir**

The true firs occupy 2.3 percent of the forest area of the Soviet Union, and 95 percent of the exploitable fir forests occur in Siberia and the Soviet Far East. Among the commercial tree species, the genus *Abies* or true firs has a species (Sokolov et al., (1971) lists 10 species); 6 species are localized, well-distributed, and represented in the Asian taiga. These species are geographically distributed as follows and appear in order of economic importance:

European-Uralian Soviet Union and Western Siberia:

- A. sibirica* Ledeb—Siberian fir
- A. alba* Mill.—Silver or European fir
- A. nordmanniana*—Caucasian fir

Eastern Siberian and the Soviet Far East:

- A. sibirica* Ledeb—Siberian fir
- A. holophylla* Maxim—Wholeleaf fir
- A. nephrolepsis*—(Trautv.) Maxim—Amur, Khingan, or Whitebark fir
- A. gracilis* Kom.—Slender fir
- A. mayriana* (Miyabe et Kudo)—Mayerova fir
- A. semenovii* B. Fedtsch.—Semenova fir
- A. sachalinensis* Fr. Schmidt—Sakhalin fir

Localized distribution and domestic consumption importance make it hard to determine which species may be exported to the United States or the Pacific Rim. All six Soviet Far Eastern firs have been profiled, but more information is available about *A. sibirica* and *A. holophylla* because of their wide range, higher value, and greater export potential.

***Abies sibirica* Ledeb.—Siberian fir—Pikhta sibirskaya**

**Range:** The Siberian fir is the most common Russian fir and occurs over large areas in Northeastern European Soviet Union, the Urals, throughout much of Siberia (from the Baykal region into the Altay Mountains), and southward into Mongolia and China. The western and southern range coincides with that of the Siberian larch (*Larix sibirica*), but it does not penetrate as far north as the larch. It grows to an elevation of up to 2,400 meters in the Altay Mountains. Siberian fir occupies 13.6 million hectares of forest land in the Soviet Union, with reserves of 2 billion m<sup>3</sup>.

**Silvics:** Siberian fir is most abundant on deep, rich, and well-drained soils with adequate moisture. It is less tolerant of unfavorable conditions than spruce and does not grow well in marshy conditions (Kalinin et al.,

1985). Siberian fir grows on rocky soil at upper elevations. It grows in pure and mixed stands and is more windfirm (able to withstand strong winds) than spruce. In mixed stands, it is most commonly associated with Siberian spruce (*Picea obovata*) and Siberian stone pine (*Pinus sibirica*) in the classic dark taiga. It has a deep, wide-spreading root system and is relatively windfirm.

Cones are produced after 15 to 18 years in open stands and 60 to 70 years in dense forests. Forty-five percent of the seeds from this species germinate. The species is very shade tolerant and regenerates well either by seed or vegetatively in deep shade. Mature trees retain needles for 7 to 10 years.

Siberian fir grows slowly for the first 10 to 15 years and rapidly thereafter. Its overall growth compared to spruce and pine is relatively slow. It grows well outside its geographic area, particularly as an ornamental species in the Soviet Union.

**Insects and Disease Pathogens:** According to Soviet sources, at age 70 to 80, 60 percent of Siberian fir is affected by an undetermined form of trunk rot and suffers from wind blast. See Appendix H for more information.

**Height:** 30 meters

**Diameter:** 50 to 80 centimeters

**Maximum Age:** 200 to 250 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** Rail and water transport are used to bring Siberian fir to market.

**Primary and Secondary Uses:** The technical value of the wood is marginal and, consequently, is primarily used for pulpwood and not construction. The bole of *A. sibirica* is thin and smooth with resin blisters. The wood is soft, light, and without heartwood or resinous substances. Like all fir trees, the bark and needles are used for chemical byproducts, such as balsam oil and other ethereal oils.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

***Abies holophylla* Maxim.—Wholeleaf fir—Pikhta tsel'nolistnaya, or manchurskaya, primorskaya**

**Range:** The wholeleaf fir is found in the far south of the Maritime Oblast of the Far East in the mountain elevations below 500 meters.

**Silvics:** *A. holophylla* forests are divided into upland and lowland forests; upland forests are periodically dry, cool, and humid and lowland forests are humid and moist. This fir commonly grows in a floristically rich community along the Pacific Coast. This fir variety is extremely fast growing and shade tolerant.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 40 meters

**Diameter:** Up to 2 meters

**Maximum Age:** 450 years

<b>Wood Characteristics:</b> Moisture content	212 percent
Specific gravity	0.39
psi MOR	9,440
psi MOE	1.32
psi Compression Parallel	4,635

**Logging, Transport, and Storage:** The same procedures used for other conifers are used for the wholeleaf fir.

**Primary and Secondary Uses:** *A. holophylla* is used for pulpwood and possibly sawtimber.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

*Abies nephrolepis* (Trautv.) Maxim.—White bark fir—Pikhta belokoraya, podocheshuynaya, and amurskaya

**Range:** The white bark fir is found in the mountains of the Far East, in the Primorskiy (Maritime) Kray. This tree is also found in regions of the Amur River (Priamur'ye); the southern shore of the Sea of Okhotsk; the mountains; Central Kamchatka; the Sakhalin, Iezo, and Southern Urals; North Korea; East Manchuria; and South Yakutsk A.S.S.R. (the Aldan River). This fir grows to an elevation of up to 1,200 meters or more.

**Silvics:** White bark fir often grows in association with *Picea ajanensis* in a cool and humid climate. This fir grows relatively quickly.

**Insects and Disease Pathogens:** This fir is subject to rot at an early age. (See Appendix H.)

**Height:** 25 meters

**Diameter:** 50 centimeters

**Maximum Age:** 150 to 200 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** No information available.

**Primary and Secondary Uses:** *A. nephrolepis* is used for pulpwood and possibly sawtimber.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

***Abies sachalinensis* Fr. Schmidt—Sakhalin fir—Pikhta sakalinskaya**

**Range:** Sakhalin fir grows throughout Sakhalin Island and extends to the Schmidt peninsula. It is the basic coniferous species in the southern Kuril Islands. This fir has a vertical range up to 1,000 meters.

**Silvics:** *A. sachalinensis* often grows in association with *Picea ajanensis* in a cool and humid climate. It grows relatively quickly and is ecologically similar to *A. nephrolepis*. After 200 years of growth, it occupies the upper canopy of the mature forest.

**Insects and Disease Pathogens:** *A. sachalinensis* is subject to rot at an early age. See Appendix H.

**Height:** 40 meters

**Diameter:** Undetermined

**Maximum Age:** 250 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi Compression Parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** Rail and water transport are used to bring *A. sachalinensis* to market.

**Primary and Secondary Uses:** *A. sachalinensis* is used for pulpwood and possibly sawtimber.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** Moderate to high

***Abies gracilis* Kom.—Slender fir—Pikhta stroinaya or tonkaya**

**Range:** *A. gracilis* is found in the Far East; primarily Kamchatka peninsula and near the mouth of the Seml'nachik River.

**Silvics:** This fir grows in a limited range along the Pacific Coast in a cool and humid climate. It is ecologically similar to other Soviet Far East true firs and regenerates in the organic matter of old rotten logs. This tree is more frost tolerant than other fir species. Relic populations remaining in the Soviet Union are of little commercial value.

**Insects and Disease Pathogens:** *A. gracilis* is subject to rot at an early age. See Appendix H.

**Height:** 15 to 16 meters

**Diameter:** Undetermined

**Maximum Age:** Undetermined

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = not available.

**Logging, Transport, and Storage:** No information available.

**Primary and Secondary Uses:** The slender fir has no commercial uses.

**Importance to Soviet Timber Economy:** Minor

**Potential Export Value to Pacific Northwest:** Low

*Abies mayriana* Miyabe et Kudo—*Mayriana fir*—*Pikhta maira*

**Range:** The *Mayriana fir* is found in the Far East, Southern Sakhalin, and the Kuril Islands. It is also found along the Seml'nachik River. It is found 100 meters above mean sea level.

**Silvics:** *A. mayriana* grows in a limited range along the coast in a cool and humid climate. Ecologically and structurally, this fir occupies the same spatial and temporal distribution in the canopy as *Picea ajanensis*. It regenerates in pure stands after harvesting.

**Insects and Disease Pathogens:** *A. mayriana* is subject to rot at an early age.

**Height:** 35 meters

**Diameter:** Undetermined

**Maximum Age:** 240 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** No information available.

**Primary and Secondary Uses:** *A. mayriana* is probably used for pulpwood.

**Importance to Soviet Timber Economy:** Minor

**Potential Export Value to Pacific Northwest:** Low

**Family Pinaceae Lindl. Genus *Picea* Dietr.—Spruce**

The genus *Picea* is an extremely important component of the Eurasian taiga. Spruce grows on 80 million hectares with a reserve of 12 billion m<sup>3</sup>. It occupies 11.9 percent of the commercial timberlands and is the fourth most common species after larch, pine, and birch. The most extensive areas and greatest reserves of spruce are found in Northern European Russia, the Urals, and the Soviet Far East. Eight species grow in the Soviet Union,

according to Sokolov et al. (1977), although Tseplyayev (1965) has documented 11. Five species of *Picea* occur in the Asian U.S.S.R. Spruce species are geographically distributed as follows and appear in order of economic importance.

European-Uralian Soviet Union and Western Siberia:

- P. abies* (L.) Karst.—Whitewood, European, or Norway spruce
- P. fennica* (Regel) Kom.—Finnish spruce
- P. orientalis* (L.) Link.—Eastern or Caucasian spruce

Eastern Siberian and Far Eastern Soviet Union:

- P. obovata* Ledeb. or *P. sibirica*—Siberian spruce
- P. ajanensis* (Lindl. et Gord.) Fisch. ex Carr.—Jeddo spruce
- P. schrenkiana* Fisch. et Mey.—Shrenk's or Tien-Shan spruce
- P. koraiensis* Nakai—Korean spruce
- P. glehnii* (Fr. Schmidt) Mast—Glenn's spruce

Three of these species have commercial importance, *Picea obovata*, *Picea ajanensis*, and *Picea koraiensis*. *Picea abies*, found only in European Russia, is of major economic significance and is related closely to *P. obovata*. The botanical characteristics of the two species are not radically different, except for the cone formation. Their general habitats, ecological requirements, and silvical features are almost identical. *P. abies* dominates the European Russian taiga, while *P. obovata* occurs less frequently in the Eastern Siberian taiga, probably because of more adverse climatic conditions. Growth conditions and timber productivity are more favorable in European Russia.

Another indigenous spruce, *P. ajanensis*, a native of the Soviet Far East, is one of the most interesting species from a ecological and commercial perspective. It grows to a height of 50 meters and a diameter of 1.5 meters; with exceptional specimens reaching an age of 350 years. Depending on the spruce's resistance to insects and disease, it plays an important role in domestic spruce sawtimber production and the export market. Because of its importance to the Siberian or Ussuri tiger habitat, harvesting this species is prohibited in the Soviet Union.

***Picea obovata* Ledeb.—Siberian spruce—Yel' sibiriski**

**Range:** The range of the Siberian spruce extends from Northeastern European U.S.S.R. through the Urals to Siberia, with periodic occurrences along the Amur River, in the Transbaykal, and in the Sayan and Altay mountains up to 2,000 meters. In the west it grows with pine, birch, and aspen; in the Cis-Ural to the Yenisey River, it usually grows in association with Siberian fir (*A. sibirica*) or stone pine (*P. sibirica*). East of the Yenisey River, it occurs mostly in river valleys and is a rare tree in the Pacific maritime region.

**Silvics:** In general, the range of the Siberian spruce is more closely connected with climate and particularly with precipitation than is pine, for example. This spruce does not occur in the steppes and in regions with low precipitation and humidity. It grows best in well-drained, sandy loams, or alluvial soils. Occasionally it is found on dry, sandy sites, but its growth is usually poor.

Fruiting begins in May or June at age 30 to 50 years and the seeds mature in October. Cones open in February or March during sunny weather and dry winds. The winged seeds are distributed 10 to 25 meters in windy weather. Seed dispersal on hard crusted snow or ice may exceed a few kilometers.

The spruce seed germinates in the spring and growth is slow. It usually grows at a rate of 4 to 5 centimeters per year until the tenth year when it reaches a height of 1 to 2 meters (Kalinin et. al, 1985). From 10 to 15 years, *P. obovata* will grow at a rate of 30 to 70 centimeters per year. Like most boreal spruces, self pruning is poor and the branching pattern is dense with small diameter branches. It will grow up to 1 to 2 meters after 40 to 60 years in the understory of mature stands and responds well to release.

This spruce has shallow rooting and is subject to windthrow, particularly in seed tree cuts or shelterwoods. Like other spruce, it is shade tolerant (although less shade tolerant than *P. ajanensis* or *A. nephrolepsis*) and natural regeneration of spruce is prolific under the shelter of overwood. A mid-range or second age-class of spruce is found almost everywhere in the forests, particularly on favorable soil conditions.

**Insects and Disease Pathogens:** See Appendix H.

**Height:** 30 to 35 meters

**Diameter:** Undetermined

**Maximum Age:** 200 to 300 years

<b>Wood Characteristics:</b> Moisture content	N/A
Specific gravity	N/A
psi MOR	N/A
psi MOE	N/A
psi compression parallel	N/A

N/A = Not available.

**Logging, Transport, and Storage:** Spruce is less dense than other conifers and floats easily for water transport. Its dense branching increases limbing time, particularly in manual operations where axes are used for delimiting. Merchantable range for commercial operations is 12 to 18 centimeters in diameter. This material is brittle and results in excessive breakage in cold weather. Due to branch distribution, felling is dangerous in windy weather because the entire root wad may uproot (Kalinin et al. 1985). In terms of insects and disease pathogens, root compaction and residual damage are serious problems in mechanized operations.

**Primary and Secondary Uses:** Siberian spruce is used for sawtimber for construction grade lumber, pulpwood, and export logs. The bark is used for tanning extracts used in the leather industry. Approximately 1 ton of bark can be extracted from 1 hectare of spruce woodland.

**Importance to Soviet Timber Economy:** Major

**Potential Export Value to Pacific Northwest:** High

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## Appendix E Pest Risk Assessment Methodology

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### Introduction

The complete pest risk assessment methodology, as developed by USDA Animal and Plant Health Inspection Service (APHIS), is presented in this section even though the specific pest risk assessment on Soviet larch may not incorporate all of the methodology's feedback loops. The purpose for presenting the "total" methodology is to provide guidance for potential future log pest assessments.

To achieve the level of quality desired, the pest risk assessments should be:

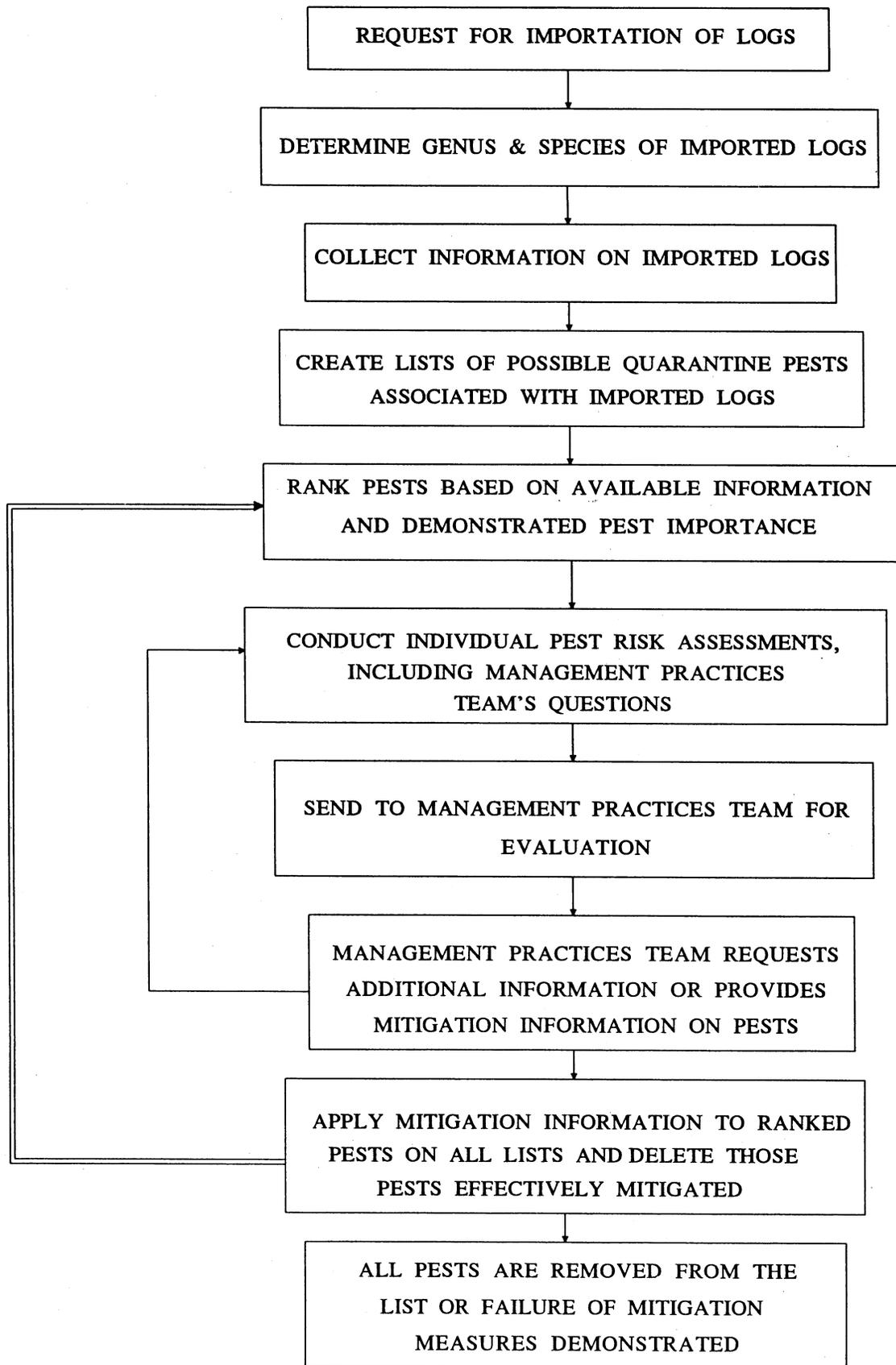
- Comprehensive—review the subject in detail and identify sources of uncertainty in data extrapolation and measurement errors. The assessment should evaluate the quality of its own conclusions. The assessment should be flexible to accommodate new information.
- Logically Sound—up-to-date and rational—reliable, justifiable, suitable, unbiased, and sensitive to different aspects of the problem.
- Practical—commensurate with the resources made available.
- Conducive to Learning—have enough scope to have carry-over value for conducting similar assessments in the future.
- Open to Evaluation—recorded in sufficient detail so that the process could be repeated with similar results by independent reviewers.

Figure E-1 outlines the pest risk assessment methodology for the importation of logs. Details of the information shown in figure E-1 are described in the following pages of this section.

### **Collect Information on Imported Logs**

The following information should, to the extent that resources will allow, be gathered on the imported logs:

- exact species and their origin(s);
- amount to be imported;
- value of importing the logs into the United States;
- distribution (time of importation, transit times, and destination) after importation;
- intended use of logs (i.e., wood chips, pulp, lumber);
- importation process and history of process (i.e., storage of logs, harvest times and methods, and logging practices);
- history of past interceptions (including foreign countries) of Siberian log imports; and
- past and present regulations for importing Siberian logs (including foreign countries).



**Figure E-1. Pest Risk Assessment Process**

## Create Lists of Possible Quarantine Pests Associated With Imported Logs

When creating lists of possible pests, make the following determinations:

- (1) Determine what pests or potential pests are associated with the logs from the producing region.
- (2) Determine which of these pests merit further evaluation, using table E-1.
- (3) Produce a preliminary list of possible quarantine pests from (2) categories 1a, 1b, 1c, and 2a. Taxonomic confusion or uncertainty should also be noted on the list.
- (4) Divide list into ecological groups depending upon where the organism is most likely to be found (i.e., on the bark, in or under the bark, in the wood).

The listing of the organisms showing where the pests are located in the log will place the various pest organisms into groups that correspond to the Management Practices Team's mitigation categories.

**Table E-1. Categories of Pests**

Category	Pest Characteristics	Place on List
1a	Foreign, not present in country	Yes
1b	Foreign, in country, and capable of further expansion	Yes
1c	Foreign, in country, and reached probable limits of range, but genetically different enough to warrant concern or able to vector a foreign plant pest	Yes
1d	Foreign, in country, and reached probable limits of range, but not exhibiting any of the other characteristics of 1c	No
2a	Native, but genetically different enough to warrant concern or able to vector a foreign plant pest and/or capable of further expansion	Yes
2b	Native, but not exhibiting any of the characteristics of 2a	No

### Rank Pests Based on Available Information and Demonstrated Importance

Rank pests in each list placing those pests first (1) on which the most biological information is available on life cycle, ecology, and invasion ability, and (2) which demonstrate a known economic importance. Rank those pests last for which biological information and pest importance are unknown. The ranking of pests will require some subjective judgment, but it is not important which specific pest is first or second on the list as long as they are both about equal using the two criteria listed above.

### Conduct Specific Individual Pest Risk Assessments

Conduct a pest risk assessment on the highest ranked pest(s) on each list. The actual number of pests on a given list that will be assessed at any one time will depend upon the time available and number of lists needing to be assessed. Individual pests are evaluated, on the pest risk assessment form (figure E-2), using the risk elements listed below. Information on the pests should be matched with the appropriate risk element. This will help evaluate the amount of information and uncertainty, for a specific pest, for each of the risk elements. Responses to the various elements can be as specific or as general as time and information allow.

The pest risk model and standard risk formula, showing how the various risk elements interrelate, are illustrated in figure E-3.

## Summary of the Pest Risk Assessment

Risk elements are underscored in the following text. The statements below asking for actual probability or impact are not attainable goals. Their function is to direct the known pest information into the risk assessment process. Getting an overall "feel" of the probability or impact is a more pragmatic goal.

### A. Probability of Pest Establishment

#### Pest with Host at Origin

- (1) Determine probability of pest being on, with, or in the imported plant commodity at the time of importation.

#### Entry Potential

- (1) Determine probability of pest surviving in transit.
- (2) Determine probability of pest being detected at port of entry under present quarantine procedures.

#### Colonization Potential

- (1) Determine probability of pest coming in contact with an adequate food resource.
- (2) Determine probability of the pest coming in contact with appreciable environmental resistance.
- (3) Determine probability of pest to reproduce in the new environment.

PEST RISK ASSESSMENT FORM Reference # \_\_\_\_\_

Scientific Name of Pest \_\_\_\_\_

Scientific Name of Host(s) \_\_\_\_\_

Specialty Team \_\_\_\_\_

Assessors \_\_\_\_\_

Dated Started by Assessors \_\_\_\_\_

Completed \_\_\_\_\_

**Pest Risk Assessment (Including References)**

Summary of natural history and basic biology of the pest—

Specific information relating to risk elements:

A. Probability of Pest Establishment

1. Pest with Host at Origin—
2. Entry Potential—
3. Colonization Potential—
4. Spread Potential—

B. Consequences of Establishment

5. Economic Damage Potential—
6. Environmental Damage Potential—
7. Perceived Damage (Social and Political Influences)—

Estimated Risk for Pest—

Additional Remarks—

=====

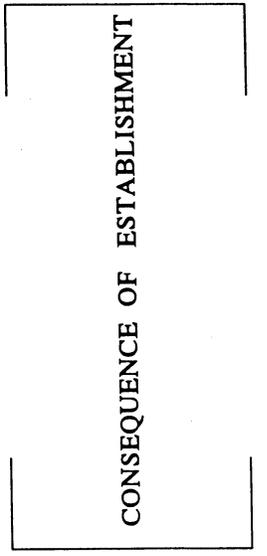
Date Received by Management Practices Team \_\_\_\_\_ Completed \_\_\_\_\_

Approved Mitigation Procedure—

Additional Remarks—

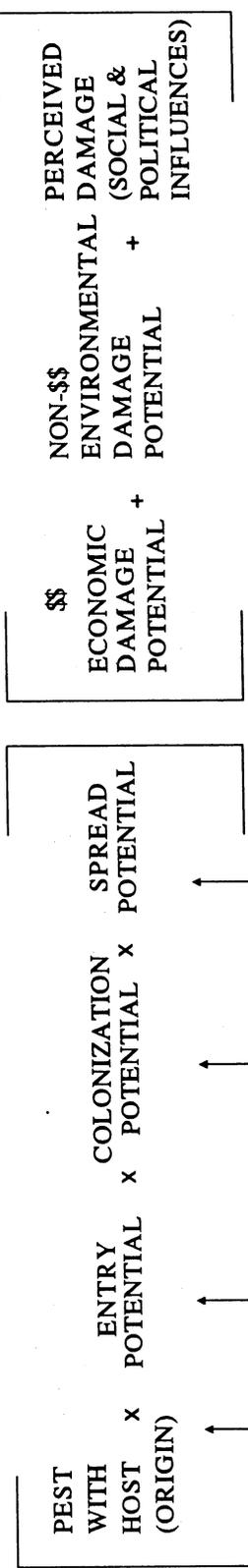
**Figure E-2. Pest Risk Assessment Form**

STANDARD RISK FORMULA



RISK =

ELEMENTS of the MODEL



RISK =

Notes: For model simplification the various elements are depicted as being independent of one another. The order of the elements in the model does not necessarily reflect the order of calculation.

Figure E-3. Model for Assessing Pests on Imported Logs

### Spread Potential

- (1) Determine probability of pest to spread beyond the colonized area.
- (2) Estimate the range of probable spread.

## **B. Consequences of Establishment**

### Economic Damage Potential

- (1) Determine economic impact if established, including the cost of living with the pest.

### Environmental Damage Potential

- (1) Determine environmental impact if established.

### Perceived Damage (Social and Political Influences)

- (1) Determine impact from social and/or political influences. Record the information for each pest under the individual elements. Quality and amount of uncertainty should also be addressed under the individual elements.

There is no proven way to calculate the effects of the various elements into a combined final risk number or statement. A good risk assessment is as much art as science. The best that can be done, at this time, is to have the assessors subjectively determine the risk based on the scientific information under each element. Include a brief statement at the end of the pest risk assessment form about the subjective "total" amount of risk of the pest (i.e., risk is low, medium, or high).

In addition, the assessors will have to complete the biological questions requested by the Management Practices Team along with each pest risk assessment form.

When assessors complete the pest risk assessment form and answers to the specific biological questions supplied by the Management Practices Team for a specific pest, they should forward them to the Management Practices Team.

## **Requests for Additional Information**

If the Management Practices Team requires further biological information, it can request the information from the Core Assessment Team. This cycle will continue until the Management Practices Team can provide either an effective mitigation measure or determines that the known mitigation measures have failed.

If the Management Practices Team determines an effective mitigation measure that can be used on the pest, detailed information about the mitigation measure is returned to the Core Assessment Team. (See figure E-4.)

Failure of mitigation measures or the need to supply experimental data to show efficacy in existing mitigation measures on the initial risk assessments may stop or cause a hiatus in the risk assessment process.

## **Apply Mitigation Information to Ranked Pests on All Lists**

The returned mitigation measure(s) is (are) assumed to be required for the importation of the logs.

The mitigation measure(s) may now be used (if possible) to eliminate other pests on the various lists. Those pests remaining on the list(s) are ranked again and the process is repeated, as indicated by the double-line arrow in figure E-1.

Again, if mitigation measures fail on the initial risk assessments, this feedback loop (this section) may not be necessary.

### **All Pests Are Removed From the List or Failure of Mitigation Measures Demonstrated**

A single potential failure of the mitigation measure in providing protection against a pest may not stop the assessment process. The Management Practices Team will make this decision in the event of a failure of the mitigation measures. Their decision will be based on the risk of the pest as presented in the pest risk assessment.

It is possible that a few pests will remain on the list because their uncertainty will not allow them to be addressed against the (by that time) applied mitigation measures. Even though the risk is not demonstrated on these pests, their presence will be considered by the Management Practices Team before making any final decision.

### **Consolidate All Data and Prepare Final Report on the Log Pest Risk Assessment**

Both the process of the pest risk assessment and the actual data accumulated should be recorded in the final document.

The document does not have to determine whether the imported logs are to be allowed entry or which mitigation measures should be enforced. The Management Practices Team report will address the entry status of the logs. However, the final report can make recommendations to the Management Practices Team on the overall pest risk of importing the logs.

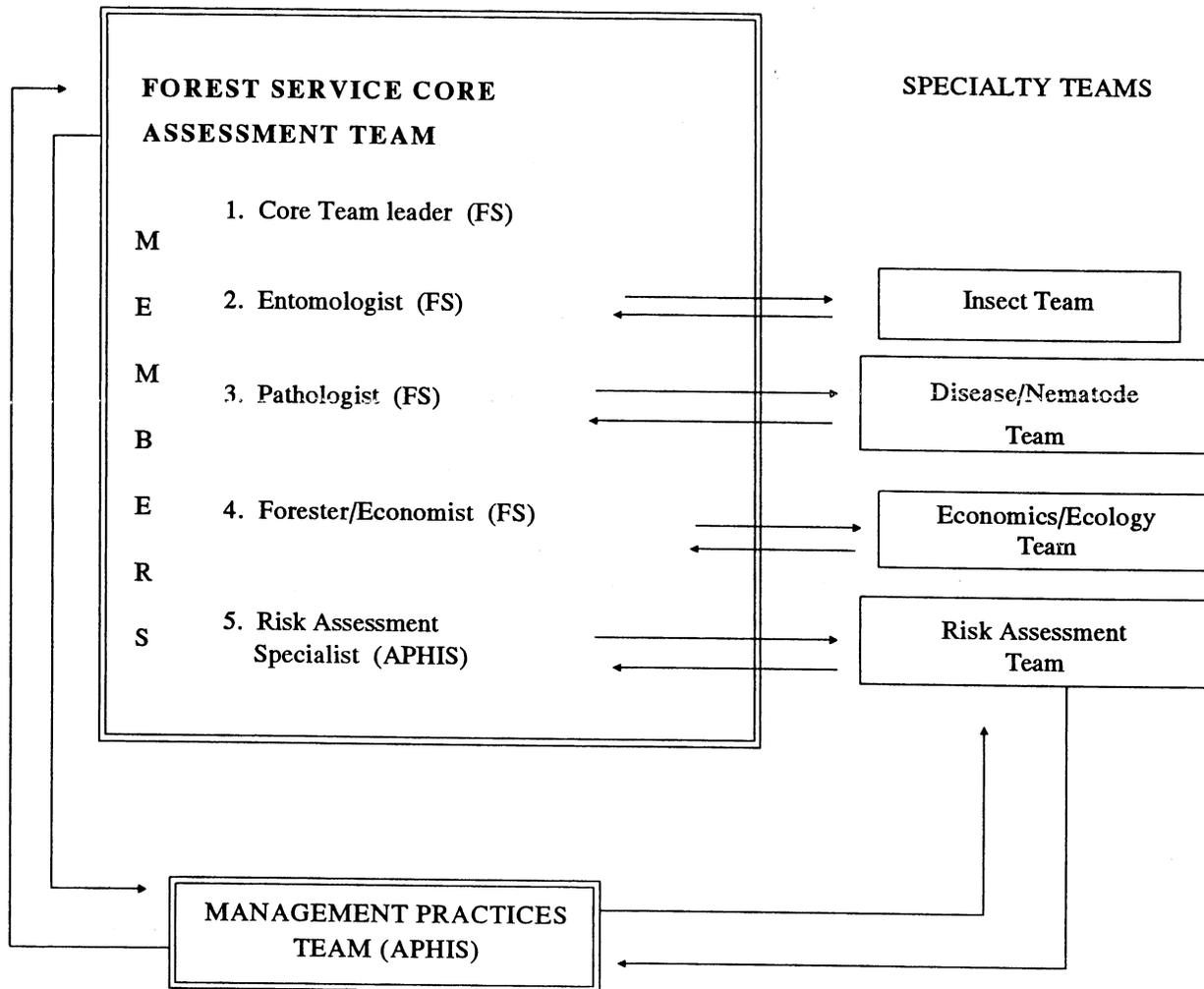


Figure E-4. Siberian Log Pest Risk Assessment Team Structure



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**Appendix F**  
**Participants of the**  
**First Siberian Timber**  
**Workshop**

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Name	Affiliation
Fred Baker	Utah State University
Jerry Beatty	USDA Forest Service
Roy Beckwith	USDA Forest Service
Jon Bell	Agriculture Canada
Alan Berryman	Washington State University
Yuri Bihun	University of Vermont
Harold Burdsall	USDA Forest Service
Ralph Byther	Washington State University
Gary Chastenger	Washington State University
Mo-Mei Chen	University of California, Berkeley
Fields Cobb, Jr.	University of California, Berkeley
Tom Duafala	Balsa Research
George Ferrell	USDA Forest Service
Greg Filip	Oregon State University
Ed Florence	Lewis and Clark University
Bob Gara	University of Washington
Robert Gilbertson	University of Arizona
Don Goheen	USDA Forest Service
John Griesbach	Oregon Dept. of Agriculture
Bob Harvey	USDA Forest Service
Paul Hessburg	USDA Forest Service
Dan Hilburn	Oregon Dept. of Agriculture
Kathleen Johnson	Oregon Dept. of Agriculture
John Kliejunas	USDA Forest Service
LeRoy Kline	Oregon State University
Ken Knauer	USDA Forest Service
Dan Kucera	USDA Forest Service
Jack Lattin	Oregon State University
Willis Littke	Weyerhaeuser
Martin MacKenzie	Self-employed
Fred McElroy	Penninsu-Lab.
Ralph Nevill	Virginia Tech.
William Otrosina	USDA Forest Service
Dave Overhulser	Oregon Dept. of Forestry
Catharine Parks	USDA Forest Service
Dick Parmeter	University of California, Berkeley
Tom Payne	Virginia Tech
Jack Rogers	Washington State University

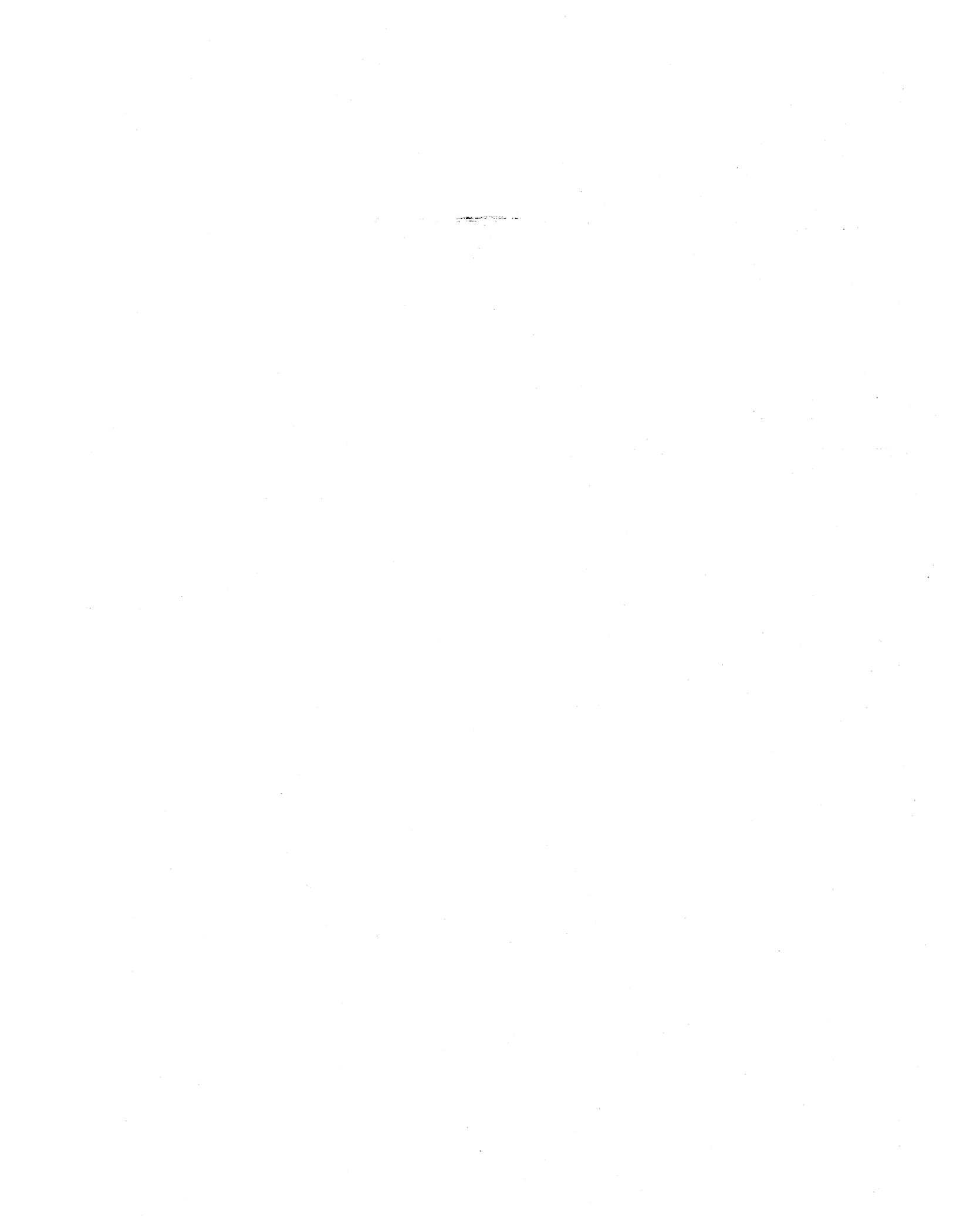
Name	Affiliation
Darrell Ross	Oregon State University
Ken Russell	Washington DNR
Dave Schultz	USDA Forest Service
Michael Shannon	USDA APHIS
Kathy Sheehan	USDA Forest Service
Eugene Smalley	University of Wisconsin
Dick Smith	USDA Forest Service
Gary Smith	USDA APHIS
Jeff Stone	Oregon State University
Borys Tkacz	USDA Forest Service
Allan Van Sickle	Forestry Canada
Bill Wallner	USDA Forest Service
Boyd Wickman	USDA Forest Service
Wayne Wilcox	University of California, Berkeley
David Wood	University of California, Berkeley

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**Appendix G**  
**Participants of the**  
**Second Siberian Timber Workshop**

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Name	Affiliation
Fred Baker	Oregon State University
Jerome Beatty	USDA Forest Service
Alan Berryman	Washington State University
Yuriy Bihun	University of Vermont
Dave Cleaves	Oregon State University
Donald Flora	USDA Forest Service
Don Goheen	USDA Forest Service
Kurt Gottschalk	USDA Forest Service
John Grobey	Humboldt State University
Bob Harvey	USDA Forest Service
Tom Holmes	USDA Forest Service
Bob Housley	USDA Forest Service
Kathleen Johnson	Oregon Dept. of Agriculture
Alan Kanaskie	Oregon Dept. of Forestry
Ken Knauer	USDA Forest Service
Dan Kucera	USDA Forest Service
Joe Lewis	USDA Forest Service
Rob McDowell	USDA APHIS
Bill McKillop	UC Berkeley
Robert Morris	Louisiana Pacific Corp.
Ralph Nevill	Virginia Tech
Jay O'Laughlin	University of Idaho
Richard Orr	USDA APHIS
Tom Payne	Virginia Tech
Ken Russell	Washington Dept. of Natural Resources
Micheal Shannon	USDA APHIS
Phil Szmedra	USDA ERS-AIPS
Borys Tkacz	USDA Forest Service
Carol Tuszynski	USDA APHIS
Bill Wallner	USDA Forest Service
Thomas Waggener	University of Washington
Marc Wiitala	USDA Forest Service



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**Appendix H**  
**Pests and Pathogens on Coniferous**  
**Trees of the Eastern Soviet Union**

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**I. Siberian Region**

**Main Species of Bark Beetles (Scolytidae)**

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**A. Larch Forests**

*Larix gmelini* (Rupr.) Rupr.

*Dryocoetes baicalicus* Reitt.  
*Ips acuminatus* Eichh.  
*I. duplicatus* Sahlb.  
*I. sexdentatus* Boern.  
*I. subelongatus* Motsch.  
*I. typographus* Lin.  
*Orthotomicus starki* Spess.  
*Pityogenes baicalicus* Egg.  
*P. chalcographus* L.  
*P. irkutensis* Egg.  
*Pityophthorus micrographus* L.  
*Polygraphus sachalinensis* Egg.  
*Scolytus morawitzi* Sem.  
*Trypodendron lineatum* Ol.

*Larix sibirica* Ledeb.

*Ips acuminatus* Eichh.  
*I. duplicatus* Sahlb.  
*I. sexdentatus* Boern.  
*I. subelongatus* Motsch.  
*I. typographus* Lin.  
*Orthotomicus starki* Spess.  
*Pityogenes baicalicus* Egg.  
*P. chalcographus* L.  
*Pityophthorus micrographus* L.  
*Polygraphus sachalinensis* Egg.  
*Trypodendron lineatum* Ol.

**B. Spruce and Fir Forests**

*Picea obovata* Ledeb.  
*Abies sibirica* Ledeb.

*Carphoborus teplouchovi* Spess.  
*Cryphalus abietis* Ratz.  
*C. saltuarius* Wse.  
*Dendroctonus micans* Kug.

*Dryocoetes autographus* Ratz.  
*Hylastes cunicularius* Er.  
*Hylurgops glabratus* Zett.  
*Ips acuminatus* Eichh.  
*I. duplicatus* Sahlb.  
*I. typographus* L.  
*Orthotomicus laricis* F.  
*O. starki* Spess.  
*O. suturalis* Gyll.  
*Phthorophloeus spinulosus* Rey  
*Pityogenes bidentatus* Hbst.  
*P. chalcographus* L.  
*P. quadridens* Hart.  
*Pityophthorus morosovi* Spess.  
*P. traegardhi* Spess.  
*Polygraphus poligraphus* L.  
*P. punctifrons* Thoms.  
*P. subopacus* Thoms.  
*Trypodendron lineatum* Ol.  
*Xylechinus pilosus* Ratz.

**C. Pine Forests**

*Pinus sibirica* Ledeb.

*Dryocoetes autographus* Ratz.  
*Hylastes opacus* Er.  
*H. opacus* Er.  
*Hylurgops glabratus* Zett.  
*H. palliatus* Gyll.  
*Ips duplicatus* Sahlb.  
*I. sexdentatus* Boern.  
*Orthotomicus golovjankoi* Pjat.  
*O. laricis* F.  
*O. proximus* Eichh.  
*O. suturalis* Gyll.  
*Pityogenes bidentatus* Hbst.  
*P. chalcographus* L.  
*P. quadridens* Hart.  
*Pityophthorus micrographus* L.  
*Polygraphus subopacus* Thoms.  
*Trypodendron lineatum* Ol.

D. Scotch Pine Forests

*Pinus sylvestris* L.

*Blastophagus minor* Hart.

*B. piniperda* L.

*Carphoborus cholodkovskyi* Spess.

*Dendroctonus micans* Kug.

*Hylastes ater* Payk.

*H. opacus* Er.

*Hylurgops glabratus* Zett.

*H. spessiotzevi* Egg.

*Ips acuminatus* Eichh.

*I. sexdentatus* Boern.

*Orthotomicus laricis* F.

*O. proximus* Eichh.

*O. suturalis* Gyll.

*Pityogenes bidentatus* Hbst.

*P. chalcographus* L.

*P. irkutensis* Egg.

*P. quadridens* Hart.

*Polygraphus poligraphus* L.

*Trypodendron lineatum* Ol.

Wood Borers (Cerambycidae)

A. Tundra Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Acanthocinus carinulatus* Gebl.

*Acmaeops pratensis* Laich.

*A. septentrionis* Thoms.

*A. smaragdula* F.

*Anoplodera sequensi* Reitt.

*Asemum striatum* L.

*Callidium coriaceum* Payk.

*Judolia sexmaculata* L.

*Monochamus impluviatus* Motsch.

*M. sutor* L.

*M. urussovi* Fisch.

*Pogonocherus fasciculatus* Deg.

*Tetropium gracilicorne* Reitt.

B. Larch Forests

*Larix sibirica* Ledeb.

*Acanthocinus carinulatus* Gebl.

*Acmaeops septentrionis* Thoms.

*A. smaragdula* F.

*Anoplodera sequensi* Reitt.

*A. variicornis* Dalm.

*Asemum striatum* L.

*Callidium chlorizans* Sols.

*C. violaceum* L.

*Clytus arietoides* Reitt.

*Cornumutilla quadrivittata* Gebl.

*Gaurotes virginea* L.

*Judolia sexmaculata* L.

*Leptura arcuata* Panz.

*Monochamus impluviatus* Motsch.

*M. salutaris* Gebl.

*M. sutor* L.

*M. urussovi* Fisch.

*Nivellia extensa* Gebl.

*Pogonocherus fasciculatus* Deg.

*Rhagium inquisitor* L.

*Strangalia attenuata* L.

*Tetropium gracilicorne* Reitt.

*Xylotrechus altaicus* Gebl.

C. Spruce and Fir Forests

*Picea obovata* Ledeb.

*Abies sibirica* Ledeb.

*Acanthocinus griseus* F.

*Acmaeops pratensis* Laich.

*A. septentrionis* Thoms.

*Anoplodera sequensi* Reitt.

*Arhopalus rusticus* L.

*Asemum striatum* L.

*Clytus arietoides* Reitt.

*Evodinus borealis* Gyll.

*Judolia sexmaculata* L.

*Molorchus minor* L.

*Monochamus salutaris* Gebl.

*M. sutor* L.

*M. urussovi* Fisch.

*Pogonocherus fasciculatus* Deg.

*Pronocera brevicollis* Gebl.

*Rhagium inquisitor* L.

*Saperda interrupta* Gebl.

*Spondylis buprestoides* L.

*Strangalia attenuata* L.

*Tetropium castaneum* L.

D. Pine Forests

*Pinus sibirica* Ledeb.

*Acmaeops angusticollis* Gebl.  
*A. septentrionis* Thoms.  
*A. smaragdula* F.  
*Anoplodera rufiventris* Gebl.  
*A. rubra* L.  
*A. sequensi* Reitt.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium coriaceum* Payk.  
*Clytus arietoides* Reitt.  
*Evodinus borealis* Gyll.  
*Monochamus salutarius* Gebl.  
*M. sutor* L.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus* Deg.  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.  
*Tragosoma depsarium* L.

E. Scotch Pine Forests

*Pinus sylvestris* L.

*Acanthocinus aedilis* L.  
*A. griseus* F.  
*Acmaeops marginata* F.  
*Anoplodera rubra* L.  
*A. virens* L.  
*Arhopalus rusticus* L.  
*A. tristis* F.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Clytus arietoides* Reitt.  
*Evodinus borealis* Gyll.  
*Gaurotes virginea* L.  
*Judolia sexmaculata* L.  
*Monochamus galloprovincialis* Ol.  
*Pachyta quadrimaculata* L.  
*Pogonocherus fasciculatus* Deg.  
*P. ovatus* Goeze  
*Pronocera brevicollis* Gebl.  
*Rhagium inquisitor* L.  
*Spondylis buprestoides* L.  
*Tragosoma depsarium* L.

---

Flatheaded Borers (Buprestidae)

---

A. Pine Forests

*Pinus sylvestris* L.

*Phaenops cyanea*

---

Weevils (Curculionidae)

---

A. Larch Forests

*Hylobius abietis* L.  
*H. moria*

B. Spruce and Fir Forests

*Pissodes cembrae* Motschulaky

C. Pine Forests

*Pissodes cembrae* Motschulaky

**Wood Wasps (Siricidae)**  
(Siberia and Far East)

---

A. Tundra Low Density Forests

*Paururus noctilio* F.  
*Urocerus gigas* L.

B. Spruce, Fir, and Pine Forests

*Paururus ermak* Sem.  
*P. juvencus* L.  
*P. mongolorum* Sem. et Guss.  
*P. noctilio* F.  
*Tremex satanas* Sem.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*Xeris spectrum* L.  
*Xoanon mysta* Sem.

C. Fir Forests

*Paururus ermak* Sem.  
*P. juvencus* L.  
*P. noctilio* F.  
*Tremex satanas* Sem.  
*Urocerus gigas* L.  
*Xeris spectrum* L.

D. Larch Forests

*Paururus ermak* Sem.  
*P. juvencus* L.  
*P. mongolorum* Sem. et Guss.

*P. noctilio* F.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*U. umbra* Sem.  
*Xeris spectrum* L.

E. Scotch Pine Forests

*Paururus juvencus* L.  
*P. noctilio* F.  
*Urocerus gigas* L.  
*U. tardigradus* Ced.

F. Coniferous and Broad-Leaf Larch Forests

*Paururus ermak* Sem.  
*P. juvencus* L.  
*P. mongolorum* Sem. et Guss.  
*P. noctilio* F.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*Xeris spectrum* L.  
*Xiphydria eborata* Knw  
*Xoanon matsumurae* Roh.  
*X. mysta* Sem.

**II. Seacoast Forests Region (Far East)**

Main Species of Bark Beetles (Scolytidae):

---

A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.  
  
*Cryphalus latus* Egg.  
*Dryocoetes baicalicus* Reitt.  
*D. hectographus* Reitt.  
*D. rugicollis* Egg.  
*Ips acuminatus* Eichh.  
*I. duplicatus* Saheb.  
*I. sexdentatus* Boern.  
*Orthotomicus laricis* Fabr.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Polygraphus sachalinensis* Egg.

*Trypodendron lineatum* Ol.

*Larix olgensis* Henry

*Cryphalus latus* Egg.  
*Dryocoetes baicalicus* Reitt.  
*D. hectographus* Reitt.  
*D. rugicollis* Egg.  
*Ips acuminatus* Eichh.  
*I. duplicatus* Saheb.  
*I. sexdentatus* Boern.  
*Orthotomicus laricis* Fabr.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Trypodendron lineatum* Ol.

## B. Spruce and Fir Forests

*Picea jezoensis* Carr.

*Blastophagus puellus* Reitt.  
*Dryocoetes hectographus* Reitt.  
*D. rugicollis* Egg.  
*Hylurgops glabratus* Zett.  
*H. palliatus* Gyll.  
*Ips acuminatus* Eichh.  
*I. sexdentatus* Boern.  
*I. typographus* L.  
*O. golovjankoi* Pjat.  
*O. laricis* Fabr.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Polygraphus jezoensis* Niis.  
*P. punctifrons* Thoms.  
*P. sachalinensis* Egg.  
*P. subopacus* Thoms.  
*Trypodendron lineatum* Ol.  
*T. proximum* Niis.  
*Xylechinus pilosus* Ratz.

*Picea koraiensis* Nakai

*Dryocoetes hectographus* Reitt.  
*D. rugicollis* Egg.  
*Hylurgops palliatus* Gyll.  
*Ips acuminatus* Eichh.  
*I. sexdentatus* Boern.  
*I. subelongatus* Motsch.  
*I. typographus* L.  
*Orthotomicus golovjankoi* Pjat.  
*O. laricis* Fabr.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Polygraphus jezoensis* Niis.  
*P. punctifrons* Thoms.  
*P. sachalinensis* Egg.  
*Scolytus morawitzi* Sem.  
*Trypodendron lineatum* Ol.  
*T. proximum* Niis.

*Abies holophylla* Maxim.

*Dryocoetes hectographus* Reitt.  
*D. rugicollis* Egg.  
*D. striatus* Egg.  
*Ips duplicatus* Saheb.  
*Hylurgops palliatus* Gyll.  
*Orthotomicus golovjankoi* Pjat.  
*Pityogenes chalcographus* L.  
*Polygraphus proximus* Blandf.

*P. sachalinensis* Egg.  
*Trypodendron lineatum* Ol.

*Abies nephrolepis* (Trautv.) Maxim.

*Dryocoetes hectographus* Reitt.  
*D. rugicollis* Egg.  
*D. striatus* Egg.  
*Hylurgops palliatus* Gyll.  
*Orthotomicus golovjankoi* Pjat.  
*O. laricis* Fabr.  
*Pityogenes chalcographus* L.  
*Polygraphus proximus* Blandf.  
*P. sachalinensis* Egg.  
*Trypodendron lineatum* Ol.

## C. Pine Forests

*Pinus koraiensis* Sieb. et Zucc.

*Blastophagus pilifer* Spess.  
*Dryocoetes hectographus* Reitt.  
*Hylastes parallelus* Chapuis  
*H. plumbeus* Blandf.  
*Hylurgops imitator* Reitt.  
*H. interstitialis* Chap.  
*H. spessivtzevi* Egg.  
*Ips acuminatus* Eichh.  
*I. sexdentatus* Boern.  
*I. typographus* L.  
*Orthotomicus golovjankoi* Pjat.  
*O. laricis* Fabr.  
*O. proximus* Eichh.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Trypodendron lineatum* Ol.

*Pinus sylvestris* L.  
*P. sylvestris mongolica* Litv.

*Blastophagus pilifer* Spess.  
*Dryocoetes hectographus* Reitt.  
*Hylastes attenuatus* K.  
*Hylurgops imitator* Reitt.  
*H. interstitialis* Chap.  
*Ips acuminatus* Eichh.  
*I. sexdentatus* Boern.  
*I. typographus* L.  
*Orthotomicus laricis* Fabr.  
*O. suturalis* Gyll.  
*Pityogenes chalcographus* L.  
*Polygraphus sachalinensis* Egg.  
*Trypodendron lineatum* Ol.

## Wood Borers (Cerambycidae)

### A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium aeneum* Deg.  
*C. violaceum* L.  
*Cyrtoclytus capra* Germ.  
*Monochamus salutaris* Gebl.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus* Deg.  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.  
*T. gracilicorne* Reitt.  
*Xylotrechus altaicus* Gebl.

### B. Spruce and Fir Forests

*Picea jezoensis* Carr.

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.  
*A. griseus* F.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Cyrtoclytus capra* Germ.  
*Monochamus salutaris* Gebl.  
*M. sutor* L.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus* Deg.  
*Rhagium inquisitor* L.  
*Semanotus undatus* L.  
*Tetropium castaneum* L.  
*T. gracilicorne* Reitt.

*Picea koraiensis* Nakai

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.  
*A. griseus* F.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Cyrtoclytus capra* Germ.  
*Monochamus salutaris* Gebl.  
*M. sutor* L.  
*M. urussovi* Fisch.

*Pogonocherus fasciculatus* Deg.  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.

*Abies holophylla* Maxim.

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Monochamus salutaris* Gebl.  
*M. sutor* L.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus* Deg.  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.  
*T. gracilicorne* Reitt.

*Abies nephrolepis* (Trautv.) Maxim.

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.  
*A. rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Monochamus salutaris* Gebl.  
*M. sutor* L.  
*M. urussovi* Fisch.  
*Tetropium castaneum* L.  
*T. gracilicorne* Reitt.

### C. Pine Forests

*Pinus koraiensis* Sieb. et Zucc.

*Acanthocinus aedilis* L.  
*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Cyrtoclytus capra* Germ.  
*Monochamus salutaris* Gebl.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus*  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.  
*T. gracilicorne* Reitt.

*Pinus sylvestris* L.

*Acanthocinus aedilis* L.  
*A. carinulatus* Gebl.

*Arhopalus rusticus* L.  
*Asemum striatum* L.  
*Callidium violaceum* L.  
*Cyrtoclytus capra* Germ.  
*Monochamus salutarius* Gebl.

*M. sutor* L.  
*M. urussovi* Fisch.  
*Pogonocherus fasciculatus*  
*Rhagium inquisitor* L.  
*Tetropium castaneum* L.

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### Flatheaded Borers (Buperstidae)

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#### A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Ancylocheira sibirica* Fleisch.  
*A. strigosa* Gebl.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.  
*Melanophila acuminata* Deg.  
*Phaenops guttulata* Gebl.

#### B. Spruce and Fir Forests

*Picea jezoensis* Carr.

*Ancylocheira sibirica* Fleisch.  
*A. strigosa* Gebl.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.  
*Melanophila acuminata* Deg.  
*Phaenops guttulata* Gebl.

*Picea koraiensis* Nakai

*Ancylocheira sibirica* Fleisch.  
*A. strigosa* Gebl.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.

*Melanophila acuminata* Deg.  
*Phaenops guttulata* Gebl.  
*Abies holophylla* Maxim.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.  
*Melanophila acuminata* Deg.

*Abies nephrolepis* (Trautv.) Maxim.

*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.

#### C. Pine Forests

*Pinus koraiensis* Sieb. et Zucc.

*Ancylocheira sibirica* Fleisch.  
*A. strigosa* Gebl.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.  
*Melanophila acuminata* Deg.

*Pinus sylvestris* var. *mangolica* Litv.

*Ancylocheira sibirica* Fleisch.  
*A. strigosa* Gebl.  
*Anthaxia quadripunctata* L.  
*A. reticulata* Motsch.  
*Chrysobothris chrysostigma* L.  
*Melanophila acuminata* Deg.

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### Weevils (Curculionidae)

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#### A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Hylobius albosparsus* Boh.  
*Pissodes gyllenhali* Gyll.

#### B. Spruce and Fir Forests

*Picea jezoensis* Carr.

*Cryptorrhynchus electus* Roel.  
*Hylobius albosparsus* Boh.  
*H. haroldi* Faust.  
*H. piceus* Deg.

*H. pinastri* Gyll.  
*Pissodes gyllenhali* Gyll.  
*Sipalinus gigas* F.

*Picea koraiensis* Nakai

*Cryptorrhynchus electus* Roel.  
*Hylobius albosparsus* Boh.  
*H. haroldi* Faust.  
*H. piceus* Deg.  
*H. pinastri* Gyll.  
*Pissodes gyllenhali* Gyll.

*Abies holophylla* Maxim.

*Niphades variegatus* Roel.  
*Sipalinus gigas* F.  
*Melandryidae* spp.

*Abies nephrolepis* (Trautv.) Maxim.

*Niphades variegatus* Roel.

#### C. Pine Forests

*Pinus koraiensis* Sieb. et Zucc.

*Cryptorrhynchus electus* Roel.  
*Hylobius albosparsus* Boh.  
*H. haroldi* Faust.  
*H. pinastri* Gyll.  
*Pissodes gyllenhali* Gyll.  
*Sipalinus gigas* F.

*Pinus sylvestris* var. *mangolica* Litv.

*Hylobius albosparsus* Boh.  
*Pissodes gyllenhali* Gyll.

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#### Blazed Tree Borer (Melandryidae)

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##### A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Serropalpus barbatus* L.

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#### Wood Wasps (Siricidae)

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##### A. Larch Forests

*Larix gmelini* (Rupr.) Rupr.

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*Xoanon mysta* Sem.

##### B. Spruce and Fir Forests

*Picea jezoensis* Carr.

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocerus antennatus* Marl.  
*U. gigas* L.

*Picea koraiensis* Nakai

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*Xoanon mysta* Sem.

*Abies holophylla* Maxim.

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocerus antennatus* Marl.  
*Xoanon mysta* Sem.

*Abies nephrolepis* (Trautv.) Maxim.

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocerus antennatus* Marl.  
*U. gigas* L.  
*Xoanon mysta* Sem.

C. Pine Forests

*Pinus koraiensis* Sieb. et Zucc.  
*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocera antennatus* Marl.  
*U. gigas* L.  
*Xoanon mysta* Sem.

*Pinus sylvestris* var. *mangolica* Litv.

*Paururus ermak* Sem.  
*P. juvencus* L.  
*Urocera antennatus* Marl.  
*U. gigas* L.  
*Xoanon mysta* Sem.

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Pathogens

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(Pathogens of Coniferous Trees in the Eastern Soviet Union)

A. Larch (*Larix* spp.)

*Hypodermella laricis*  
*Meria laricis*  
*Melampsorium betulinum*  
*Melampsora larici-capraearum*  
*Melampsora larici-epitea*  
*Melampsora larici-populina*  
*Melampsora larici-tremulae*  
*Melampsora populnea*  
*Hymenochaete abietina*  
*Lachnellula willkommii*  
*Phacidiopycnis pseudotsugae*  
*Columnocystis abietina*  
*Fomitopsis officinalis*  
*Fomitopsis pinicola*  
*Ganoderma lucidum*  
*Hapalopilus fibrillosus*  
*Hirschioporus abietinus*  
*Hymenochaete tabacina*  
*Ischnoderma resinosum*  
*Laetiporus sulphureus*  
*Phellinusignarius*  
*Phellinus pini*  
*Phellinus torulosus*  
*Pholiota destruens*  
*Polyporus squamosus*  
*Armillaria* spp.  
*Heterobasidium annosum*  
*Inonotus circinatus*  
*Inonotus heinrichii*  
*Inonotus tomentosus*  
*Phaeolus schweinitzii*  
*Polyporus osseus*

B. Spruce (*Picea* spp.)

*Lachnellula calyciformis*  
*Lachnellula subsilissimus*  
*Ascocalyx* spp.  
*Pezicula* spp.  
*Lophodermium macrosporum*  
*Chrysomyxa ledi-ledi*  
*Chrysomyxa ledi-rhododendri*  
*Chrysomyxa woroninii*  
*Chrysomyxa pirolata*  
*Pucciniastrum areolatum*  
*Heterobasidium annosum*  
*Phaeolus schweinitzii*  
*Inonotus tomentosus*  
*Phellinus pini*  
*Phellinus chrysoloma*  
*Phellinus weirii*  
*Armillaria* spp.

C. Fir (*Abies* spp.)

*Lachnellula* spp.  
*Pucciniastrum goeppertianum*  
*Pucciniastrum epilobi*  
*Uredinopsis* spp.  
*Melampsora* spp.  
*Melampsorella* spp.  
*Ophiostoma* spp.  
*Heterobasidium annosum*  
*Phaeolus schweinitzii*  
*Inonotus tomentosus*  
*Phellinus pini*  
*Phellinus chrysoloma*  
*Armillaria* spp.  
*Phellinus weirii*

D. Pine (*Pinus* spp.)

*Cronartium flaccidum*  
*Cronartium* spp.  
*Lachnellula* spp.  
*Ophiostoma* spp.  
*Heterobasidion annosum*  
*Bursaphelenchus* spp.  
*Phaeolus schweinitzii*  
*Inonotus tomentosus*  
*Phellinus pini*  
*Armillaria* spp.  
*Phellinus weirii*  
*Phellinus torulosus*

E. Scotch Pine (*Pinus sylvestris*)

Lagenidiales

*Lagenidium pygmaeum* Zopf. (dust coat)  
*Phytophthora cactorum* Lev. and Cohn (seedling)  
*Ph. cinnamomi* Kands. (seedling)  
*Pythium aphanidermatum* (seedling)  
*P. debaryanum* Hesse (seedling)  
*P. irregulare* Buism. (seedling)  
*P. pyrilobum* Trow. (seedling)  
*P. ultimum* Trow. (seedling)  
*P. torulosum* F. (seedling)

Mucorales

*Thamnidium elegans* Link

Eurotiales

*Elaphomyces cervinus* (Pers.) Schrot (seed)  
*Ceratocystis (Ophiostoma)* (lumber)  
*C. minor* (Hedge.) Hunt (lumber)  
*C. piceae* (Muxh.) Bakshi (lumber)  
*C. pini* (lumber)  
*C. pilifera* (lumber)

Sphaeriales

*Herpotrichia juniperi* (Duby.) Petrak. (needle)  
(lumber)  
*H. nigra* Karst. (lumber)  
*Niesslia vermicularia* Zer. (branch)  
*N. pusilla* (Fr.) Sch. (needle dried, branch)  
*Spharia pinastri* Fr. (branch)

Xylariales

*Coniochaeta malacotriha* (Niessl.) Trav. (branch, lumber)  
*Rosellinia helena* (Fr.) Sch. (Root)  
*R. obliquata* Wint. (cone's scales)  
*Hypoxylon diathrauston* Rehm. (branch)

Allantosphaeriales

*Calosphaeria abietis* Krieger (bark)  
*C. ligniaria* (Grev.) Mass. (lumber, bark)  
*Diaporthe eres* Nits. (bark)  
*Valsa collicula* (Worm) Cke. (bark)  
*V. decumbens* (Sch.) Nits. (bark)  
*V. pini* (Alb. et Schw.) Fr. (bark)  
*V. superficiales* Fr. (bark)  
*Valsella abietis* (Rostr.) Munk. (branch-dried)

Melanosporales

*Melanospora chionea* (Fr.) Cda (bark and rotted wood)

Hypocreales

*Calonectria cucurbitula* (Fr.) Sacc. (bark and rotted wood)  
*Gibberella suabinetii* (Mont.) Sacc. (seedling)  
*Hypocrea alutaceae* (Pers. ex Fr.) Ces. (needle and seed)  
*Nectria cinnabarina* (Tode) ex Fr. (branch)  
*N. cucurbitula* (Tode) ex Fr. (branch)  
*N. viridescens* Booth (branch)  
*Ophionectria scolecospora* Bref. (needle, branch)

Pezizales

*Rhizina undulata* Fr. (root)  
*Desmazierella acicola* Lib. (needle)  
*Discina perlata* (Fr.) Fr. (trunk)  
*Peziza calycina* Fr. (trunk)  
*P. resiniae* Fr. (trunk)  
*Pseudoplectania melaena* Fr. (branch)

Phacidiales

*Coccophacidium pini* (Schw. ex Fr.) Rehm. (branch)  
*Hypodermella ampla* Fr. (needle)  
*H. arcuata* Dark (needle)  
*H. cerina* D. (needle)  
*H. concolar* L. (needle)  
*Hypodermella limitata* (needle)  
*H. montana* F. (needle)

*H. pedatum* D. (needle)  
*H. sulcigena* (Rostr.) Tubeuf (needle)  
*Lasiosictis fimbriata* (Schw.) Baumber (needle)  
*Lophodermium brachysporum* Rostr. (needle)  
*L. durilabrum* Darker (needle)  
*L. nitens* Darker (needle)  
*L. pinastri* (Sch.) Chev. (needle)  
*Phacidium convexum* Dearn (needle)  
*P. infestans* Karst. (needle)  
*P. planum* Davis (needle)  
*Pseudographis pinicola* (Nyl.) Rehm (bark)

#### Ostropales

*Naemacyclus niveus* Sacc. (needle)  
*Stictis fimbriata* Schw. (cone)

#### Helotiales

*Mitrula pusilla* (Nees.) Fr. (branch)  
*Sclerotinia graminearum* Elen.  
*Orbilina chryzocoma* (Bull.) Sacc. (branch)  
*Cenangium abietis* (Pers.) Duby  
*C. aciculum* Rehm  
*C. atropurpureum* Cash  
*Cenangium ferruginosum* Fr.  
*C. pinicola* (Reb.) Karst. (branch)  
*Crumenula abietina* Lagerb. (branch)  
*C. sororia* Karst.  
*Dermatea pini* Phill. et Harkn. (branch)  
*Tympanis buchsii* Rehm. (branch)  
*T. confusa* Nyl. Conn. (branch)  
*T. hypopodia* Nyl. Conn. (branch)  
*T. pinastri* Tul. (branch)  
*Dasyscypha agassizzi* (Berk ex Curt.) Sacc.  
(branch)  
*D. arida* Sacc. (branch)  
*D. calyciformis* (Willd.) Rehm.  
*D. ellisiana* (Rehm) Sacc. (branch)  
*D. oblongospora* Hahn ex Ayers. (branch)  
*D. pini* (Brunch.) Hahn ex Ayers. (branch)  
*D. pulverulentus* (Lib.) Sacc.  
*Lachnellula calycina* Sacc. (branch)  
*L. chrysophthalma* (Pers.) Karst. (branch)  
*L. flavorirens* (Bres.) Dennis (branch)  
*L. fuscanguonea* (Rehm) Dennis (branch)  
*L. pini* (Brunch.) Dennis (branch and stem)  
*L. pseudofarinacea* Dennis (branch)  
*Pezizella lythri* Sacc.  
*P. minuta* Decern.  
*Phialea acuum* (Alb. et Schw.) Rehm.  
*Biatorrella resinae* (Fr.) Mudd.  
*Pragmopora amphibola* Massal.

*Scleroderris lagerbergii* Germ.  
*Tryblidiopsis pinastri* (Pers.) Karst. (branch)

#### Dothideales

*Physalospora obtusa* (Schw.) Cke.  
*Phaeocryptopus pinastri* (Ell and Sacc.) Petz.  
*Scirrhia acicola* (Dearn) Siggers  
*Scirrhia pini* Funk.  
*Scorias spongiosa* (Schw.) Er.  
*Cucurbitaria pithyophila* (Fr.) de N. (branch)  
*Botryosphaeria ribis* Gross. (branch)

#### Capnodiales

*Capnodium pini* Berk. et Curt. (branch)

#### Hysteriales

*Hypoderma brachysporum* (Rostr.) Tubeuf.  
*H. conigenum* Cooke  
*H. desmazierii* Duby  
*H. pallidula* Br.  
*H. pinicola* Brunch.  
*Hypoderma saccatum* Dark. (branch)  
*Hysterium contortum* Ditt. (branch)  
*H. crispum* Fr. (branch)  
*H. elatinum* Fr. (branch)  
*Hysterographium nova Caesariense* (Ell.) Roum.  
*Lophium mytilinum* Pers. ex Fr. (branch)

#### Aphylophorales

*Aleruodiscus amorphus* (Pers.) Rab.  
*A. polygonius* (Pers.) H. et L.  
*Amylostereum areolatum* Fr. Boidin (bark, lumber)  
*Athelia galzinii* (Bourd.) Donk.  
*Causicium macconii* (Burt) John Erikss et Boid ex  
Parm. (branch)  
*Corticium byssinum* (Karst.) Mass.  
*C. centrifugum* (Lev.) Bres. (log)  
*C. evolvens* Fr. (branch)  
*C. laeve* Br. (lumber)  
*C. mutabile* Bres. (lumber)  
*C. ochroleucum* Bres. (lumber)  
*C. pelliculare* Karst. C. pertenuae Karst.  
*C. sulphureum* Fr.  
*C. terrigenum* Bres. (lumber)  
*C. teutoburgense* Brinkm. (lumber)  
*Cytidia albo-melea* (Bond.)  
*Gloeocystidium alutaceum* (Sch.) Bourd. et Galz.  
(lumber)  
*Gloeocystidium inaequale* H. et L. (bark, lumber)  
*G. ochraceum* (Fr.) Litsch. (bark, lumber)

*G. sphaerospora* (H. et L.) Bourd. et Galz.  
*Glocoporus amorphus* f. *molluscus* (Fr.) Killern.  
*Gl. dichrous* (Fr.) Bres.  
*Hyphodontia arguta* Erikss.  
*H. subalutaceae* (Karst.) Erikss.  
*Metulodontia cremeo-alutacea* Parm.  
*Peniophora agrillaceae* Bres. (branch)  
*P. cremea* Bres.  
*P. flavoferruginea* (Karst.) Ltisch.  
*P. gigantea* (Fr.) Mass.  
*P. serialis* (Fr.) H. et L.  
*P. subalutacea* (Karst.) H. et L. (stem)  
*P. velutina* (Fr.) Cooke (stem)  
*Phlebia gigantea*  
*Phlebiella candidissima* (Schw.) Bond. et Sing.  
*Trechispora candidissima* (Schw.) Bond. et Sing.  
*Stereum abietinum* (Pres. ex Fr.) Epicr.  
*S. pini* (Fr.) Fr.  
*S. rugisporum* (Eil. et Ev.) Burt.  
*S. sanguinolentum* Alb. et Schw.  
*Botryobasidium botryosum* (Bres.) Jo Erikss.  
*B. subcoronatum* (Hohn) Donk.  
*Sarcodon fuligineo-albus* (Fr.) Quel.  
*S. imbricatum* (Fr.) Karst.  
*S. laevigatum* (Fr.) Quel.  
*Thelephora fibriata* Schw.  
*T. laciniata*  
*T. terrestris* Ehrenb.  
*Tomentella isabellina* (Fr.) H. et L.  
*T. ochracea* Fr.  
*T. subfusca* (Karst.) H. et L.  
*Clavaria afflata* Lagerg.  
*C. apiculata* Fr.  
*C. purpurea* Fr.  
*Clavariadelphus ligula* (Fr.) Donk.  
*C. truncatus* (Quel.) Donk.  
*Mucronella calva* (Fr.) Fr. (lumber)  
*M. subtilis* Karst. (bark, lumber)  
*Pistillaria fusiformis* Kauf.  
*P. paradoxa* (Karst.) Corner  
*Pterula multifida* Fr.  
*Typhula abietina* Corner  
*Kavinia bourdotii* (Bres.) John Erikss. (lumber)  
*K. himantia* (Schw.) John Erikss. (lumber)  
*Lentaria delicata* (Fr.) Corner (lumber)  
*L. epichnoa* (Fr.) Corner (lumber)  
*L. micheneri* (Berk. et Curt.) Corner (lumber)  
*Lentaria soluta* (Karst.) Pil. (lumber)  
*L. virgata* (Fr.) Corner (lumber)  
*Ramaria apiculata* var. *compacta* (Bourd. et Gatz.)  
 Corner  
*R. crispula* (Fr.) Quel. (branch)  
*R. flaccida* (Fr.) Ricken  
*R. invalii* (Cott. et Wakef.) Donk.  
*Auriscalpium vulgare* (Fr.) Karst.  
*Hydnum auriscalpium* Fr. (lumber)  
*H. niveum* Fr.  
*H. repandum* Fr.  
*H. tomentosum* Sch.  
*Odontia ambigua* Karst.  
*O. arguta* (Fr.) Quel.  
*O. bicolor* Alb. et Schw.  
*O. floccosa* (Erikss.) Nicol. (lumber)  
*O. fusco-atra* (Fr.) Bres. (branch)  
*O. grisea* Bres.  
*O. hydroides* (Cook. et Massae) Hohn (bark,  
 lumber)  
*O. lactea* Karst.  
*O. papillosa* Karst.  
*O. queletii* Bourd. et Galz. (branch)  
*O. soloewskii* Jack. (lumber)  
*Radulum byssinum* Bres. (lumber)  
*R. orbiculare* Fr. (branch, stem)  
*R. pendulum* Fr. (branch, stem)  
*R. quercinum* (branch, stem)  
*R. spathulatum* Bres. (lumber)  
*Xylodon candidum* (Ehr.) Bourd.  
*Merulius aureus* Fr. (branch)  
*M. himantioides* Fr. (lumber)  
*M. molluscus* Fr. (lumber)  
*M. pinastri* (Fr.) Burt. (lumber)  
*Meruliporia taxicola* (Pers.) Bond. et Sing. (branch)  
*Serpula lacrymans* (Wulf. et Fr.) Bond.  
*S. minor* (Fr.) Bond.  
*S. pinastri* (Fr.) Bond.  
*S. silvester* (R. Falck) Bond.  
*Abortiporus borealis* (Fr.) Sing.  
*Amylocyctis lapponicus* (Rom.) Bond. et Sing. (bark,  
 lumber)  
*Amyloporia lenis* (Karst.) Bond. et Sing.  
*A. xantha* (Fr.) Bond. et Sing. (lumber)  
*Bjerkandera adusta* (Willd. ex Fr.) Karst.  
*B. fumosa* (Pers. ex Fr.) Karst. (lumber)  
*Ceraporia taxicola* (Pers.) E Kom. (lumber)  
*Chaetoporellus aureus* (Peck.) Bond. (stem)  
*C. radulus* (Pers.) Bond. et Sing. (lumber)  
*C. rixosus* (Karst.) Bond. et Sing.  
*C. subacidus* (Peck) Bond. et Sing. (lumber)  
*Coniophora arida* (Fr.) Karst. (branch)  
*C. cerebella* (Pers.) Sch.  
*C. puteana* (Schum. ex Fr.) Karst. (lumber)  
*Coniophorella byssoidea* Fr. (lumber)  
*C. olivaceae* Karst. (branch)  
*Coniophorella umbrina* (Alb. et Schw.) Bres.  
 (branch)  
*Coriolellus anceps* (Peck.) Parm. (lumber)  
*C. flavescens* (Bres.) Bond. et Sing. (lumber)  
*C. serialis* (Fr.) Murr.

*C. squalens* (Karst.) Bond. et Sing.  
*C. subsinuosus* (Fr.) Bond. et Sing.  
*Coriolus cervinus* (Schw.) Bond. (lumber)  
*C. hoehnelii* (Bres.) Bond. et Sing.  
*C. sinuosus* (Fr.) Bond. et Sing.  
*C. vaporarius* (Fr.) Bond. et Sing. (lumber)  
*C. subsinuosus* (Fr.) Bond. et Sing. (lumber)  
*Fibuloporia bomoycina* (Fr.) Bond. et Sing.  
*F. mollusca* (Pers.) Bond. et Sing.  
*F. reticulata* Pers. Bond. (lumber)  
*F. vaillantii* (Dc. ex Fr.) Bond. et Sing. (stem, lumber)  
*F. unita* var. *multistratosa* Pil. (lumber)  
*Fomitopsis annosa* (Fr.) Karst.  
*F. crassa* (Karst.) Bond. (stem)  
*F. officinalis* (Vill.) Bond. et Sing. (stem)  
*F. pinicola* (Schw. ex Fr.) Karst.  
*F. rosea* (Alb. et Schw. ex Fr.) Karst.  
*F. stellae* (Pil.) Bond.  
*F. subrosea* (Weir.) Bond. et Sing. (lumber)  
*Funalia trogii* (Berke.) Bond. et Sing. (lumber)  
*Gloeophyllum odoratum* (Fr.) Jmaz. (lumber)  
*G. sepiarium* (Fr.) Karst. (lumber)  
*G. trabeum* (Fr.) Murr. (lumber)  
*Hapalopilus aurantiacus* (Rostr.) Bond. et Sing.  
*H. fibrillosus* (Karst.) Bond. et Sing.  
*H. nidulanus* (Fr.) Karst. (branch)  
*Jrpex lacteus* (Fr.) (stem)  
*Laetiporus sulphureus* (Fr.) Bond. et Sing. (stem)  
*H. ochraceo-lateritius* (Bond.) Bond. et Sing. (lumber)  
*Hirschioprus abietinus* (Fr.) Donk. (lumber)  
*H. fusco-violaceus* (Ehr.) ex Fr. Donk. (lumber)  
*Osmoporus odoratus* (Wulf.) Sing. (lumber)  
*O. protractus* (Fr.) Bond.  
*Oxyporus ravidus* (Fr.) Bond. et Sing.  
*O. pearsonii* (Pil.) E. Kom.  
*Podoporia sanguinolanta* (Alb. et Schw.) Hohn  
*P. vitrea* (Fr.) Donk.  
*Polyporus picipes* (Fr.) Karst. (stem)  
*Polystictus circinatus* (Fr.) Karst.  
*P. circinatus* var. *trigueter* Bres.  
*P. tomentosus* (Fr.) Karst. (stem)  
*Poria placenta* (Fr.) Cke.  
*P. vulgaris* (Fr.) Cke.  
*P. weirii* Cke.  
*Trametes heteromorpha* (Fr.) Bres. (lumber)  
*Tyromyces albellus* (Peck.) Bond. et Sing.  
*T. albidus* (Sch. ex Secr.) Murr. (lumber)  
*T. caesius* (Sch. ex Fr.) Murr. (lumber)  
*T. cinerascens* (Bres.) Bond. et Sing.  
*Tyromyces destructor* (Schr.) Bond. et Sing.  
*T. erubescens* (Fr.) Bond. et Sing.  
*T. floriformis* (Quel.) Bond. et Sing. (bark, lumber)

*T. fragilis* (Fr.) Donk.  
*T. kymatodes* Donk. (stem)  
*T. lacteus* (Fr.) Murr. (stem)  
*T. leucomalleus* Murr.  
*T. mollis* (Fr.) Karst.  
*T. resupinatus* (B. ex Pil) Bond. et G.  
*T. semipileatus* (Peck.) Murr.  
*T. semisupinus* (Berk. et Kurt.) Murr.  
*T. sericeo-mollis* (Ram.) Bond. et Sing.  
*T. stipticus* (Fr.) Coll. et Ponz.  
*T. tephroleucus* (Fr.) Donk.  
*T. trabeus* (Rost.) Bourd et Jalz.  
*T. undosus* (Peck) Murr. (stem)  
*Ganoderma applanatum* (Pers. ex Wallr.)  
*Hymenochaete fuliginosa* (Pers.) Bres.  
*Inonotus hispidus* (Bull ex Fr.) Karst. (stem)  
*I. radiatus* (Sow. ex Fr.) Karst.  
*Ischnoderma resinosum* (Fr.) Karst. (stem, lumber)  
*Phaeolus schweinitzii* (Fr.) Pat.  
*Phellinus contiguus* (Pers.) Bourd. et Galz. (stem, lumber)  
*P. demidoffii* (Lev.) Bond. et Sing. (stem, branch)  
*P. hartigii* (All. et Sch.) Bond.  
*P. isabellinus* (Fr.) Bourd. et Galz. (stem.)  
*Phellinus nigrolimitatus* (Rom.) Bourd. et Galz.  
*P. pini* (Thore et Fr.) Pil.  
*P. pini* Til. var. *tipicus* Pil. f. *pithyusa* Negr.  
*P. pini* var. *abietis* (Karst.) Pil. (branch, stem)  
*P. pini* Pil. var. *abietis* Karst. f. *caucasicus* Nigr.  
*P. pini* var. *pini* (Thore et Fr.) Pil. (stem)  
*Cyphella vernalis* Weinm. (bark, lumber)  
*C. digitalis* Alb. et Schw.  
*C. griseo-pallida* Weinm.  
*Schizophyllum commune* Fr. (stem)

#### Agaricales

*Armillariella mellea* (Fr.) Karst.  
*Catathelasma imperiale* (Fr.) Sing.  
*Clitocybe aurantiaca* (Fr.) Stud.  
*Collybia dryophila* (Fr.) Kumm.  
*C. maculata* (Fr.) Kumm.  
*Lentinus lepideus* (Fr.) Fr.  
*L. sulcatus* Berk.  
*L. squamosus* H.  
*L. vulpinus* (Fr.) Fr.  
*Lepista nuda* (Fr.) Cke.  
*Tricholoma flavovirens* (Fr.) Lund.  
*T. portentosum* (Fr.) Quel.  
*Tricholomopsis rutilans* (Fr.) Sing.  
*Pholiota adiposa* Fr.  
*P. flammans* (Fr.) Kumm.  
*Stropharia aeropharia* (Fr.) Fr.  
*Cortinarius violaceus* (Fr.) Fr.

*Paxillus atrotomentosus* (Fr.) Fr. (stem, lumber)  
*P. acheruntius* Fr.  
*P. involutus* (Fr.) Fr. (stem, lumber)  
*P. panuoides* (Fr.) Fr.  
*Gomphidius rutilus* (Fr.) Lund. et Nant.  
*Boletus edulis f. pinicola* (Vitt.) Vassilk.  
*Leceinum percandidum* (Vassilk.) Watling  
*Suillus bovinus* (Fr.) O. Kuntze  
*S. granuiatus* (Fr.) O. Kuntze  
*S. luteus* (Fr.) S. F. Gray  
*S. piperatus* (Fr.) O. Kuntze  
*Russula aurata* Fr.  
*R. decolorans* (Fr.) Fr.

#### Tulasnellales

*Tulasnella araeosa* Bourd. et Galz.  
*T. fuscoviolaceae* Bres.  
*T. violaceae* (Johan, Olsen) Juel.

#### Dacrymycetales

*Arrhytidia involuta* (Schw.) Coker  
*Calocera cornea* (Fr.) Fr.  
*C. visoca* (Pers.) Fr.  
*Cerinomyces altaicus* Parm.  
*C. canadensis* Jacks et Martin  
*C. crustulinus* ((Bourd.) et Gats) Martin  
*Ditiola brunnea* (Martin) Kennedy  
*D. nuda* Berk. et Br.  
*Dacrymyces chrysocomus* (Fr.) Tul.  
*D. dictyosporus* Martin  
*D. deliquescens* (Merat) Duby  
*D. estonicus* Raitv.  
*D. ovisporus* Bref.  
*D. palmatus* (Schw.) Bres.  
*D. tortus* Fr.  
*Guepiniopsis merulinus* (Pers.) Pat.

#### Tremellales

*Ditangium cerasi* (Tul.) Cost. et Duf.  
*Exidia pithya* Fr.  
*E. saccharina* Fr.  
*E. testaceae* Raitv.  
*Exidiopsis calcea* (Pers.) Wells.  
*E. fugacissima* (Bourst. et Galz) Sacc. et Trott  
*Protodontia piceicola* (Kuhn.) Martin  
*Pseudohydnum gelatinosum* (Fr.) Karst.  
*Stypella papillata* Moller  
*Tremella encephata* (Willd.) Pers. (branch)  
*T. foliaceae* Fr.  
*T. translucens* Gordon

#### Auriculariales

*Septobasidium linderi* Couch  
*S. pinicola* Snell.

#### Uredinales

*Coleosporium apocynaceum* Cke.  
*C. campanulae* (Pers.) Lev.  
*C. crowellii* Cumm.  
*C. euphrasiae* (Schum) Wint.  
*C. helianthi* Arth.  
*C. inconspicuum* Hedge et Long.  
*C. inulae* (Kze.) Rabenh.  
*C. ipomoeae* (Sch.) Arth.  
*C. laciniariae* Arth.  
*C. melampyri* (Rebent) Karst.  
*C. petasitis* (Dc.) Lev.  
*C. pinicola* Arth.  
*C. pulsatillae* (Str.) Lev.  
*C. rhinanthacearum* Lev.  
*C. senecionis* Kickx.  
*C. solidaginis* (Sch.) Thuem.  
*C. sonchi* (Str.) Lev.  
*C. sonchi-aroensis* (Pers.) Lev.  
*C. terebinthinaceae* (Sch.) Arth.  
*C. tissilaginis* (Pers.) Lev.  
*C. vernoniae* Berk. et Curt.  
*Cronartium cerebrum* Hedge et Long.  
*C. coleosporioides* Hedge et Long. (branch)  
*C. compotniae* Arth. (branch)  
*Cronartium flaccidum* (Alb. et Schw.) Wint.  
 (branch, stem)  
*C. himalayense* W.  
*C. quercus* Schrot f. sp. fusiforme Sch.  
*C. ribicola* (Lasch.) Fisch. v. Waldh. (stem,  
 branch)  
*C. strobilinum* Hedge et Hohn.  
*Endocronartium harknessii* Hir.  
*Melampsora pinitorquea* (Fr.) Rostr. (branch,  
 stem)  
*Peridermium comptoniae* (Link.) Chev.  
*P. fusiforme* Chev. (branch, stem)  
*P. kurilense* (Link.) Chev. (branch, stem)  
*P. montezumae* Cummis sp. nov. (branch)  
*P. cerebrum* Chev. (branch, stem)  
*P. pini* Lev. et Kleb. (branch)  
*P. pyriforme* L. (branch, stem)  
*P. stalactiforme* L. (branch, stem)

#### Moniliales

*Aspergillus flavus* Link.  
*A. glaucus* Link.

*A. herbariorum* F.  
*A. niger* V. Tiegh.  
*A. wentii* Wehm.  
*Botrytis cinerea* Pers. ex Fr.  
*Fusoma pinii* Harting  
*Helicomycetes candidus* Sacc. (branch)  
*Penicillium coryophilum* Dietr.  
*P. glaucum* Link.  
*P. luteum* Jukal  
*Trichoderma viride* var. *kirhanense* (lumber)  
*Krap. Pol. Sizova*  
*Trichothecium roseum* Link.  
*Verticicladiella* sp.  
*Verticillum albo atrum* Rke. et Berth.  
*V. terrestre* Pke. et Berth.  
*Alternaria alternata* (Fr.) Keissl.  
*A. humicola* Qud. (lumber)  
*A. tenuis* Nees. emius Neerg.  
*Cercospora pinidensiflora*  
*Cladosporium herbarum* Link. ex Fr.  
*Helicosporium phaeosporum* (Fres.) Sacc.  
*Nigrospora gallarum* (Nol.) Potl.  
*Phialophora fastigiata* (Lager. et Melin) Conant.  
 (lumber)  
*Pullularia pullulans* (De-By) Berkhout (lumber)  
*Rhinocladiella atrovirens* Nannf. (lumber)  
*Sporodesmium cladosporioides* Cda. (lumber)  
*Stachybotrys macrocarpa* L. (lumber) (lumber)  
*Trichoporum heteromorphum* Nannf. (lumber)  
*Leptographium lundbergii* Lagerh. (lumber)  
*Aegerita torulosa* Sacc.  
*Bactridium flavum* Kze. (branch)  
*Exoporium pyrosporum* Hohn et Melin (branch)  
*Fusarium bulbigenum* W.  
*F. lateritium* Nees f. *pini* Hepting  
*F. martii* App. et Woll.  
*F. oxysporum* Sch. var. *aurantiacum* (Dk.) Wr.  
*F. sporotrichioides* Sherb.  
*Tuberculina maxima* Rostr. (branch)

#### Melanconiles

*Cryptosporium lunasporum* Linder  
*C. pinicola* Linder  
*Cylindrosporium acicola* Bres.  
*Gloeosporium pineae* Bub.  
*G. pini* Oud.  
*Monochaetia pinicola* Dearn.  
*Pestalotia funerea* Desm.  
*P. hartigii* Tub.  
*P. peregrina* Ell. et Martin.  
*P. truncata* var. *lignicola* Grove  
*Phragmotrichum chailletii* Kze.

*Stilbospora pinicola* Berk.  
*Truncatella truncata* (Lev.) Stey

#### Sphaeropsidales

*Zythia cucurbitula* Jacz. (branch)  
*Z. resinae* (Ehr.) Karst. (branch)  
*Brunchorstia destruens* Erikss.  
*B. pinea* (Karst.) Hohn  
*Leptothyrium pinastri* Karst.  
*L. stenosporum* Dearn.  
*Leptostroma pinastri* Desm.  
*Coniothyrium dispersellum* Farst. (branch)  
*C. pini* Qudem.  
*Cytospora curreyi* Sacc. (branch)  
*C. kazachstanica* Sch. (branch)  
*C. kunzei* Sacc.  
*C. pinastri* Fr.  
*Diplodia conigena* Desm.  
*Diplodia megalospora* Berk.  
 et Curt. (branch)  
*D. natalensis* P. Evans (branch)  
*D. pinea* Kickx.  
*D. sapinea* (branch)  
*D. thujae* West. (branch)  
*Diplodiella crustaceae* Karst. (branch)  
*D. pini-silverstris* All. (branch)  
*D. pityophila* Sacc. et Penz.  
*Dothistroma pini* Herb.  
*D. septospora* Hulb.  
*Haplosporella pini* Fk. (branch)  
*Helicomycetes candidius* Sacc.  
*Hendersonia acicola* Munch et Tub. (branch)  
*H. folicola* (Berk.) Fekl.  
*H. pini* (branch)  
*H. strobilina* Curr.  
*H. thujae* Died. (branch)  
*Hendersonula pini* Died. (branch)  
*H. pinicola* Dearn. (lumber)  
*Hermiscium antiquum* (Cda.) Sacc. (lumber)  
*Phoma acicola* (Lev.) Sacc.  
*P. bacteriophilla* Pk. (branch)  
*P. cembrae* Karst.  
*P. douglasii* Oud. (branch)  
*P. eguttulata* Karst.  
*P. geniculata* Sacc. (branch)  
*P. harknessii* Sacc. (branch)  
*P. inopinata* Oud. (branch)  
*Phoma juniperi* (Desm.) Sacc.  
*P. piciana* Karst.  
*P. pinastrella* Sacc.  
*P. pinastri* (Oud.) Sacc. (branch)  
*P. pinicola* Sacc.  
*P. strobiligena* Desm.

*Phomopsis conorum* (Sacc.) Died. (branch)  
*P. occulta* (Sacc.) Trav.  
*P. strobil* Syd. (branch)  
*Rhabdospora mirabilissima* (Pk.) Dearn.  
*R. pini* Berk. et Curt.  
*Rhisosphaerella pini* Maubl.  
*Sclerophoma pini* Gucev. sp. n.  
*S. pithya* v. Hohn (branch) (branch)  
*S. pithyophila* (Corda) Hohn  
*S. pityella* (Sacc.) Hohn  
*Septoria acuum* Oudem.  
*S. pinicola* Dearn.  
*S. spadicea* Pat.  
*Sphaeronaema aciculare* Fr. (branch)  
*S. piliferum* Sacc. (bark, lumber)  
*S. pithyum* Sacc. (stem, branch)  
*Sphaeropsis ellissii* Sacc. (branch)  
*S. malorum* Pk. (branch)  
*Biatoridina pinastri* Golov. et Zchzedr. (branch, stem)  
*Discula brunneo-tingens* H. Meyer (lumber)  
*D. pinicola* (Namn.) Petr. var. *mammosa* Lagerh. (lumber)  
*Discula rubra* H. Meyer (lumber)  
*Dothichiza ferruginosa* Sacc. (branch)  
*D. kazachstanica* Sch.

*Patellina caesia* Ell. et Stansf.  
*Pseudopatellina conigena* V. Hohn  
*Rhizochonia endophytica* var. *falicata* var. *nov.* (branch)  
*R. globularis* sp. nov. (branch)  
*R. hiemalis* K. (branch)  
*R. solani* Kuhn (branch)

#### Bacteria

*Erwinia multivora* Sez. Parf. (stem, root)  
*Pseudomonas halepensis* L. (stem, root)  
*P. pini* Vuil.

#### Angiospermae

*Visum austriacum* Wiesb. (branch)  
*V. sp.* (branch, branch)  
*Arceuthobium pusillum* K. (branch)  
*A. americanum* L. (branch)

#### Viroae

Tobacco mottl virus  
 Tobacco ringspot virus

### Wood Decay and Canker Diseases of *Abies Sibirica* Ledb.

*Lachnellula calyciformis* (Fr.) Dharne.  
 = *Dasyscypha calyciformis* Rehm.  
*Scleroderris* sp.  
*Lophodermium nervisequum* (D. S.) Rehm.  
*Herpotrichia nigra* Hart.  
*Aleurodiscus amorphus* (Fr.) Schroet.  
*Calyptospora goeppertiana* Kuehn.  
*Melamsorella caryophyllasearum* Schr.  
 = *M. cerastii* (Pers.) Wint.  
*Pucciniastrum epilobii* Otth.

*Bactrodesmium obligum* Sutton var. *suttonnii* Hughesctwhite  
*Cirrenalia donnae* Sutton  
*Capnobotrys neesii* Hughes.  
*Seiridium abietium* (Ell. et Ev.) Sutton  
*Toxosporium camptospermum* (Pk) Maublanc  
*Micropera pinastri* Sacc.  
*Zythiostroma pinastri* Karst.  
*Phoma abietella-sibirica* Schw.  
*Sclerophoma pithiophila* (Cda) Hohn.  
*Rhizosphaera pini* (Corda) Maubl.

### Wood Decay

*Phellinus hartigii*  
*Armillariella mellea*  
*Heterobasidion annosus*  
*Laetiporus sulphureus*  
*Phaeolus schweinitzii*  
*Fomitopsis pinicola*

*Ganoderma applanatum*  
*Fomes fomentarius*  
*Gloeosphyllum sepiarium*  
*Schizophyllum commune*  
*Stereum sanguinolentum*

## Stem Insects in Larch and Pine, and Their Location in the Log

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### Larch

*Acanthocinus griseus* (phloem)  
*Acmaeops septentrionis* (phloem)  
*Anoplodera varicornis* (feed on withered tree)  
*Asemum amurense* (phloem, xylem)  
*Callidium chlorizans* (stem)  
*C. violaceum* (stem)  
*Dryocoetes baicalicus* (stem phloem)  
*Hylobius abietis* (seedling collar and young stem phloem)  
*H. albosparsus* (seedling collar and young stem phloem)  
*Ips acuminatus* (branch phloem)  
*I. subelongatus* (stem phloem)  
*Melanophila guttulata* (stem)  
*Melanophila acuminata* (stem)  
*Monochamus salutaris* (xylem, phloem)  
*M. sutor* (xylem, phloem)  
*M. urussovi* (xylem, phloem)  
*Pityogenus chatcographus* (stem thick branch)  
*Rhagium* (phloem)  
*Sirex ermak* (stem xylem)  
*Tetropium castaneum* (xylem, phloem)  
*T. gracilicornis* (xylem, phloem)  
*Urocerus gigas taiganus* (stem xylem)

*Xeriss pectrums pectrum* (stem xylem)  
*Xyloterus lineatus* (stem xylem)

### Pine

*Acanthocinus aedilis* (xylem, phloem)  
*A. griseus* (phloem)  
*Acmaeops septentrionis* (phloem)  
*Anthaxis quadripunctata* (stem)  
*Arhopalus rusticus* (xylem, phloem)  
*Asemum amurense* (xylem, phloem)  
*Blastophagus minor* (stem phloem, shoot)  
*B. piniperda* (stem phloem, shoot)  
*Buprestis sibirica* (stem)  
*Callidium chlorizans* (stem)  
*Chrysocothris saucedanea* (stem)  
*Dendroctonus micans* (trunk phloem)  
*Hylastes angustatus* (stem phloem)  
*Hylobius albosparsus* (seedling collar and young stem phloem)  
*H. abietis haroldi* (seedling collar and young stem phloem)  
*Ips acuminatus* (stem phloem)  
*I. sexdentatus* (stem phloem)  
*Magdalis* (shoot tip)  
*Melanophila guttulata* (stem)  
*Melanophila acuminata* (stem)



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## Appendix I

### Pest Species Profiles

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#### Siberian Forest Pests of Concern on Bark

##### Insects

##### Siberian Silk Moth

Scientific Name of Pest—*Dendrolimus* spp.: *D. sibericus* L. (Lepidoptera: Lasiocampidae): similar species, *D. pini* (L.) and *D. punctatus* Walker.

Assessors—Robert Gara

##### Pest Risk Assessment (Including References)

##### Summary of Natural History and Basic Biology of the Pest—

(a) Biology—*Dendrolimus pini* occurs in pine stands of Northern and Central Europe, eastward into the U.S.S.R., in particular, the Ukraine and into the Urals, and southward into the Caucasus. It occurs in Siberia as far west as the Yenisey. *Dendrolimus punctatus* extends into the pine stands of Indochina and China. *Dendrolimus sibericus* occurs throughout Siberia where its hosts are larch, firs, pines (especially stone pine, *Pinus sibirica*) and perhaps spruce. The adults are active from late June through August. Females oviposit 150 to 200 eggs in linear clusters on twigs and needles. Caterpillar activity is noted in July-August when they devour needles up to the fascicles. In fall, about mid-September to early October, the caterpillars are approximately 25 mm long, and they drop to the ground. There they crawl into the litter and enter diapause. In spring, perhaps about April, when soil temperatures reach 4 to 5 °C, the caterpillars emerge from overwintering sites, crawl back up their hosts, and begin to feed on old needles as well as on newly flushing buds. Most of the population begin to pupate in June and July; they form silken cocoons on branchlets intertwined with the foliage. Apparently these insects also pupate in bark crevices.

(b) Impact—Damage by the Siberian silk moth is dramatic because even relatively few larvae can completely defoliate small conifers. Repeated defoliations of conifers result in severe attacks of secondary insects, such as *Ips sublongatus* and various species of Buprestids and Cerambycids, e.g., *Monochamus urussovii* on *Abies sibirica* and *P. sibirica*.

(c) Plasticity—A characteristic that makes the *Dendrolimus* particularly threatening is their wide ecological niche. They are found on a variety of coniferous hosts and have significant variations in their life cycles to "accommodate" different hosts and climatic conditions. Further indications of this plasticity is noted in the number of different species of the genus found in the coniferous forests of Northern China, e.g., *D. huashanensis*, *D. rubripennis*, and *D. taibaiensis*. Besides these examples, there is considerable taxonomic debate on the affinity of several other Lasiocampid genera that also attack conifers.

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—*D. sibericus* prefers larch, but Soviet literature often discusses problems with this insect in stone pine and true firs; again attesting to the ecological flexibility of this defoliator. Moreover, because *D. pini* occurs throughout the Western U.S.S.R. and *D. punctatus* in Asia and China, it is conceivable that there may be host and range overlaps with these species, and they too may be found on export material.

- 2) Entry Potential—*D. sibericus* oviposits during summer on branchlets and even in bark crevices of the bole. Winter logging would greatly reduce the danger of importation of the insect as eggs. However, because the population overwinters in the duff and litter, diapausing larvae could be introduced if sufficient duff, litter, and soil were included in log shipments.
- 3) Colonization Potential—The Siberian silk moth is oligophagous as it feeds on several coniferous species. There is no reason to believe they would not infest western larch as well as other North American conifers. Introduction of this insect, therefore, would pose a serious threat to the intensively managed forests of the Pacific Northwest.
- 4) Spread Potential—Adult *D. sibericus* and *D. pini* are good fliers. Although the larvae do not balloon, they are well known for their crawling tenacity. A relentless spread within their main and secondary hosts would be expected.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—Possessing an oligophagous feeding behavior in conifers and the potential presence of host material in most regions of North America constitute a definite economic threat to forests and ornamental plantings. The greatest potential damage would be a reduction in expected yields of intensively managed stands.
- 2) Environmental Damage Potential—If *D. sibericus* and/or *D. pini* were introduced, and if this event coincided with intensive forest management initiatives, remedial insecticide spraying regimes would be recommended. This possibility could produce environmental hazards.
- 3) Perceived Damage (Social and Political Influences)—All *Dendrolimus* species are large and voracious feeders and possess urticating hairs. Accordingly, not only would defoliation foster high forest protection costs, but the presence of larvae would cause allergic responses in humans. Undoubtedly, the American public would react strongly against this "high-profile" pest, and the government would be pressured into spending millions in pest eradication programs, and the whole log importing program would be scrutinized.
- 4) Overall Risk—Because of the transportability of diapausing larvae in duff and litter and the possible inclusion of random egg masses on logs (e.g., trailing edge of a late summer oviposition), the probability of detection would be slight. Successful introduction would gain public attention because late instars are large, ravenous, and covered with urticating hairs.

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## Root/Stump Insects

Scientific Name of Pest—Scolytidae, *Hylastes cunicularis*, *Hylurgus ligniperda*, *Hylastes ater*, and the Curculionidae *Hylobius abietis*

Scientific Name of Host(s)—

Specialty Team—Entomology  
Assessors—Robert Gara

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest —

These insects feed and breed in phloem of logging slash, stumps, stump roots, moribund and dead conifers, and at the root crown of seedlings. Even more importantly, all have the potential to be vectors of diseases associated with intensive management, e.g., the black stain root disease, *Ceratocystis wagneri*.

*Hylastes cunicularis* Erichson—*Hylastes cunicularis* is distributed throughout Central and Northern Europe, into the Lapland, south to the Caucasus, and east into Siberia; spruces are its principal hosts. From May through June, *H. cunicularis* fly and infest felled stems, stumps, and moribund or recently dead trees. The attacking females construct short galleries with the wood grain (ca. 8 cm long) in the phloem and lay their eggs along the margins of these excavations. Developing larvae feed in the succulent phloem tissues within these galleries and generally do not produce feeding mines. By fall the larvae are fully developed and overwinter as last instars or pupae. Early the following summer, sexually immature female adults emerge and feed at the base of young seedlings or young trees for amino acids and other compounds necessary for ovarian maturation. This feeding behavior often results in a high mortality of recently planted seedlings. This maturational feeding behavior continues until late summer or early fall. Mature adults overwinter in maturational feeding galleries or in the litter at the base of trees. From the next May through June the insects fly and attack new host material. These insects have a 2-year life cycle.

*Hylurgus ligniperda* (Fab.)—This bark beetle is distributed in pines throughout Europe, into the Caucasus Mountains and Western Siberia. It has already been introduced to other countries involved in intensive forest management, such as Japan, New Zealand, and Chile. Brood galleries, initiated by females, consist of short entry tunnels that lead to a chamber cut in the phloem; mating occurs in these nuptial chambers. Females then construct long egg galleries parallel with the grain. Eggs are laid in notches cut in the walls of the egg gallery and are covered with grass. Eggs are laid over 100 to 200 mm of the gallery; the female will then rest before once more extending the egg gallery. Accordingly, larvae feeding in the phloem are found in at least two sizes. The insects overwinter in the phloem of their hosts as fourth instars and then pupate in late April or early May. They emerge as adults in 2 weeks and begin host selection flights. The main damage of this bark beetle is that the new adults are sexually immature and feed on roots of young pine seedlings until they reach sexual maturity.

*Hylastes ater* (Paykull)—This scolytid is similar to *H. ligniperda* both in distribution, habits, and damage potential. The population breeds primarily in pines; however, sexually immature adults feed in seedlings of pine, spruce, true firs, Douglas-fir, and larch. These insects, together with *H. ligniperda*, have entered many countries that practice intensive forestry, e.g., Chile, New Zealand, Australia, Great Britain, and possibly Canada. Brood galleries consist of short entry tunnels leading to an oblique nuptial chamber where mating takes place. Single egg galleries are dug along the grain by females. About 100 eggs are oviposited in individual notches that the females cut in the lateral walls of the egg galleries. The larvae make feeding tunnels initially at right angles to the egg galleries, but later these become random in direction and eventually obliterate both the early larval tunnels and those made by the parent adults. The insects overwinter as late instars and emerge in late spring as sexually immature adults.

*Hyllobius abietis* (L.)— The large pine weevil occurs throughout the distribution of *Pinus* and *Piceae* in Europe and Siberia. It also is native to Japan and parts of Asia and China. From May to September, females lay eggs in punctures they gnaw in the bark of fresh pine and spruce stumps; but in regions with short growing seasons, they lay eggs from May to the end of July. Each female oviposits from 60 to 100 eggs during this period. Hatching takes place in about 2 weeks, and the larvae bore into the phloem and excavate longitudinal feeding tunnels in the root-phloem. There are five instars that develop over a period of 13 to 14 months. Mature larvae pupate in cells cut into the sapwood (chip cocoons) or in the outer bark. The pupal stage lasts about 2 to 3 weeks, and teneral adults remain in their chip cocoons or cells cut in the bark for an additional 2 to 3 weeks. Then, the sexually undeveloped adults emerge and do maturational feeding on young coniferous seedlings from July through August. For maturational feeding the adults feed on seedling bark and phloem tissues of Douglas-fir, Scotch pine, white pine, Norway spruce, larch, and fir. This feeding causes significant seedling mortality, especially when a harvested area is regenerated soon after timber removal.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Three members of this ecological group primarily breed in pine, and the fourth breeds in spruce. Because adults of these insects are strongly attracted to resinous odors, it is possible that beetles may be found incidentally on exported larch logs. If pine and/or spruce were in the log mix, the chances of finding the insects within the phloem of their hosts would be high.
- 2) Entry Potential—If only larch were imported, the entry of this insect group would be potentially low. Inclusion of other coniferous species would markedly increase the entry potential.
- 3) Colonization Potential—The species, which primarily breed in pine, could colonize stumps, fallen branches, and moribund pines if the material were found around the port of entry. Chances that suitable pine breeding material would be present in Pacific Northwest ports would be minimal except where *Pinus contorta* occurs along the coast from northern California to British Columbia. The large pine weevil and *H. cunicularis* can breed in spruce, and Sitka spruce material is readily available near all Pacific Northwest ports, so the colonization potential for these pests would be high.
- 4) Spread Potential—The scolytid members of this ecological group are good fliers and concentrate in response to host volatile materials over long distances. I am unsure about the flight capability of the curculionid, but the weevils easily detect odors diffusing through soil and roots of suitable hosts. As long as recently cut or broken host material is available, infestations of these four species can inexorably spread.

##### B. Consequences of Establishment

- 1) Economic Damage Potential—The damage potential of these rhynchophorans is high; they would readily breed in pines and spruce breeding material, and maturational feeding would destroy planted seedlings. Worse would be the potential vectoring of the black stain root disease. Seedling and young stand mortality (black stain root rot kills) may not be an immediate problem to the PNW forestry sector. But as carefully planned harvesting operations; thinning regimes; and replanting programs, utilizing expensively selected planting stock, become routine forestry practices, little growth loss or stand mortality will be tolerated. In other words, as the economic damage level allowed in intensively managed stands drops, the rhynchophorans in question will become increasingly important economic pests.

- 2) Environmental Damage Potential—Although the economic damage caused by these insects would not cause environmental problems, one of the suggested control strategies would. Seedling mortality can be reduced by dipping bare rooted seedlings in a slurry containing a pesticide. This potential practice would raise environmental concerns.
- 3) Perceived Damage (Social and Political Influences)—These rhynchophorans would not reach the attention of the general public because damage caused by these insects is subtle. Either the private forestry sector or governmental agencies that practice intensive forestry would readily see the damage potential of these pests.
- 4) Overall Risk—If only larch logs are imported, the risk of accidentally introducing these pests is minimal. If pine and spruce logs are included, introduction of these rhynchophorans within the imported material is probable, and the risk would be high.

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## Pine Needle Scales

Scientific Name of Pest—*Matsucoccus koraiensis* and *M. matsumurae*

Scientific Name of Host(s)—*Pinus* spp.

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest —

All of the species of this genus are associated with trees of the genus *Pinus* and are found in both the Old and New World (Danzig, 1986). Most of the species are found in North America on pine. At least one species, the red pine scale, has been introduced into the Eastern United States and has become a serious pest of *Pinus resinosa* in plantations (Bean and Godwin, 1955; Hartzell, 1957; Doane, 1965; Kosztarab and Kozar, 1988; Anderson et al., 1976). A number of species are found on pines in Western North America, all native (Furniss and Carolin, 1977). According to Danzig (1986), members of this group of scale insects live under the bark of trees and sometimes on the roots. They are very small insects and quite inconspicuous in appearance. Eggs are laid under bark in the spring by the female. These hatch into a legless nymph. Nymphs that will become females go through a series of molts to the wingless female. Those that will become males molt into a mobile nymph that molts into a pupa; eventually a winged male emerges. The male will seek out the female, mate, and die. This is such an inconspicuous insect that its occurrence often goes undetected for some time. The developing nymphs feed directly on the tree by means of their elongated beak. Because they are wingless in this stage, they sometimes occur in considerable numbers where they are found. Dispersal is normally believed to be via wind. One nymphal stage is legless. This results in rather slow dispersal. Native species of this scale occur over considerable areas, showing that although dispersal may be slow, it does occur. The initial detection and subsequent spread of the red pine scale in southern New England provides useful information about the rate of spread of an introduced species. There are two generations per year of this species in New England. *Matsucoccus koraiensis* Young and Hu is found in Europe, China, Japan, and Siberia. Its natural host is *Pinus koraiensis* (Danzig, 1986).

These very small insects would be easily overlooked. They occur deep under the bark of the tree and could be easily transported. Nymphs overwinter under the bark and mature in spring, and females lay eggs in the spring that will produce both males and females. Eggs are deposited on the trunk. The hibernating stages are the nymphal stages of the male and female. There appears to be only a single generation per year, but the red pine scale has two generations per year in the Eastern United States.

These insects are well documented in the scientific literature, but relatively little is known about the habits of many of the species except those known to be pests (i.e., the red pine scale). In general, data base material on these pests are good, but much remains to be learned about their habits. Because nymphs overwinter, the female deposits eggs under the bark, and these eggs produce both males and females, the risk of transport is high. Detection of these stages under the bark would be very difficult.

Summary of Natural History. These scales overwinter as nymphs under bark; eggs are laid in spring, and they hatch into male and female nymphs. One nymphal stage is legless. The nymphs that will become females continue to molt until the wingless female is produced. The nymphs that will become males molt into a mobile form that molts into a pupa from which the winged male emerges. The male seeks out the wingless female and mates. There may be several generations per year.

## Specific Information Relating to Risk Elements:

### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Danzig (1986) does not comment on its pest status in Siberia but indicates that it is found under the bark on the trunks of *Pinus koraiensis*.
- 2) Entry Potential—High because of the great difficulty in detection on the trunks. The nymphs and likely females would be present as the eggs might be as well.
- 3) Colonization Potential—Moderate because of the low vagility of the stages. However, at least one species has been introduced into the Eastern United States (the red pine scale).
- 4) Spread Potential—Potential for spread is moderate compared with many insects, but the great difficulty in detecting the presence of the insect would allow spread before it is even known the insect is there. Only the males are winged. Dispersal is usually via the "crawler" stage (young nymph). One of the nymphal stages is legless.

### B. Consequences of Establishment

- 1) Economic Damage Potential—The damage would be to pines because that is the only group of trees it is known to feed upon. One introduced species is a serious pest of red pine grown in plantations in the Eastern United States, where it kills the trees.
- 2) Environmental Damage Potential—High. Damage to trees is documented. Spread is slow and difficult to detect.
- 3) Perceived Damage (Social and Political Influences)—Reduction in tree vigor allows possible attack by other insects/diseases. Will kill the tree. Attacks ornamental species in urban settings too.

Estimated Risk for Pest—High for pines.

### Spread Potential

- 1) Probable Rate of Spread—Low, but well documented in southern New England. It is very difficult to detect insect, so spread may be undetected at first.
- 2) Estimated Range of Spread—Range of various species of pines. Many species of pines in the western portions of North America. *Pinus contorta* occurs along the coast of Western North America.
- 3) Damage will be from weakening the trees, sometimes death. Other organisms are then able to attack tree. Will kill trees (Drooz, 1985).

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## Shortneedle Evergreen Scale

Scientific Name of Pest—*Nuculaspis tsugae* (Martatt)

Scientific Name of Host(s)—*Abies* spp., *Thuja* spp., *Picea* spp., *Tsuga* spp., and *Taxus* spp.

Specialty Team—Entomology

Assessor—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

According to Danzig (1986), there are five species found in this genus, all inhabiting conifers. *Nuculaspis tsugae* is found in Eastern Siberia and Japan. It lives on the underside of the host needles where its feeding causes chlorosis and early needle drop. It overwinters as a second instar nymph. Crawlers are found from May to July and August to November (there are two generations per year). This species was introduced into the east coast where it is a pest of fir, cedar, spruce, hemlock, and yew. A second species, *Nuculaspis californica*, is believed to be native to North America but may be an introduction (Drooz, 1985). It is known as the black pineleaf scale and is widely distributed. In Western North America it is especially common on ponderosa, Jeffrey, sugar, Monterey, and digger pine. It also attacks Douglas-fir. Heavy infestation may result in the death of the tree. According to Drooz (1985), outbreaks of this species are often associated with air pollution. Generally, this reduces the effectiveness of any form of control. There is a single generation in the north (British Columbia) and two or three generations in the south (California). As indicated above, the scales are found on the needles of the tree but enough damage occurs to kill trees if infestation is heavy enough (Furniss and Carolin, 1977). All sizes of trees are attacked. The introduction of *N. tsugae* into Western North America would be a serious threat to the 72 species of conifers found there.

Scale insects are small, inconspicuous, and difficult to detect under normal circumstances. They occur on the needles of the trees where the feeding on their tissues causes chlorosis of the tissues, damage, and even death of the trees. This species overwinters as a small nymph and, thus, is quite likely to be moved. Overwintering occurs in the second instar. These nymphs become males or females in the spring.

A single generation occurs in the north, and two or three generations may occur in the southern part of the range. These scale insects are well documented in the scientific literature, not only their occurrence but their role as pests on a variety of conifers. The general data base is quite good because of their pest status. Transport possibilities are high because the insects are small and easily overlooked. Detection would be difficult.

Summary of Natural History. *Nuculaspis tsugae* hibernates as a second stage nymph. These mature in the spring when both males and females are produced. The female lays yellow eggs. These hatch and one generation is completed by the end of the season. A closely related species, *N. californica*, has several generations per year, depending on the locality. The hosts of *N. tsugae* include fir, cedar, spruce, hemlock, and yew (Drooz, 1985).

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Yes, but populations numbers vary (Danzig, 1986). Found on *Tsuga*.
- 2) Entry Potential—High because it is very small, difficult to detect, and overwinters as second instar nymphs. These produce males and females in spring.

- 3) Colonization Potential—Moderate, but the ease of transport enhances the chances of success. The wide host plant range of some species makes colonization likely. This is an insect of rather modest vagility; but at least one species has been introduced.
- 4) Spread Potential— High if it becomes established. Spread likely by means of wind.

B. Consequences of Establishment

- 1) Economic Damage Potential—High. Established species attacks the needles, causing yellowing and early drop. Continued infestations will kill the tree. Variety of native and ornamental hosts.
- 2) Environmental Damage Potential—High. Damage is severe, often leading to the death of the tree.
- 3) Perceived Damage (Social and Political Influences)—Loss of needles from tree, yellowing of trees, eventual death of tree if infestation persists. Seems to do well as a pest where air pollution is present.

Estimated Risk for Pest—High for host plants.

Spread Potential

- 1) Probable Rate of Spread—Low but difficult to detect in early stages. Potential for rapid spread along the seaboard is great. Wind dispersal is remarkably efficient for scale insects.
- 2) Estimated Range of Spread—Throughout entire range of host trees. These are well-adapted organisms. They occur on *Picea*, *Abies*, and *Tsuga*.
- 3) Damage will result from feeding on needles, which turn yellow and fall off. Repeated attacks will kill the tree (Drooz, 1985).

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## Pseudotsuga Scale

Scientific Name of Pest—*Lepidosaphes pseudotsugae*

Scientific Name of Host(s)—*Picea ajanensis*, *Abies sachalinensis*, *Tsuga* spp., and *Pseudotsuga* spp.

Specialty Team—Entomology  
Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

This scale insect belongs to a larger group of scales that is well represented in the Soviet Far East. The genus to which it belongs, *Lepidosaphes*, contains a number of pest species on other trees, including *Salix*, *Populus*, *Juglans*, *Betula*, *Rosa*, *Spiraea*, *Fraxinus*, *Rhododendron*, *Malus*, *Crataegus*, *Prunus*, *Cornus*, *Alnus*, *Ulmus*, *Physocarpus*, and *Tilia* among the broadleaved trees—all well represented in the Western North America and on *Picea*, *Abies*, *Tsuga*, *Pinus*, and *Pseudotsuga* among the conifers. The life cycle is similar to *Aspidiotus*, with the second instar nymph being the hibernating stage (Danzig, 1986). The nymphs produce both males and females in the spring. The insect occurs on the lower parts of the tree on branches and thin-barked regions of the tree. While not considered a pest in Siberia, its occurrence on *Pseudotsuga* in Japan (Takagi, 1960) suggests a serious potential pest. The fact that other acceptable host plants include *Picea*, *Abies*, and *Tsuga* simply amplifies the potential pest status (Borchsenius, 1963). The species occurs naturally in Eastern Siberia and Japan (Danzig, 1986; Borchsenius, 1963; Takagi, 1960; Balachowski, 1954).

A closely related species, *Lepidosaphes ulmi*, the oystershell scale, was introduced into North America from Europe and is a serious pest on a wide variety of broadleaved trees, including many important fruit trees (Furniss and Carolin, 1977; Drooz, 1985). While it does not occur on conifers, it documents the possibility of colonization and spread as well as risk of damage.

This is a difficult insect to detect because of its small size and inconspicuous appearance. Hibernation as a second instar nymph on the host makes it even more difficult to detect. This species occurs on the branches and thin-barked parts of the tree on all stages. There appears to be a single generation per year.

The documented range and host associations are well known in the literature, and there is a good scientific base for information on this group. The insect is found on living trees but would be expected to occur on freshly cut logs because they overwinter as second instar nymphs on the host. These nymphs will become both male and female in the spring.

**Summary of Natural History.** This species hibernates as a second instar nymph on its host. These nymphs become adult males and females the following season. Apparently, there is only a single generation per year. The insect occurs on the twigs, branches, and thin-barked portions of the trunk. Damage is caused by feeding on the tree by means of sucking mouthparts. This species is reported from a number of conifer hosts including *Pseudotsuga*. Related species are serious pests of broadleaved plants.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin— No potential pest status based upon pest status of related species and the host range of this species that includes the major genera of coniferous hosts in Western North America.

- 2) Entry Potential—High, based upon entry and establishment of related species (oystershell scale). Many potential hosts at entry points.
- 3) Colonization Potential—High, based upon information on closely related species. Hibernation as both male and female nymphs increases introduction of both sexes.
- 4) Spread Potential—High because of widespread occurrence of potential conifer hosts in Western North America. The wide spread of the other species introduced suggests similar spread for this species.

B) Consequences of Establishment

- 5) Economic Damage Potential—Documented damage to trees by related species that have been introduced into North America. This species is not considered a pest at point of origin.
- 6) Environmental Damage Potential—Damage to trunk, branches, and twigs. Weakening of trees, allows attack by other organisms.
- 7) Perceived Damage (Social and Political Influences)—Less visible because the insect feeds on the trunk, branches, and twigs.

Estimated Risk for Pest —High because of the broad host range, including *Pseudotsuga* (containing Douglas-fir).

Spread Potential

- 1) Probable Rate of Spread—Moderate because female lacks wings, but nymphs are spread by wind. Widespread occurrence of oystershell scale shows that dispersal is not difficult.
- 2) Estimated Range of Spread—Moderate, but possible to calculate if historical records for oystershell scale are examined for Eastern North America.
- 3) Damage results from feeding on twigs, branches, and trunk. General weakening of tree allows attack by other organisms.

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## Cryptomeria Scale

Scientific Name of Pest—*Aspidiotus cryptomeriae*

Scientific Name of Host(s)—Wide variety, including *Abies*, *Picea*, *Pseudotsuga*, *Tsuga*, *Cupressus*, *Cryptomeria*, *Thuja*, *Taxus*, *Pinus*.

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

Danzig (1986) reported *Aspidiotus cryptomeriae* from much of Eastern Siberia, Japan, Korea, parts of China, and Taiwan. It is a typical armored scale and is found on the foliage of the trees. A wide variety of conifer hosts have been recorded in the literature, including species of *Abies*, *Picea*, *Pinus*, *Taxus*, *Chamaecyparis*, *Cryptomeria*, *Keteleeria*, *Torreya*, *Juniperus*, and others (Danzig, 1986). On native hosts it is rather widespread but reaches larger populations in more sparsely wooded regions, apparently responding to increased insolation. In some parts of its range, the species prefers the lower branches, especially where the branches are covered with snow. It has been reported to be a pest of spruce and fir on Sakhalin Island in plantations (Kovalenko, 1965). The second nymphal stage overwinters in Siberia. Adults appear in late July at which time the eggs are laid. This species damages the needles of the host plants upon which it feeds, causing damage to the tree (Murakami, 1970).

This species has been introduced into the Eastern United States, apparently from Japan. It is known to occur in Connecticut, Indiana, Maryland, New York, and Pennsylvania (Drooz, 1985). This establishes the fact that the species can be introduced. Within this region, two generations per year occur, again showing that even though only a single generation occurs in Siberia, more are possible if the climate permits. This scale has a very wide host plant range that includes essentially every genus of conifers found in Western North America from British Columbia to southern California as well as ornamental genera and species.

As with the other scale insects, they are small, inconspicuous animals and are easy to overlook. They spend the winter months on the host as second-stage nymphs. These nymphs will produce both males and females, increasing the risk of introduction. Overwintering occurs as second instar nymphs. In Siberia, only a single generation per year occurs, but in warmer climates, two generations per year occur.

There is good documentation in the literature on this group of scales, chiefly because of their pest status. The general data base on this group is good. Transport possibilities are high because of the dormant stage being found on the host and the fact that there are so many potential host plants in Western North America.

Summary of Natural History. This species hibernates as a second instar nymph on the host. In the spring, these nymphs develop into males (winged) and females (wingless). These mate, and the female lays eggs on the host. In cooler areas, development stops in the fall and overwintering occurs as a second instar nymph. These scale insects feed upon the needles of the plant, causing chlorosis. It is a reported pest of spruce and fir on Sakhalin Island (Kovalenko, 1965). Two generations per year occur in warmer regions (Drooz, 1985). A very wide range of coniferous hosts are known and reported in the literature.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Yes, reported pest of spruce and fir on Sakhalin Island by Kovalenko (1965).

- 2) Entry Potential—Good because the species overwinters on the host as a second instar nymph—both males and females develop from these nymphs. The insect at that stage is very small and difficult to detect.
- 3) Colonization Potential—High because of the wide range of host plants. Western North America has 72 species of native conifers plus a wide variety of ornamental species. The fact that the species has been introduced into the Eastern United States clearly demonstrates it can be introduced and become established.
- 4) Spread Potential—Moderate to high in the west because of the much higher percentage of conifers in western forests compared to eastern forests and the greater variety of potential hosts in urban and rural locales.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—Documented damage to foliage of the trees at point of origin and in the area of the eastern seaboard where it has been introduced. Thus, economic damage potential already demonstrated.
- 2) Environmental Damage Potential—Damage to foliage, reduced vigor of trees, makes tree susceptible to damage by other insects and disease. Attacks trees in urban and rural areas.
- 3) Perceived Damage (Social and Political Influences)—Discoloration of foliage, premature needle drop, potential attack by other pest organisms.

Estimated Risk for Pest —High for a variety of host plants.

#### Spread Potential

- 1) Probable Rate of Spread—Moderate but difficult to detect because of small size. May not be recognized in early stages of attack. Spread by wind. Rate of spread partially dependent on host availability—this is much higher in Western North America because of the dominance of conifers in the forest.
- 2) Estimated Rate of Spread—Determined partly by the conditions stated above. Calculations could be made based upon the information from the eastern seaboard.
- 3) Damage comes from feeding on the needles, causing chlorosis, premature needle drop, and weakening of the tree. This may allow damage from other pest insects and disease.

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## Spruce Scale

Scientific Name of Pest—*Physokermes jezoensis* (Siraiwa)

Scientific Name of Host(s)—*Picea ajanensis*, *P. korajensis*, *P. glehnii*.

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest --

Danzig (1986) has determined that the spruce scale is found in many localities in Eastern Siberia. The species was described from southern Sakhalin. This species belongs to a Holarctic genus with at least 5 species found in the Old World. One of these, *Physokermes piceae* (Schrank), has been introduced into North America from Europe. It attacks spruce in the New World (Drooz, 1985; Furniss and Carolin, 1977; Fenton, 1917). The females of *Physokermes* grow on branches and the males on the lower sides of conifers as needles. There is one generation per year. The immature stages overwinter on the tree. The adult females are found in the spring. They retain the eggs in the body cavity. The early instar nymphs appear in late spring and are found on the new growth. Damage to the branches may be severe. Danzig (1986) reports the species as a pest of *Picea* plantations in Siberia. Based upon the habits of *Physokermes piceae* in North America, *P. jezoensis* is a potential pest if introduced into North America. The occurrence of Sitka spruce along the Pacific Coast provides a ready host. The establishment of the European *P. piceae* in North America demonstrates the capability of members of the genus to colonize and spread.

As mentioned for other scale insects, these are small, inconspicuous organisms and are easily overlooked. They do occur on the host and resemble the buds of the plant (Furniss and Carolin, 1977), making detection even more difficult. The overwintering nymphs are extremely small and are found on various parts of the tree, especially the branches and needles. They would be easily transported during the cold season. The overwintering nymphs produce both males and females, thus transporting the nymphs would transport both sexes and increase chances of colonization. Danzig (1986) states that male adults and male pupae have not yet been found. The species may be parthenogenetic, in which case only females are needed for colonization.

There is good documentation of occurrence of this species in the potential export production area (Danzig, 1986). There is also excellent scientific documentation. Scales live on live trees naturally. As overwintering nymphs they would occur on freshly cut logs and on seasoned logs if the timing of the season were correct.

Summary of Natural History—Overwinters as young nymph on host plant. Adults develop in the spring. There is a probability that the species is parthenogenetic (Danzig, 1986) because no males or male pupae have yet been found. There is likely only a single generation per year. Young nymphs are found on undersides of new shoots and on buds. A related species, *P. piceae*, has been introduced into North America from Europe.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Yes. Danzig (1986) states that the scale is found abundantly in spruce plantations.
- 2) Entry Potential—Good transport via young nymphs (overwintering stage). Occurrence of Sitka spruce along Pacific Coast. Introduction of a closely related European species has occurred.

- 3) Colonization Potential—Good. See item #2 above.
- 4) Spread Potential—Good, based upon spread of *P. piceae*, introduced from Europe. There are many more conifers in Western North America than in Eastern North America. Spruce species are very important in Canada, where they form a belt across the entire country.

B. Consequences of Establishment

- 1) Economic Damage Potential—Documented damage caused by related species (Furniss and Carolin, 1977; Drooz, 1985). Danzig (1986) reports *P. jezoensis* from spruce plantations in Siberia.
- 2) Environmental Damage Potential—All species of spruce (including ornamental species) at risk.
- 3) Perceived Damage (Social and Political Influences) —Discoloration of foliage, death of lower branches, and possible weakening of tree allowing other organisms to attack.

Estimated Risk for Pest—High.

Spread Potential

- 1) Probable Rate of Spread—Moderate, but likely to be difficult to detect because of small size. Dispersed by wind via young nymphs. Dispersal is partially dependent upon available host material.
- 2) Estimated Range of Spread—There are historical records of establishment and spread of related *P. piceae* introduced into Eastern North America. First reported in 1906, it is now found in Alberta and the Northwest Territories (Furniss and Carolin, 1977).
- 3) Damage comes from nymphs feeding on the buds and needles. This results in premature needle drop and weakening of tree.

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## Woolly Adelgids

Scientific Name of Pest—*Adelges laricis* (Vall.) and *A. tardoides* (Chol.)

Scientific Name of Host(s)—*Larix*

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

The various species of *Adelges* are very small, inconspicuous insects with sucking mouthparts. They often go unnoticed until the damage to the trees becomes evident, at which time the trees are likely to be killed (Mitchell, 1967). Species of *Adelges* occur on a wide variety of conifer species (Rozhkov, 1966; Mitchell, 1967; Carter, 1969; Bevan, 1987). While species occurring naturally on their native hosts may be of relatively little economic importance, when introduced into a new area on new hosts the results may be devastating. The balsam woolly aphid introduced into North America is a well-documented example (Mitchell, 1967). The insect may have several generations per year. While males are found with the females (at critical times of the year) in their native areas, when introduced, only the females are required for establishment because they can reproduce without fertilization (parthenogenesis). Specifically, the balsam woolly aphid (*Adelges picea*), introduced into North America from Western Europe in 1928, occurs only as females and has from two to four generations per year. The adult females lay 30 to 100 eggs each. The eggs hatch in a few days, producing the crawler stage. This is the mobile stage, and they may be moved from tree to tree by the wind. Once a proper site has been found, the small insect inserts its beak into the tree and remains in place until maturity. Very large populations can build up on individual trees. The saliva injected by the insect into the tree is toxic, resulting in abnormal responses by the tree. The amount and type of damage to the tree depends upon the location and concentrations of the insect. According to Mitchell (1967), over a billion and a half board feet of commercial timber (true firs) was killed or weakened in a 400,000-acre area in Washington State between 1950 and 1957. Bevan (1987) considers *Adelges laricis* Vall. the most damaging species of *Adelges* on larch in the United Kingdom. *Adelges laricis* occurs on larch in Siberia (Rozhkov, 1966). Other species of *Adelges* are found on spruce (Bevan, 1987). Although small and not easily noticed, some very serious pest species are found in this group. The ability of the females to reproduce without the males and their ready dispersal makes them a high-risk group. Carter (1969) reports on the damage caused by the introduction of three species from the European continent.

These insects are very small and easily overlooked. They occur on the bark of the trunk and on the branches. They would be easily transported. Eggs are deposited on the trunk. Hibernating stage is the young larva under the bark of the tree and under the scales on the branches. There are from two to four generations per year, depending upon the species and the locale. Only the females are required to establish a colony because they can reproduce parthenogenetically. The saliva of the bug is toxic and causes a response from the cells of the host plant. When concentrations of the bug are high enough, trees are killed. These insects are well documented in the scientific literature, chiefly because many are pests. General data base is quite good. Very good documentation on the pest status of many species. The fact most colonization and establishment requires only females (e.g., balsam woolly aphid introduced into North America) greatly enhances the likelihood of establishment. The very small, hibernating nymphs would make detection extremely difficult.

Summary of Natural History—Overwinters as a young nymph under the bark of trunk or branch. Completes development to adult female (if males are absent). Female lays eggs that hatch in a few days producing a very small, active "crawler." The crawler may move a short distance and settle down or be dispersed by wind to another tree. When a suitable locale is found, the crawler molts and becomes a sedentary nymph, feeding on the host by means of a long beak. There may be from two to four generations per year. The female is able to reproduce without being fertilized, making it very easy to build up large numbers of individuals.

## Specific Information Relating to Risk Elements:

### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Some species of *Adelges* are considered pests at origin (Bevan, 1987). That includes native tree species and North American species planted in Europe. *Adelges laricis* Vall. is not considered a pest of larch by Rozhkov (1966) in Siberia but is considered a serious pest of larch in the United Kingdom (Bevan, 1987).
- 2) Entry Potential—Excellent. Overwinter on the trees as extremely small nymphs (difficult to detect), able to reproduce without male, able to survive for extended periods.
- 3) Colonization Potential—Excellent. Seventy-two conifer species in Western North America. Ability of female to reproduce without male makes colonization very easy.
- 4) Spread Potential—Excellent. Spread of *Adelges picea* in North America is well documented.

### B. Consequences of Establishment

- 1) Economic Damage Potential—High. This group of insects kills trees (Mitchell, 1966). Their toxic saliva causes damage to the cells in the trees.
- 2) Environmental Damage Potential—High. Documented examples (balsam woolly aphid) clearly demonstrate the potential damage (see above) of species of *Adelges* in both Old and New World.
- 3) Perceived Damage (Social and Political Influences)—Tree death, serious weakening of other trees not killed. High concentration of damage in restricted areas. Likely to attack trees in urban areas as well as forests.

Estimated Risk for Pest—High in all categories.

### Spread Potential

- 1) Probable Rate of Spread—Example: balsam woolly aphid in Western North America (Mitchell, 1967). First detected on the West Coast in 1928. Spread to Willamette Valley in Oregon by 1930. Detected around Mt. St. Helens, Washington, in 1954. By 1957, 600,000 acres of forest in Oregon and Washington infested. By 1959, found on Vancouver Island and at Vancouver, British Columbia.
- 2) Estimated Range of Spread—Throughout ranges of host plants (72 species in Western North America).
- 3) Damage will be by killing trees and weakening remaining trees, making them more susceptible to damage by other organisms.

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## Larch Aphid

Scientific Name of Pest—*Cinara laricis*

Scientific Name of Host(s)—*Larix sibirica*, *Larix* spp.

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

*Cinara laricis* is a small, gray insect with numerous dark brown spots on the upper surface of the abdomen. The species occurs on various species of larch from Western Europe to far-eastern Siberia and Japan (Shaposhnikov, 1967; Rozhkov, 1966). While not considered a pest of larch by Rozhkov (1966), the species is very widespread in the Old World and biotypes are likely. Members of this genus are confined to conifers throughout the northern hemisphere. Another species of *Cinara*, *C. pini*, occurs from England east into Siberia and occurs on *Pinus sylvestris* throughout the range of this tree. Bevan (1987) reports this as a pest of *Pinus sylvestris* and the American *Pinus contorta* in England. According to Shaposhnikov (1987), the association of aphids with conifers is an ancient one. Further, he states that if a potential new host is closely related to the normal host, the transition to the new host may be fairly easy, although the range of hosts may be narrow (i.e., conifers). According to Eastop and Hille Ris Lambers (1976), there are over 215 species of *Cinara* known in the world, occurring on a wide variety of coniferous hosts. The presence of 72 species of conifers in Western North America provides many potential hosts for newly introduced aphid species. This is a colonial insect, often found living in groups on the host. The insect usually lives on the bark of the branches of older trees and on the trunk of younger trees. The populations are dynamic and often break up into smaller groups, sometimes in response to increased numbers. Adults may be winged or wingless. The females are normally parthenogenetic during the six or seven generations per year. The males only appear late in the season, mate with the female, and die. The females seem to overwinter in the fertilized state and lay eggs in the spring. This makes them excellent candidates for transport and colonization. The ability to reproduce without the male makes it possible for aphids to exploit an environment in the absence of the male. Crowded conditions often result in the production of winged individuals that are able to move to other plants.

This is a small, inconspicuous insect that is not easily detected by casual observation. During the cooler months, the overwintering females are often under bark chips on the branches and trunk. While the species is found on the surface of branches and trunk in the summer, winter is spent as a fertilized female, often under bark. There are six to seven generations per year, all females except the final generation when the males are produced. They mate with the female and die. The female overwinters as a fertilized female. Many aphids are vectors of disease. The range of this species is documented by many publications. There are a number of aphid specialists who have described many species of *Cinara*. A catalog exists that lists all the species found in the world. While new localities are certain to be found, the general data base is good. The fact that the fertilized female overwinters under the bark of trunks and branches and deposits eggs on the surface of the trunks and branches in the spring provides a very long period for potential movement via logs. The proximity and abundance of potential conifer hosts also enhances the possibility of establishment.

Summary of Natural History—Overwinters as fertilized female on trunk, lays eggs in spring on trunk and branches. Eggs hatch into stem mothers (females) who reproduce parthenogenetically. If crowding occurs, winged individuals are produced that move to another tree and establish new colonies. There are six to seven generations per year. The young aphids move out onto the needles when they molt, returning to the branch or trunk after molting. At the end of the season, males are produced. These mate with the females and these mated females overwinter. Aphids feed by means of beak, sucking plant fluids from the trees. Many species of aphids are vectors of diseases.

## Specific Information Relating to Risk Elements:

### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Not considered a serious pest in Siberia but other species of *Cinara* (e.g., *Cinara pini* that occurs on *Pinus sylvestris*) are considered pests on some trees including *Pinus contorta* in England (Bevan, 1987). Abundant species in Siberia.
- 2) Entry Potential—Excellent. They overwinter as fertilized females under bark on branches and trunks.
- 3) Colonization Potential—Excellent. Able to reproduce without males, able to produce winged individuals if crowding occurs, abundant hosts very similar found in immediate region of contact.
- 4) Spread Potential—Excellent, aphids have shown a remarkable ability to spread once they reach North America (e.g., Russian wheat aphid—in 4 years it reached all of Western North America; Blue alfalfa aphid, essentially the same). The 72 species of native conifers in Western North America provide ample potential host material.

### B. Consequences of Establishment

- 1) Economic Damage Potential—Potential pest causes yellowing of foliage of trees, smaller trees likely to be most vulnerable but will occur on all stages.
- 2) Environmental Damage Potential—Rather high, very likely to establish and spread widely. Likely to encounter favorable environments within the ranges of the potential hosts.
- 3) Perceived Damages (Social and Political Influences)—Alteration of appearance of trees, perceived change in quality of forests, potential loss of trees.

Estimated Risk for Pest—Moderate, but certain.

### Spread Potential

- 1) Probable Rate of Spread—High. Aphids have demonstrated unusually high spread rate—example: Russian Wheat Aphid—in the first 4 years in North America it reached the entire western portion of the United States and much of Canada.
- 2) Estimated Range of Spread—Entire range of host plants.
- 3) Damage will be to foliage of trees; younger trees likely to be most susceptible. Aphids are well-known vectors of plant diseases. Little known about this subject on conifers.

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## Pine Flatbug

Scientific Name of Pest—*Aradus cinnamomeus* (Panzer)

Scientific Name of Host(s)—*Pinus sylvestris* and other pines; rarely on larch.

Specialty Team—Entomology

Assessors—John D. Lattin

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

*Aradus cinnamomeus* is a small, flat bug that occurs chiefly on pines in the Old World. Its favored host is *Pinus sylvestris*, but it is known to occur on other pines and on larch (Rozhkov, 1966). The natural range of *A. cinnamomeus* extends from the United Kingdom east across Europe at least as far as Barnaul, Siberia (Kirichenko, 1955). This species is a serious pest of young pine trees in many parts of its range including European U.S.S.R. (Rozhkov, 1966). That it is capable of movement is documented by its relatively recent recovery from England (Leston, 1951a), a country whose Hemiptera fauna is very well known (Southwood and Leston, 1959). Strawinski (1925) provides a very detailed study of the biology of this species. The damage is caused by the direct feeding upon the stem (chiefly) and the branches of the young trees. The individuals are found under the bark or scales of the tree. Their small size and inconspicuous appearance make their discovery difficult. The insects occur on mature trees as well as young trees. Damage is chiefly on young trees.

This species of Aradidae occurs in several different forms. Some individuals have fully developed wings and are able to disperse, while other individuals have reduced wings and are unable to fly. This creates a population able to respond to quite varying conditions, able to exploit a habitat without expending excess energy in dispersing, and at the same time having some individuals with fully developed wings able to move to new environments. These facts, coupled with their small size and normal occurrence under the bark of the trunk and branches of the tree, make them very difficult to detect and likely to be transported on logs. Forty-six species of Pinaceae occur in Western North America, including *Pinus contorta* that occurs along the north Pacific Coast. This species of pine, along with its other subspecies, is the most widespread species of pine in North America. It occurs with other pines, including *Pinus ponderosa*, another very widespread species.

References under this name for North America should be referred to *Aradus kormilevi* Heiss (Heiss, 1980). The North American taxon is considered a distinct species.

This insect is difficult to detect by casual inspection because it is small, inconspicuous, and found under bark or bark chips, on the trunk, and on branches. The insect is found throughout the year as nymphs and adults. The adults would be the normal colonizing stage.

The documented range of this species is based upon literature published in Europe and Russia. The general distributional information is reliable because it is based upon the work of highly regarded scientists. The range of this species in the eastern Soviet provinces is likely to be greater than reported simply because of the vast area involved. The insect is found on living trees but would be expected to occur on fresh cut logs as well. Seasoned logs might contain these insects, depending upon the season. They remain inactive during the colder parts of the year and thus could be transported with ease.

Summary of Natural History. Egg, spring; nymphs and adults overwinter; gradual metamorphosis with five nymphal instars, found under bark of conifers. Adults are either fully winged or brachypterous. It is a serious pest of young pine trees in Europe and parts of the U.S.S.R. While many Aradidae are fungus feeders, this species feeds upon the tree itself.

## Specific Information Relating to Risk Elements:

### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—This insect is very widely distributed in the Old World, from Western Europe to Siberia. Its chief host is *Pinus sylvestris*, but it is known to occur on other conifers, including larch.
- 2) Entry Potential—Excellent. This is a very inconspicuous insect and is easily overlooked. All stages occur under bark and it hibernates as both nymphs and adults. It is inactive at low temperatures, thus able to be transported with ease.
- 3) Colonization Potential—Excellent. Leston (1951b) documents the colonization of this species in England. Shore pine (*Pinus contorta*) occurs along the Pacific Coast from north central California to the Yukon Territory. The other subspecies of *P. contorta* occur in the Sierra Nevada, Cascade, and Rocky Mountains.
- 4) Spread Potential—Excellent because of the many species of Pinaceae found in Western North America (46 species). This includes species of considerable economic value.

### B. Consequences of Establishment

- 1) Economic Damage Potential—Strawinski (1925) provides detailed biological information. The damage would be to young trees rather than mature trees. This is considered a serious pest of pine in the Old World.
- 2) Environmental Damage Potential—Damage to young trees, reduction of generation of trees. Might be serious where even-aged stands are being regenerated.
- 3) Perceived Damage (Social and Political Influences) -- Reduced generation of trees when mature forests are removed. Could slow the reforestation efforts in some areas.

Estimated Risk for Pest—High

Additional Remarks—Greatest risk would be to young regenerating stands or reforestation efforts. The many species of Pinaceae in Western North America make the possibility of damage to some of these tree species quite high.

### Spread Potential

- 1) Probable Rate of Spread—Slow because most individuals are flightless, but a small percentage have functional wings. Estimated rate 1 to 5 miles/year.
- 2) Estimated Range of Spread—Most of Western North America because of the high number of species (46) of the Pinaceae found in that region. There is also a possibility of spread across Northern North America via *Pinus banksiana* to the pine regions of Eastern North America.
- 3) Damage will be to seedlings and young trees rather than to mature trees, especially in regenerating stands.

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## Pathogens

### Larch Needle Cast

Scientific Name of Pest—*Meria laricis* and other *Meria* spp.

Scientific Name of Host(s)—*Larix* spp., *Pseudotsuga menziesii*

Specialty Team— Pathology

Assessors—Jeffrey Stone

#### Pest Risk Assessment (Including References)

Summary of Natural History and Basic Biology of the Pest—

Teleomorph: Unknown for *M. laricis*; the teleomorph of the nearly identical species, *M. parkeri*, which occurs on Douglas-fir, is *Rhabdocline parkeri* (Sherwood-Pike, Stone, and Carroll, 1986). The genus *Rhabdocline* contains species that cause severe defoliation of Douglas-fir, *R. weirii* and *R. pseudotsugae*, although *R. parkeri* is not pathogenic. The two species of *Meria* are distinguished by their occurrence on different hosts. It is therefore likely that if a teleomorph is discovered for *M. laricis*, it will be a relative of *Rhabdocline*, either congeneric or at least in the family Hemiphacidae.

Prior to 1986, the name *Meria laricis* was applied to taxa occurring on both *Larix* spp. and on *Pseudotsuga menziesii*. The discovery of the teleomorph of the taxon from Douglas-fir resulted in the separation of the taxa into two distinct species, *Meria laricis* on *Larix* spp. and *Meria parkeri* on Douglas-fir. It is possible that critical examination of *Meria laricis* will show that the taxon is not monotypic and result in recognition of additional species. For example, the taxon from Eurasia may in fact represent a species or a species complex different from that of North America. For the purposes of this risk assessment, *Meria laricis* and *Meria parkeri* will be considered together as *Meria* species parasitic on conifers. A critical examination of Siberian collections of *Meria laricis* should be made to determine whether they are in fact the same taxon as North America *Meria laricis*.

Summary of Natural History —*Meria laricis* conidia overwinter on dead foliage. Rain dispersed conidia infect newly emerging foliage in the spring; diseased needles abscise prematurely in summer. Moist conditions in spring favor the dispersal and infection process. *M. laricis* is already present in Western North America, distributed with the range of its natural host, *Larix occidentalis*. Damage from larch needle cast is sporadic, because *Larix* spp. are deciduous, defoliation is seldom fatal to mature trees.

*Meria parkeri* infests needles of Douglas-fir beginning in the fall of the first year after bud break and continuously thereafter. Incidence of infection increases with needle age, needles become multiply-infected as they age from repeated reinfection (Bernstein and Carroll, 1977; Stone, 1987a; Todd, 1988). The conidia are rain-dispersed and are produced either on abscised needles or on galls of the Douglas-fir gall midge, *Contarinia* spp. (Sherwood, Stone, and Carroll, 1986; Stone, 1987a). Ascospores of the *Rhabdocline* teleomorph are produced on abscised needles in the winter. Host genotype and degree of *Contarinia* infestation affect the level of infection (Todd, 1988).

Infection of Douglas-fir needles by *M. parkeri* does not ordinarily cause disease symptoms. Infections are restricted to single epidermal cells in healthy foliage. Colonization of the needles does not occur until the onset of senescence or upon injury (Stone, 1987b). Disease has been reported in nurseries and orchards under wet spring conditions (Funk, 1985). *M. parkeri* should therefore be considered at worst a weak parasite of Douglas-fir. The species is widespread in Douglas-fir in western Oregon, Washington, and northern California (Carroll and Carroll, 1978).

Given the taxonomic similarities between *M. laricis* and *M. parkeri* and their relationship to known pathogens of Douglas-fir, the possible existence of a more virulent Eurasian strain or species of *Meria* capable of infecting and damaging Douglas-fir should be considered before *Meria* is dismissed as an insignificant risk. The widespread distribution of *M. parkeri* in foliage of Douglas-fir in the Pacific Northwest suggests that native Douglas-fir would have little or no genetic resistance to infection by an introduced virulent strain.

Whereas the deciduous habit of *Larix* spp. mitigates the severity of damage from larch needle cast, Douglas-fir would be much more severely affected by a defoliating pathogen. In addition, because *Larix* is found primarily east of the Cascade range far from the proposed ports of entry, the probability of an introduction from Siberia finding a suitable *Larix* host is remote. However, the possibility of a strain capable of infecting Douglas-fir is not remote; if such a strain exists the potential for introduction is high; and the potential for damage resulting from such an introduction is very large.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—*M. laricis* is reported on larch from Siberia and the Soviet Far East (Rozhkov, 1966). See remarks above concerning whether this taxon is monotypic. The infective propagules (conidia) will be present in foliage even where disease is not apparent, symptoms would be apparent only during the summer when the diseased needles are being shed. The disease is probably very widespread in its distribution, but may be inapparent.
- 2) Entry Potential—The conidia overwinter and would presumably survive the transit from the U.S.S.R. to ports of entry in North America. Needles lodged in bark crevices and attached to small branches would be difficult to detect and remove completely. Any mitigation procedure designed to prevent entry of pests from bark (e.g., gypsy moth) would probably also effectively reduce the potential to introduce *Meria* spp.
- 3) Colonization Potential—The potential for colonization of North American *Larix* spp. is low. As discussed above, however, species of *Meria* can infect Douglas-fir and the potential for possible colonization of Douglas-fir by a Eurasian strain should also be considered. In this case, potential for colonization would be high, as virtually all the Douglas-fir foliage in western Oregon and Washington is infected with *Meria parkeri*. All life stages of these species are restricted to foliage.
- 4) Spread Potential—The potential for spread of the disease will depend on the proximity of a suitable host. If western larch is the only host, then spread potential is low. Ornamental larch grown in landscape settings might be infected and act as a bridge to native western larch stands. If Douglas-fir is a potential host, even if less favorable a host than western larch, spread potential is high. The conidia are rain dispersed and can apparently survive for long periods on foliar residues.

This is not an insect-vectored disease. Conidia, and ascospores if they are important in spread of the disease, are rain-dispersed. Spread will depend therefore on meteorological factors, the distribution and density of suitable hosts, and the efficiency of the pest in establishing on a host. I am unable to offer any specific quantitative estimate of rate of spread. The range of probable spread will coincide with the distribution of the host. If the host is western larch, *M. Laricis* is already established throughout its natural range. If Douglas-fir is the host, the range will coincide with that of Douglas-fir. Direction of spread will probably follow prevailing winter wind patterns in a northeasterly direction.

B. Consequences of Establishment

- 1) Economic Damage Potential—Probably low, unless a novel, more virulent strain is introduced, or a strain capable of infecting Douglas-fir.
- 2) Environmental Damage Potential—Unknown, severity of disease is impossible to predict.
- 3) Perceived Damage (Social and Political Influences)— Unknown.

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## Melampsora Rust

Scientific Name of Pest—*Melampsora* spp.

Scientific Name of Host(s)—*Larix* spp., *Populus* spp., *Salix* spp., *Betula* spp.

Specialty Team—Pathology

Assessors—J.D. Rogers

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

*Melampsora Castagne* is a rust genus with both heteroecious and autoecious species. Species of particular interest herein are heteroecious and macrocyclic, requiring conifers (*Abies*, *Larix*, *Tsuga*, or *Pseudotsuga*) and hardwoods (*Populus* or *Salix*) to complete the ordinary life cycle. It is noteworthy, however, that several *Melampsora* species, including *M. epitea* Thuem. can become perennial on the hardwood host and persist indefinitely in the absence of the coniferous host, spreading to additional hardwood via urediniospores. Moreover, there are subtaxa of *Melampsora* species that—though morphologically indistinguishable—have different host ranges. Additionally, some species (for example, *M. epitea*) in cold climates can do without the coniferous host, becoming perennial on two angiospermous hosts. Finally, at least one *Melampsora* has been found on an entirely unexpected coniferous host—*M. albertensis* Arth. was found on a pine host in British Columbia. *Melampsora medusae* Thuem has been found on six coniferous hosts.

Potential damage by *Melampsora* rusts is great. Heavy infection on *Larix* can cause severe premature defoliation and several successive years of defoliation stress could have a severe impact on growth.

*Populus* and *Salix* can be severely damaged by heavy leaf infections. Damage can be particularly significant on hosts with perennial infections.

#### Specific Information Relating to Risk Elements

*Melampsora* rusts of interest herein have five spore stages, as follows:

Spermatia (pynciospore) (O)—Fertilizing element. Noninfective. On conifer needle.

Aeciospore (I)—On conifer. Infects hardwood, but cannot re infect conifer. Probably very resistant to desiccation and loss of viability. Can be carried hundreds of miles by wind.

Urediniospore (II)—On hardwood. Spreads fungus among hardwoods. Cannot infect conifer. Probably very resistant to desiccation and loss of viability. Can be carried hundreds of miles by wind.

Teliospore (III)—On hardwood. Noninfective. Produces basidiospores.

Basidiospore (IV)—On hardwood. Infects conifer needle. Cannot infect hardwood. Fragile; loses viability rapidly after formation. Cannot be carried far in viable condition under ordinary circumstances.

#### Pest with Host of Origin—

*Melampsora* spp. reported to occur in Siberia and the Soviet Far East include:

*M. betulinum* (alternate hosts = *Betula* spp.)

*M. larici* - *Capraearum* (alternate hosts = *Salix* spp.)

*M. larici* - *epitea* (alternate hosts = *Salix* spp.)

*M. larici - populina* (alternate hosts = *Populus* spp.)  
*M. larici - temulae* (alternate hosts = *Populus* spp.)  
*M. populnea* (alternate hosts = *Populus* spp.)

There may be other species as well. There are reported to be 148 known species of Melampsoraceae in the U.S.S.R. as compared to only 90 in the United States and Canada.

Survival potential of spore states—

Stages I, II, and III could very probably survive on conifer (I) or hardwood foliage (II, III) that inadvertently was brought into the country. Stages I and II could potentially "hitchhike" on logs (debarked or barked) or other debris. Because these spores are microscopic, they would not be readily detectable.

Establishment potential of *Melampsora* spp.—

The most resistant spore stages, which are likely to survive the importation, infect the hardwood host. Thus, one might expect that *Populus* and/or *Salix* in the vicinity of ports would be infected first. There would be a high potential for perennial infection of these hosts; the alternate *Larix* host might not be required for survival and intensification.

Entry potential of *Melampsora* spp.—

Potential would be high if any foliage debris is present on the introduced logs.

In my opinion *Melampsora* spp. would eventually be introduced, given the cryptic nature and the number of chances.

Colonization Potential—Risk is high.

Rust spores are windborne and can be carried for great distances. There are large areas of native poplar throughout the Pacific Northwest and frequently adjacent to import sites and milling sites as well as along transport routes. Within 100 miles of the Columbia River on both the Washington and Oregon sides from the Pacific Ocean at Astoria to the Tri-cities area in Washington, there are large acreages of hybrid poplar being grown under a Short Rotation Intensive Cultivation (SRIC) program. The hybrid poplar have been developed from clones throughout the United States, and their rust susceptibility is totally unknown. It is likely to be high.

Spread Potential of *Melampsora* spp.—

The potential spread from *Larix* to hardwood via stage I and hardwood to hardwood via stage II is great, perhaps for hundreds of miles. Spread from hardwood to *Larix* would be generally local owing to the fragility of stage IV.

A. Consequences of Establishment

- 1) Economic Damage Potential—There is potential for great damage to *Larix* and to *Populus* and *Salix*. The potential damage to the hardwood species is especially worrisome because of the great interest and investment in fast-growing and high-yielding *Populus* spp. in the Western United States. Unfortunately, the genetic potential for damage by *Melampsora* spp. is unknown. Even though some damaging *Melampsora* species are already in North America, we know nothing about the distribution of genotypes.
- 2) Environmental Damage Potential—

- 3) Perceived Damage (Social and Political Influences)—*Melampsora* spp. cause great aesthetic damage to foliage of both conifer and hardwood hosts. The public would not tolerate such damage from introduced pathogens.

Estimated Risk for Pest—Both in terms of likely introduction and potential damage, the risk is considered to be HIGH. It would be very difficult to monitor the cryptic spore states. Quarantine, in the restricted sense, would be virtually impossible.

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## Conifer Shoot Blight

Scientific Name of Pest—*Sirococcus strobilinus* (Preuss.) L.

Scientific Name of Host(s)—*Larix* spp., *Pinus contorta*, *Picea excelsa*, *P. sitchensis*, *Tsuga heterophylla*, *Pseudotsuga menziesii*, *Calocedrus* spp.

Specialty Team—Pathologists

Assessors—Mo-Mei Chen, Darroll Skilling, Fred McElroy

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

Since its original description (see Sutton, 1980, for taxonomy), this pathogenic fungus has been reported on cones and needles of *Picea*, *Pinus*, *Tsuga*, and *Pseudotsuga* in the U.K., France, Switzerland, Canada, and the U.S.S.R. *S. strobilinus* already occurs in North America, but the Siberian biotype may be different. Needles are infected and the fungus spreads to the current year's shoot, resulting in shoot mortality. In general, the disease is identified by fruiting bodies of the casula fungus, which are found on the dead portions of infected needles and cones. Complete defoliation is usually fatal. Primary spread is by ascospores; secondary spread, by conidia. Infection occurs primarily in warm spring weather.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Reported on shoots, cones, and needles of pines, but no records show this disease on a specific larch host in the U.S.S.R.
- 2) Entry Potential—If needle or cone bits stick in bark crevices or small twigs escape removal, there is a high entry potential. This pathogen could be a "hitchhiker" on logs of species other than its preferred host.
- 3) Colonization Potential—High. It is a hazard to forest trees, especially those in nurseries and young plantations (from seedlings to 30-year-old trees). The pathogen survives saprophytically in dead needles and cones and can easily be transported.
- 4) Spread Potential—High potential for gradual spread from the point of entry to interior lands. Because there is an airborne ascospore stage, spread could be rapid and cover great distances, especially because highly susceptible young larch or pine plantations (to 30 years old) are common in eastern Oregon, Washington, Idaho, and Montana.

##### B. Consequences of Establishment

- 1) Economic Damage Potential—Low, unless a different, more virulent biotype enters and causes young plantation, nursery, and ornamental failures.
- 2) Environmental Damage Potential—Generally low, but composition of stands could change if reproduction of some species is restricted.
- 3) Perceived Damage (Social and Political Influences)—Estimated risk for pest low unless different biotype is introduced. Brown foliage could be unsightly in areas of high aesthetic value.

Additional Remarks—Mitigation would involve excluding foliage, cones, and twig contaminants on logs. This may be difficult. A similar situation in East Asian coniferous plantations involved introduction of brown-spot needle blight cases by *Lecanosticta acicola* from the Southern United States into slash pine plantations in the northern region of Fujian province in China. Another example, the larch needle blight (*Mycosphaerella laricileptopsis*) was introduced from Japan causing larch to defoliate 2 months earlier than normal, especially those on 10- to 30-year-old larch plantations.

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## Siberian Forest Pests of Concern in Bark and Inner Bark

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### Insects

#### Engraver Beetles

Scientific Name of Pest—*Ips duplicatus*

Scientific Name of Host(s)—*Picea* primarily; *Pinus* sp.; *Abies* sp.; *Larix* sp.

Specialty Team—Entomology

Assessors—Roy Beckwith and David Wood

#### Pest Risk Assessment (Including References)

Summary of Natural History and Basic Biology of the Pest—

It is a Trans-Paleartic taiga species that occurs from the Nordic countries through Eastern Siberia. Generally prefers spruce but readily infests larch in pure stands and reported to prefer larch stands in Eastern Siberia. The insect prefers thin stands infesting weakened and dying trees, fresh windfall and timber with succulent phloem that have not been infested by other bark beetles.

Hibernate as adults or larvae in the host. In the Baykal area, the adults fly as early as mid-May. Larvae are found in galleries in June and July with young adults in late July or August. Varying with locality, there can be one to three generations per year.

Specific Information Relating to Risk Elements:

A. Probability of Pest Establishment

- 1) Pest with Host at Origin—High -- Especially if larch originates in Eastern Siberia.
- 2) Entry Potential—High -- Survival should be excellent in logs.
- 3) Colonization Potential—High -- Especially because some entry ports will contain log decks of host species. Spruce may be relatively nearby.
- 4) Spread Potential—Moderate to high varying with location.

B. Consequences of Establishment

- 1) Economic Damage Potential—High -- Could spread throughout the range of susceptible hosts. Sitka spruce is an extremely valuable species in U.S. coastal forests.
- 2) Environmental Damage Potential—Possible adverse effect on the species composition and all the associated organisms that depend upon a particular stand composition.
- 3) Perceived Damage (Social and Political Influences)—Moderate to high.

Estimated Risk for Pest—High.

Additional Remarks—Suggest bark removal and/or fumigation as mentioned for *Ips subelongatus*.

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## Engraver Beetles

Scientific Name of Pest—*Ips sexdentatus*

Scientific Name of Host(s)—*Pinus* sp., *Larix* sp., *Picea* sp., *Abies* sp.

Specialty Team—Entomology

Assessors—Roy Beckwith and David Wood

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest —

Trans-Paleartic species that occurs throughout Europe and Siberia. This species prefers pines but predominates in pine-larch forests and is found in pure larch forests. Also found in Japan and Thailand.

This insect is the largest species of *Ips*. Attacks weakened and downed trees in stands of varying densities. Seems to prefer the exposed sunny-side of logs that are unbarked and contain fresh phloem.

The insect goes through one to three generations varying with geographical location. It usually has a 1-year generation in Nordic countries. Hibernates under the bark and in the duff and soil. In the Baykal area, peak flight occurs at the end of May or early June. Second generation adults are active in August.

#### Summary of Natural History—

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—High -- Especially if logged trees are present during adult activity or are already infested.
- 2) Entry Potential—High -- Could reinfest logs at deck sites or during transit if conditions of the host permit.
- 3) Colonization Potential—High -- Especially if pine or other host logs are available at or near port-of-entry.
- 4) Spread Potential—Moderate to high depending upon local area and conditions. Could spread throughout the western coniferous forests if they succeed in adapting to U.S. tree species.

##### B. Consequences of Establishment

- 1) Economic Damage Potential—High -- Has the potential to come in on larch and spread to pine in log decks and eventual spread throughout our western coniferous forests.
- 2) Environmental Damage Potential—High -- Same as other *Ips* sp.
- 3) Perceived Damage (Social and Political Influences)—Moderate to high.

Estimated Risk for Pest—High.

Additional Remarks—Suggest bark removal and/or fumigation as mentioned for *Ips subelongatus*.

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## Engraver Beetles

Scientific Name of Pest—*Ips subelongatus*

Scientific Name of Host(s)—*Larix* sp. primarily (probably attack all conifers in mixed larch conifer forests)

Specialty Team—Entomology

Assessors—Roy Beckwith and David Wood

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

Distributed throughout the entire conifer zone of North Asia. Occurs primarily in larch forests; rarely in stands of pine and "dark" conifers. Most numerous in larch stands with a large number of weakened and dying trees, felling areas, and timber yards of fresh logs. During mass increase in these materials, this species can infest living trees in all age classes. Infestation on standing trees mainly on the median and apical parts of the trunk; on recently felled trees, infests the entire trunk with possible exception of the very thick bark on the butt.

Adults hibernate partly in pupal cells, feeding tunnels, and forest litter. Goes through one to two generations per year. In the Baykal area, mass adult flight occurs in late May or early June. The second generation starts in July.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—High -- Especially if log decks of fresh logs have been allowed to remain during adult flight or the trees have been infested before or during cutting.
- 2) Entry Potential—High -- Survival in the phloem should be excellent.
- 3) Colonization Potential—High -- Especially if unloaded in areas that have local log decks of susceptible hosts and/or if logs are transported through areas containing host stands.
- 4) Spread Potential—High -- If colonization is successful, the species has the potential to spread throughout the range of larch in the Western United States and Canada.

##### B. Consequences of Establishment

- 1) Economic Damage Potential—High -- Potential to spread throughout the range of its host(s) in North America. Larch is an extremely important species in the ecosystem.
- 2) Environmental Damage Potential—High -- Could change species composition within the area now occupied by larch.
- 3) Perceived Damage (Social and Political Influences)—High.

Estimated Risk for Pest—High.

**Additional Remarks—**

Suggest mitigating practice of fumigation or bark removal at the point of origin. The fumigation should be done before off-loading of logs at destination.

Most Scolytids can be carriers of fungi and other organisms that may be detrimental to the host species.

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## Engraver Beetles

Scientific Name of Pest—*Dendroctonus micans*

Scientific Name of Host(s)—*Larix* spp., *Picea abies* spp., *Pinus* spp., occasionally *Abies* spp., *Pseudotsuga* spp.

Specialty Team—Entomology

Assessors—George Ferrell (USFS)

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

This Eurasian bark beetle (family Scolytidae) attacks trunks of living, mature trees in either vigorous or weakened condition. Emerging adults frequently attack the same, or a neighboring, tree but can fly considerable distance to attack distant trees. In contrast to most bark beetles, this species usually mates before emerging, attacks singly instead of *en masse*, and thus kills a small patch of the cambial zone but seldom the entire tree. Over time, however, the tree can be weakened and predisposed to other bark beetles.

Except for dispersal and host-finding by emerged adults, all stages occur beneath the bark in the cambial zone. The entire life cycle requires 1 to 3 years, depending on variations in ambient temperatures and other factors. Because of these variations, adults can be present at any season, and under controlled lab conditions, are ready to emerge after 44 days at 20 °C. This pest is present in live trees, fresh-cut logs, and in older, still-seasoning logs.

During sporadic outbreaks occurring in response to tree stress, trees are frequently mass-attacked, and many are killed. Spruces are the primary hosts, with North American Sitka and white spruces actually more susceptible than Eurasian spruces in some instances. Also, host-switching to pines is reported in some locales. Larch, true fir, and Douglas-fir are occasional hosts.

There is presently little evidence implicating this beetle as a vector of those fungi or other biological agents causing tree diseases.

This pest has spread west from Siberia into Europe in relatively recent times, in 1982 reaching the British Isles. Detailed range records are lacking, but generally, this beetle ranges across Eurasia from the southern limit of its Norway spruce host to the northern limit of coniferous forests. In locales scattered throughout Eurasia, silvicultural and biological control have shown some success, provided they were applied once outbreaks have subsided.

#### Specific Information Relating to Risk Elements:

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Pines, spruces, and larches are hosts, and these conifers are common and widespread throughout most of Siberia.
- 2) Entry Potential—Very high because many, if not most, host trees have been attacked at some time in the past, and a considerable proportion are probably currently infested because of the 1 to 3 year longevity beneath bark.
- 3) Colonization Potential—Very high because females mate before emergence and need not be present in large numbers to successfully attack and reproduce and because susceptible hosts are common as ornamentals and forest trees in North America,

especially Sitka spruce growing along the coast of Oregon, Washington, British Columbia, and Alaska.

- 4) Spread Potential—Very high because it attacks healthy as well as low vigor hosts that are widespread and common, particularly in coastal Pacific Northwest and Alaska and the continuous belt of spruce forests in Northern North America.

B. Consequences of Establishment

- 1) Economic Damage Potential —Very high because it attacks, weakens, and sometimes kills mature trees of commercially important conifer species. This pest has successfully attacked Sitka, white, black, and blue spruces where these North American species have been planted in Europe, and Sitka spruce has repeatedly shown to be even more susceptible than Norway spruce, its primary European host.
- 2) Environmental Damage Potential—Very high as Alaskan and Pacific Northwest forests are largely composed of susceptible hosts and these forests are often on steep watersheds important for spawning of valuable stocks of anadromous fish.
- 3) Perceived Damage (Social and Political Influences)—Very high, because remnant, ancient forests with high aesthetic and biological values could be affected.

Estimated Risk for Pest—Very high because of its attack habits and longevity beneath bark. Its frequent single attacks and cryptic subcortical infestation sites make discovery difficult. Because females emerge from brood chambers already mated, each can cause a reproductively successful infestation. Proximity of susceptible forests to arrival ports, storage areas, and manufacturing facilities increases risk. Ability to successfully attack healthy hosts suggests this pest could be most damaging as a predisposer of such trees to North American bark beetles.

Additional Remarks— Successful establishment of this bark beetle in North America would seriously hamper efforts to reduce damage caused by bark beetles by improved forest management practices.

Reference

Gregoire, J.-C., 1988. The Greater European Spruce beetle, p. 455-478. In A.A. Berryman (ed.), Dynamics of forest insect populations. Plenum Press, New York.

## Weevils

Scientific Name of Pest—*Pissodes piniphilus* and *Pissodes harcyniae*

Scientific Name of Host(s)—

Specialty Team—Robert Gara  
Assessors—Entomology

### Pest Risk Assessment (Including References)

Summary of Natural History and Basic Biology of the Pest—

*Pissodes piniphilus* (Hrbst.) breed in stems and branches of weakened pines and *Pissodes harcyniae* (Hbst.) infest spruces.

*P. piniphilus* is distributed throughout Central and Northern Europe up to northern Lapland. It is frequently found in Siberia especially around the Amur River. This species mainly attacks pines at the age of 30 to 40 years. A fertilized female deposits up to four eggs in an ovipositional puncture made in the bark of host stems. Larvae then make irregular feeding galleries in the phloem and pupate within a chip cocoon dug in the sapwood. Adult weevils overwinter in litter. The weevils attack weakened pines, but when populations are high they attack healthy trees. Spring-emerging adults are sexually immature and have to feed on pine branches for sexual maturation. The main damage produced by this species is introduction of blue staining fungi into the sapwood.

*P. harcyniae* is found throughout the range of European and Siberian spruces. In Siberia adults overwinter in the duff and litter at the base of trees. In May to June, when ambient temperatures reach about 10 °C, these sexually immature adults make their first appearance from their overwintering sites. They crawl up spruce trees and make feeding punctures in the upper stems. Upon reaching maturity, the insects mate, and gravid females fly off in search of suitable hosts. These females excavate egg-laying cavities into the phloem of weakened trees and oviposit one to five eggs per cavity. As the eggs hatch, the larvae feed in the succulent tissues and, in this manner, construct star-like gallery patterns. These galleries end in a chip cocoon dug into the sapwood. There is one generation a year.

Specific Information Relating to Risk Elements:

#### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Both weevil species will attack weakened host material as well as log decks.
- 2) Entry Potential—If only larch were imported, the entry potential of these insects would be low. The weevils could be passively included in shipments if a significant amount of litter also accompanied the logs. However, if pine and/or spruce were imported, the likelihood of introducing these weevils would be high because a small part of the overwintering population is left within the logs.
- 3) Colonization Potential—*Pissodes harcyniae* and *P. piniphilus* if accidentally introduced could probably locate pine and spruce log decks located near seaports. Accordingly, the colonization potential of these weevils is high. *Pinus contorta* and *Picea sitkensis* will be in the vicinity of ports in northern California, Oregon, Washington, and British Columbia.

- 4) Spread Potential—*Pissodes* are not known as strong fliers. On the other hand, they are K-selected insects and as such have well-developed host selection behaviors. This propensity means that their spread would be slow and deliberate, but eventually their populations would be well installed in North American pine and spruce growing sites.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—*Pissodes harcyniae* is well known for its capacity to infest medium-aged spruce stands that have been weakened by root diseases or industrial pollution. It is reasonable to assume these stands would also be available in North America. *P. piniphilus* is the more aggressive of the two weevils. Large populations of these weevils can produce primary attacks and kill living trees. Their most important damage would be the log degrade they would produce by infesting stored logs.
- 2) Environmental Damage Potential—Environmental damage would not be expected from introductions of these weevils. The only conceivable damage, might come from spraying particularly valuable decked logs with an insecticide. This event is unlikely as stacked logs can be protected by installing water sprinkler systems.
- 3) Perceived Damage (Social and Political Influences)—It is not likely that the general public would perceive these insects as being major pests. The blue stain produced by *P. piniphilus*, however, would be looked upon as a major problem by the timber industry—especially those involved in log exporting.
- 4) Overall Risk—If only larch logs are imported, the risk of introducing these weevils is small. If pine and/or spruce logs are imported, introduction of these weevils is probable, and the risk of economic damage is high.

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## Siberian Forest Pests of Concern in Wood

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### Insects

#### Wood Boring Insects

Scientific Name of Pest—*Monochamus sutor*, *M. urussovi*

Scientific Name of Host(s)—*Picea* spp., *Abies* spp., *Larix* spp., *Pinus* spp., *M. urussovi*. Adults have also been reported to infest *Salix*, *Quercus*, *Acer*, *Populus*, and *Betula*.

Specialty Team—Entomology

Assessors—Darrel Ross, Kathleen Johnson, Dan Hilburn

#### Pest Risk Assessment (Including References)

##### Summary of Natural History and Basic Biology of the Pest—

*Monochamus sutor* and *M. urussovi* have a 2-year life cycle in Siberia. Adults of both species are active from June to September in this region. The adults feed primarily on bark and phloem of twigs in the crowns of conifers, including spruce, fir, larch, and pine. *Monochamus urussovi* may apparently also feed on some hardwoods, also, including birch, willow, oak, maple, and aspen. Adults feeding on twigs can kill the distal portions of the stems and significantly reduce the foliage area in the canopy of heavily infested trees. Typically *Monochamus* adults become sexually mature 7 to 10 days after emergence. The sexually mature beetles are attracted by volatile compounds to weakened, dying, or recently dead trees or logs to mate and oviposit. Trees weakened by fire, defoliation, or other disturbances are particularly susceptible to attack. Windthrown trees and logs are also highly attractive to breeding adult beetles. *Monochamus sutor* females can lay at least 50 eggs. Eggs are laid in the phloem at the base of niches excavated by the females in the bark of tree boles and logs. From one to six eggs may be found in individual niches and thousands of eggs may be laid in a single log or tree.

The neonate larvae feed on the phloem and sapwood throughout their first year. The larvae overwinter primarily as second instars and resume feeding the following spring. During the second year, the larvae continue feeding and bore deeper into the wood. There are five larval instars. The mature larvae form pupal cells in the wood near the surface where they spend the second winter. Pupation and adult emergence occurs the following spring.

Apparently *Ceratocystis* spp. are associated with *M. urussovi* in the U.S.S.R., but the relationship between the fungi and beetles are unclear.

##### Specific Information Relating to Risk Elements—

###### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—There is a high probability that logs cut in Siberia will become infested during storage and transport to port cities or during storage at port cities. Because only 50 percent of the annual harvest is removed from the forests between December and March because of poor road conditions at other times, logs are likely to be stored in the forest at the time when adult beetles are actively breeding. The longer the storage period for logs at the upper and lower landings between the months of June and September, the higher will be the probability of infestation by

*Monochamus* spp. These insects are also very likely to be in some standing trees before harvest. Both *Monochamus* species are found throughout the forest zone of the Palearctic region from Europe to the Pacific Ocean. In the mountains of the Baykal region, *M. sutor* occurs all the way to timberline; *M. urussovi* up to 1,600 m.

- 2) Entry Potential—There is a high probability that untreated Siberian logs entering the United States would harbor living *Monochamus* (all life stages, but especially larvae in the wood). *Monochamus sutor* is frequently found in timber imported into Great Britain from Europe. In the past, timber delivered to Bulgaria during the months of July and August from the Komi ASSR was heavily infested by *M. sutor*, *M. urussovi*, and *M. galloprovincialis*. The first test shipment of Siberian logs imported into California was found to contain live cerambycid larvae and adults (adults were identified as *Tetropium gabrieli*), proving that cerambycids are easily capable of surviving the logging/transport process. Older larvae and pupae could be transported in debarked logs and green or air-dried lumber.
- 3) Colonization Potential—There is a high probability of colonization by these insects because of the presence of abundant susceptible host tree genera (living and down trees and cut logs) near port cities, along transportation routes, near milling sites, and where lumber would be used. Segregating Siberian logs at the mill would do little to prevent colonization by these insects. Based on the flight capabilities of other *Monochamus* spp. (Kobayashi et al., 1984), adults are probably able to fly up to several kilometers. Consequently, if suitable breeding material is available within that distance of the imported logs or certain wood products, then there will be no impediment to colonization by emerging adults. The larval stage may be extended in green or air-dried lumber if *Monochamus* larvae react like other cerambycid larvae to milling. This would lengthen the time over which *Monochamus* could emerge and colonize a new area. An infestation could go undetected for several years.
- 4) Spread Potential—Susceptible host tree genera range from Central America north through Canada and from the Pacific to Atlantic Oceans. Rate of natural spread may be slow (probably only a few miles/year), but spread would be greatly enhanced by transport of logs, firewood, and lumber (non-kiln dried). Thus, the spread potential of these pests would be high.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—*Monochamus urussovi* and *M. sutor* represent a serious economic threat to Pacific Northwest forests and the forest industry. Larval feeding can significantly degrade the value of salvageable timber or logs in storage. Current outbreaks of western spruce budworm, Douglas-fir tussock moth, and numerous bark beetle species are creating abundant breeding sites for these cerambycids if they were to be introduced into the United States. These *Monochamus* spp. could drastically reduce the potential for salvaging timber damaged or killed by native pests or wildfires. In the Eastern United States, *Monochamus* spp. "often cause heavy losses in windthrown or fire-killed timber, in sawlogs left too long in the woods before milling, and in improperly handled pulpwood" (USDA, Forest Service, 1985). In the Baykal region of the U.S.S.R., *M. sutor* is an important pest of harvested logs. The U.S.S.R. forest industry suffers large annual losses in timber yards where wood is stored. In one study in the Baykal area, from 10 to 80 percent of larch wood in a timber yard was found to be infested by *M. sutor*. Because oviposition can occur only when bark is present, sawn lumber is usually immune from attack, though larvae already present in the wood at the time of milling can continue to develop. Rozhkov (1966) states that the economic importance is ". . . very great for *M. sutor* in larch forests. For example,

in the Baykal area the species destroyed a very great quantity of larch building timber logged in the preparation for the Bratsk Sea [Bratsk Reservoir] bed. . . *M. sutor* is, also, a serious physiological pest of forests in a large part of its range."

*Monochamus urussovi* has caused significant economic damage in the U.S.S.R., particularly following defoliator outbreaks and fires. In the Krasnodar region, a severe outbreak of *M. urussovi* affected more than 1 million hectares in the 1950's. At high population densities, adult feeding by this insect can weaken trees and increase their susceptibility to other pests such as bark beetles.

*Monochamus* spp. are vectors of the pine wood nematode species complex (*Bursaphelenchus* spp.). Direct damage by these beetles could be less important than their role in introducing or vectoring nematode-induced pine wilt disease. *Monochamus* adults typically move pine wood nematodes to healthy trees during feeding and to dead and dying trees or logs during oviposition. Pine wood nematodes move into newly emerging *Monochamus* adults as they leave the infected wood. Siberian logs are highly likely to contain *Monochamus* life stages capable of moving pine wood nematodes to U.S. trees. Because the logs may have been stored in extremely cold temperatures since harvest or have been transported to the United States in a timely manner, the nematodes can also arrive in logs still suitable for oviposition and larval development by native *Monochamus*. Introduced pine wood nematodes from Siberia may show greater pathogenicity in the United States than do native nematode populations because native trees would not have developed resistance to the introduced nematodes. Introduction and spread of a virulent pine wood nematode species/pathotype into the United States would likely cause tree species composition shifts (as in Japan) and tremendous economic and other damage (see pest risk assessment and economic analysis for pine wood nematode).

- 2) Environmental Damage Potential—If *M. urussovi* or *M. sutor* populations reach high densities by breeding in damaged or dead trees, they could exacerbate problems associated with outbreaks of indigenous pests and wildfires. Feeding by adults could weaken healthy trees predisposing them to attack by indigenous insects. This could lead to more frequent or prolonged pest outbreaks. The larvae could also impact the natural community of organisms decomposing logs. Because these beetles feed on living trees, there is also the possibility that they could become important vectors of native or introduced pathogens (e.g., *Bursaphelenchus* spp. or *Ceratocystis* spp.). If adults introduce and vector an exotic pathogenic species/pathotype of pine wood nematode, for example, to healthy trees, great environmental damage resulting from tree mortality and tree species composition shifts could occur.
- 3) Perceived Damage (Social and Political Influences)—Public interest in the health of forests throughout the United States, including the Pacific Northwest, is currently very high. Defoliators, bark beetles, pathogens, and wildfires are causing a great deal of visible damage to our forests, particularly east of the Cascade Range. Public concern has led to increasing pressure by many groups and individuals on government to take actions to improve forest health. Introduction of these *Monochamus* spp. has a high potential to increase the incidence, severity, and impact of the pest outbreaks that are already causing significant problems.

**Estimated Risk for Pest**—The risk of introduction, establishment, and spread is high. The risk of significant economic or environmental damage directly attributable to these beetles alone is moderate to high. The risk of them vectoring exotic pine wood nematodes is high. The overall estimated risk for *M. sutor* and *M. urussovi* is high.

Additional Remarks—Debarking, milling, and air drying are not reliable control measures for insects boring deep in the wood such as these *Monochamus* spp. Fumigation and kiln-drying are the standard methods for dealing with cerambycid wood borers. Because of a lack of effective detection and control techniques for *Monochamus* spp., it is unrealistic to hope that an established infestation of an exotic species could be eradicated.

Significant literature exists in Russian on *M. sutor* and *M. urussovi*; much remains untranslated, however. Computer models generated for *M. urussovi* populations in the U.S.S.R. are reported in the Russian literature.

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## Wood Boring Insects

Scientific Name of Pest—*Xylotrechus altaicus*

Scientific Name of Host(s)—*Larix* spp.

Specialty Team—Entomology

Assessors—Dan Hilburn, Dave Schultz

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

*X. altaicus* is a longhorned beetle. The larval stage is a wood borer. This species is common in Siberia where it infests larch. Spruce, fir, pine, and hardwoods are not attacked by this insect. Adult beetles are active in June, July, and August. Females fly to potential host trees and lay their eggs singly in bark crevices. Each lays 50 to 145 eggs. In Siberia, *X. altaicus* has a 2-year life cycle. During the first summer, larvae feed in the phloem under the bark. After hibernating through the first winter, they resume feeding and excavate long transverse galleries in the phloem, then they bore into the sapwood (1 to 10 cm deep) where they again overwinter. The following spring they move closer to the surface and construct a pupal cell.

*X. altaicus* infests mainly previously stressed trees, such as those affected by fire, insect defoliators, or overmaturity. In Siberia, there is an alternation of years of relative scarcity and years of mass abundance. This insect is a secondary pest except during outbreaks when they will attack healthy larch. During outbreaks, trees damaged by the larvae die and timber loses its marketable value. Stands of valuable timber can be turned into fuel wood in 3 to 5 years.

Rozhkov (1966) summarizes the economic importance of *X. altaicus* with these words: Very great. This species is one of the most serious physiological and technical pests of larch forests which have been weakened by primary pests, fire, or other causes. The damage is increased by this species' ability to multiply in large numbers over large areas. Foci of mass multiplication of this species may last for decades.

#### Specific Information Relating to Risk Elements —

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—*Xylotrechus alticus* infests larch in Siberia. It is found from the Urals (Sverdlovsk) to the Pacific coast, from Yakutia to Altay, Amur, Sakhalin, and northern Mongolia; especially common in the foothills of Altay, Tuva, and southern Trans-Baykal. There is a very high probability that this insect will be found in larch timber from Siberia.
- 2) Entry Potential—All life stages could survive transport and storage of logs. Older larvae and pupae would be present even in debarked logs. There would be no visible evidence of infestation by this insect detectable by inspection of raw logs. Round "grubholes," somewhat smaller than the diameter of a pencil, would be visible on debarked logs and lumber. In one study of 40 damaged trees, an average of 36 to 37 penetrating larval galleries were found per meter length of trunk.
- 3) Colonization Potential—The potential for successful colonization by *X. altaicus* depends on the proximity of *Larix* spp. to the ports and mills where Siberian logs would be unloaded and processed. Adult beetles could emerge and fly from infested wood anytime from when the ship arrives in port to after the lumber is milled. If logs or

green lumber are transported or stored in the vicinity of native or ornamental larch trees, the potential for colonization is high. If not, the potential is low. In the Pacific Northwest, natural stands of western larch (*Larix occidentalis*) are found east of the Cascades. The closest natural stand of larch to the port of Portland, OR, (Larch Mountain), is about 35 miles away; the port of Coos Bay, OR, is at least 150 miles from any native larch stands.

Larch, however, is also planted as an ornamental tree in residential areas. Although larch is not common in western Oregon, sixteen nurseries in Oregon produce ornamental larch varieties for shipment all over the country. This scattered distribution of ornamental larches and nurseries growing and selling larches significantly increases the potential for *X. altaicus* colonization.

The eucalyptus borer, *Phoracantha semipunctata*, provides an example of a cerambycid wood borer that has become a tree pest in this country after being introduced. This beetle is native to Australia, but it has been spread by commerce to all areas of the world where eucalyptus trees are grown, including California. The initial introductions are thought to have occurred from crates or pallets manufactured from infested wood.

- 4) Spread Potential—Once established on native or ornamental trees, spread potential would depend on the distribution and abundance of larch in the newly infested area. Initially, build up would be rather slow due to the insect's 2-year life cycle. If this insect established first in ornamental trees in a residential area, its presence could go unnoticed for years. Eventually, however, if stands of native larch became infested, an outbreak could build up rapidly (within a few years). Western larch forests cover approximately 2.7 million acres in mountainous regions of eastern Oregon, Washington, and British Columbia, northern Idaho, and western Montana. There are several other *Larix* species in North America; the most common and widespread is *Larix laricina* known as the American larch, tamarack, or hackmatack. Human transport of infested logs, lumber, and firewood would increase the rate of spread significantly.

Using the eucalyptus borer as an example, we can estimate how fast a new cerambycid wood borer could spread. The borer was first discovered in 1984 infesting eucalyptus trees in Orange County, California. By 1986, the borer was found in six counties in southern California. By 1989, all southern California counties were infested, as well as three counties in the San Francisco Bay area. The beetle spread a distance of 375 air miles in 6 years. Although the beetle is a strong flier, most of the long-distance spread is thought to be because of the transport of infested firewood. Eventually, it is expected to spread throughout California wherever eucalyptus is grown.

## B. Consequences of Establishment

- 1) Economic Damage Potential—Western larch is an important timber tree in this country. It is used for construction lumber, plywood, poles, and paneling. Production has averaged over 500 million board feet per year during the past few decades. Larch is also used as an ornamental tree in residential areas. *Xylotrechus altaicus* has the potential to cause considerable larch mortality if it becomes established in North America. The quality of larch lumber could also be lessened by the presence of more "grubholes." It is difficult to predict the economic damage potential of this insect, but we know it is of "very great" economic importance in Siberia and in a new environment, without its complex of natural enemies, its impact could be worse.

In Australia, the eucalyptus borer occurs throughout the eucalyptus forests, but is usually restricted to dead or dying trees, broken branches, or logging residue. During droughts it will attack standing trees that are under severe moisture stress but seldom kills them. Numerous natural enemies are associated with the beetle in Australia but are absent from most beetle populations outside its area of origin. In California, South Africa, and the Mediterranean region, where it has been introduced, the beetle will kill living trees. The greatest economic impact in California has been the cost to remove dead eucalyptus from residential or recreational areas. Some plans to grow eucalyptus on short rotations to produce paper or fuel for electric generating plants have been made uneconomical because extensive thinning or irrigation would be necessary to avoid losses from the eucalyptus borer.

- 2) Environmental Damage Potential—Larch is an important component of some forest ecosystems. In the Pacific Northwest, it commonly occurs in mixed stands with Douglas-fir. *Xylotrechus altaicus* has the potential to suppress or even eliminate larch from these ecosystems, thus reducing species diversity and impacting other organisms which are associated with these trees. Bears, moose, elk, deer, squirrels, porcupines, and a variety of other wildlife find food and protection in larch forests.
- 3) Perceived Damage (Social and Political Influences)—Larch foliage turns yellow in the fall before dropping. It contributes to the aesthetics of fall foliage in areas where larch is found. Any mortality to native and ornamental larches would reduce the aesthetic value of this species.

Estimated Risk for Pest—Low to High. Accidental introduction of this insect could prove almost harmless or nearly disastrous. It is very likely to arrive alive and undetected in larch logs (with or without bark) or green lumber from Siberia. Establishment could occur easily if infested wood is transported or stored in the vicinity of native or ornamental larch. Once established, its impact could be minor or extremely serious. Probably the safest assumption is that, as in Siberia, *X. altaicus* could become a secondary pest of larch with periodic outbreaks that affect healthy trees. If, however, in the absence of natural constraints *X. altaicus* became a primary tree killer in North America, it could have serious economic and environmental repercussions. Douglas-fir, *Pseudotsuga*, is not native to Siberia, but it is a very close relative of *Larix*. A host shift by this insect to Douglas-fir could have disastrous consequences for the timber industry in the Pacific Northwest.

Additional Remarks—Cerambycids are difficult to control because of life stages that are found deep in the wood. Fumigation or kiln-drying are the standard methods of dealing with wood infested with wood borers. In most cases, there are no practical treatments for infested standing trees. An established infestation of an exotic species like *X. altaicus* would be virtually impossible to eradicate because of our lack of good detection and control tools.

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## Wood Boring Hymenoptera

Scientific Name of Pest—Siricidae: *Sirex*, *Parurus*, *Xeris* (family, general)

Scientific Name of Host(s)—*Larix* spp., *Abies* spp., *Pinus* spp., *Pseudotsuga*, spp.

Specialty Team—Entomology

Assessors—Boyd Wickman

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest —

Wood boring hymenoptera of the siricid family are important insects associated with coniferous trees worldwide. In a strictly ecological context, they are beneficial organisms because they decompose and recycle dead trees providing mulch and nutrients for forest soils. A symbiotic association exists between several basidiomycete fungi and various siricids that hastens the decomposition process.

This group becomes a pest in two ways—first, when introduced fungi and larval galleries degrade wood products sawn from infested trees, and second, when attacks on live trees cause the trees to die. According to Rozhkov (1966) this is one of the principal pests of Siberian larch. It is a trans-Siberian species occurring everywhere up to timberline in the Baykal area. It prefers warm, well-illuminated forests; it has been found in large numbers in stands defoliated by *Dendrolimus sibiricus*. It can make mass attacks in trees weakened by defoliators and cause tree mortality. This family flies and makes attacks from the end of July through September.

The taxonomy of this family is not well worked out. For instance, Benson (1962) reduced to subspecies five forms of *S. juvencus* previously treated as species. *S. juvencus monglorum*, *S. juvencus ermak*, and *S. juvencus carinthiacus* occur in the U.S.S.R.; and *S. juvencus californicus* occurs in the Pacific Northwest. It could be argued that if Benson's subspecies taxonomy is correct, then cross introductions of subspecies may be insignificant biologically. This may be tenuous reasoning because of the long-term evolved adaptation to geographically specific environments and hosts of each subspecies. The damage caused by *S. noctilio* to *Pinus radiata* when introduced to New Zealand and Australia demonstrates the non-adaptive parasite/host relationships that often result from introductions.

The following notes summarize the biology, ecology, and life history of the family in a general fashion.

#### Typical Life History - Average 2 to 3 years

Eggs - Female oviposit deeply (6 to 20 mm) into the wood. Number of eggs varies from 1 to 7, average 3 to 4 per tunnel. 1.5 mm long, incubation period 3 to 4 weeks.

Larvae - Approximately 21 months spent in larval stage. The young larva starts boring at right angles to the horizontal oviposition tunnel and remains in the sapwood for 6 to 8 months before moving into the heartwood. The larva usually makes a loop from the sapwood to the heartwood and back to the sapwood before it pupates. The larval tunnels may vary from 6 to 30 inches in length for various species and are tightly packed with grass. The larvae molt 3 to 4 times. Cutting infested trees for lumber may prolong the length of life of the larval stage for a year or more. Wood-destroying fungi are associated with larvae.

Pupae - The larva pupates about ½ inch from the surface of the wood and remains in the pupal stage from 5 to 6 weeks. If pupation takes place too far below the surface of the wood, the adult may die when it emerges from the pupal case.

Adults - Emerge in the summer, are present from early summer to early fall. Some have been found flying as late as November. Adults fly mostly in bright sunshine, and females usually outnumber the males. Males are reported to resort in tree tops or high ground where pairing takes place. The genitalia are of slight significance for purposes of taxonomic distinction.

"These insects are widely disseminated by shipments of infested lumber or timber, and the adults may not emerge until several years have elapsed." (Middlekauff, 1960)

"Female *Sirex areolatus* have even been reported as attacking recently sawed redwood lumber." (Essig from Middlekauff, 1960, and Keen, 1952. All probably citing Essig.)

Females usually oviposit in weakened trees, occasionally selecting a healthy tree. "Members of the family are attracted to forest fires and it is not unusual to find them ovipositing in smoking logs, material too hot for the bare hand to touch, whether or not eggs deposited in such situations hatch is not known." (Chamberlin, 1949)

"Horntails are of additional interest to biologists because of the symbiotic relationship of *Sirex*, *Urocerus*, and *Tremex* with certain wood-destroying fungi. No fungi or fungal sacs have been found in adult males. The egg becomes infected as it is laid and the wood-destroying fungus penetrates the wood surrounding the larvae as it feeds. Experiments have demonstrated that larvae can live for at least 3 months on a pure culture of the fungi." (Middlekauff, 1960)

"A number of natural enemies prey upon the horntails; of these, various Hymenoptera are most important. Members of the cynipid genus *Ibalia* and the ichneumonid genera *Rhyssa* and *Megarhyssa* parasitize the larvae of Siricidae." (Middlekauff, 1960)

"Prompt utilization of unseasoned wood exposed to attack by these insects is the best means of avoiding damage. Logs placed in mill ponds and frequently rolled will not suffer from attacks. Kiln-drying gives complete control, destroying the infesting larvae, and there is little danger of these insects attacking dry, finished lumber products." (Keen, 1952)

"Horntail wasps, or wood wasps, settle on freshly felled trees, sometimes before the woodsmen have finished cutting them into logs, and on fire-killed trees before the fire is out . . . ." (Keen, 1952)

The above material was cited from Middlekauff, 1960, and Chamberlin, 1949.

One interesting quote from Middlekauff, 1960, on life histories follows:

"According to Hanson (1939), the life cycle of *Sirex cyaneus* normally extends for a period of three years from egg to adult, but development may be retarded and the adult insects may not emerge from the timber until several additional years have elapsed. A number of generations may be present in a single log at any one time, and this greatly complicates understanding the composition of the population."

Specific Information Relating to Risk Elements:

A. Probability of Pest Establishment

- 1) Pest with Host at Origin—Weakened and dead trees (fire killed, defoliated, windthrown, drought stressed) and log decks left in the woods can be expected to contain eggs, larvae, and/or pupae. Their common occurrence in coniferous forests of

the world mean that there is a high probability that some trees being harvested will contain siricids. Log decks left in the woods during female flight periods are also susceptible to infestation.

- 2) Entry Potential—Because eggs, larvae, and pupae are deep in the sapwood of logs, there is a high probability that siricid brood would survive storage and shipment to the United States and emerge from logs after arrival.
- 3) Colonization Potential—The family has the capacity to attack most coniferous species and some hardwoods. Given the colonization experience of *S. noctilio* into New Zealand and Australia, they must be considered serious threats to colonize after introduction.
- 4) Spread Potential—Males and females are strong fliers and known to fly long distances to forest fires. Adults have also commonly emerged from finished lumber in homes, pallets, boxes, and so forth. So, spread could also take place over very long distances (transcontinental) in finished products, unless all lumber is kiln treated immediately after milling.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—The attacks can result in wood degrade and can cause structural damage. Adult emergence in new dwellings and furniture is disconcerting and often results in lawsuits by homeowners.
- 2) Environmental Damage Potential—It is possible that attacks will occur in live stressed trees in plantations causing mortality. The family can be considered a serious pest even when it does not kill trees outright. The fungi introduced by female oviposition increases the rate and severity of decay. In the U.S.S.R., heavy attacks can result in blue stain and decay and the complete economic loss of wood products according to Rozhkov (1966).
- 3) Perceived Damage (Social and Political Influences)— If members of this family become established and duplicate the experience of *S. noctilio* in New Zealand and Australia, there could be large expenditures needed for research and control activities. The economic loss to the resource could be large, especially if they become tree killing pests in plantations. There could be quarantine measures applied against States processing Siberian lumber.

Estimated Risk for Pest—High, based on known introduction of *S. noctilio* into Australia and the problems that occurred as a result.

Additional Remarks—These are the most difficult wood borers to control because eggs are inserted into the wood and larvae more deeply into the wood as they develop. Kiln treatment of lumber is the only certain method of killing the insects in the wood. Tree mortality caused by attacks of *Sirex ermak* has been reported in weakened Siberian larch. The most renowned example of tree mortality has occurred in New Zealand and Australia after *Sirex noctilio* was introduced from Europe. *Sirex noctilio* is considered a secondary pest in Europe, but when it was introduced along with its fungi into New Zealand at around the turn of the century, it developed into a primary tree killer in *Pinus radiata* plantations. Most of the damage occurred in trees stressed by drought or overcrowding nevertheless, hundreds of thousands of crop trees were killed in the 1940's and 1950's in New Zealand; by 1952, the insect was introduced into Australia with similar consequences. The economic impact was severe in terms of lost fiber resources and costs of developing control and preventive measures.

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## Pathogens

### Wood Ring Rot

Scientific Name of Pest—*Phellinus pini*

Scientific Name of Host(s)—*Larix, Pinus, Abies, Calocedrus, Picea, Chamaecyparis, Tsuga, Pseudotsuga, and Thuja* spp.

Specialty Team—Forest Pathologists  
Assessors—Robert L. Gilbertson

#### Pest Risk Assessment (Including References)

##### Summary of Natural History and Basic Biology of the Pest—

*Phellinus pini* is a cosmopolitan species, distributed throughout the coniferous forest ecosystems of the Northern Hemisphere. It decays heartwood in living trees and has been reported in virtually all North American species in the Pinaceae. It is especially important in Douglas-fir, larch, pine, and spruce. Infection of living trees occurs by wind borne basidiospores germinating on branch stubs to produce mycelium that grows through the branch stub into the heartwood. After a period of several years of growth in the heartwood, *P. pini* forms basidiocarps (conks) under branch stubs 4 to 20 feet behind the farthest extent of decay in heartwood above and below conks. Basidiospores liberated from these conks may be transported long distances in the air and are the propagules that cause more infections. The conks are perennial and grow and sporulate on the living tree for years.

In Douglas-fir in the Pacific Northwest, the dominant, fast-growing trees that begin self-pruning early are the first infected in a stand at about 50 years. The fungus has a pathogenic effect on these trees, eventually slowing the growth rate, resulting in the release of other trees which then become the dominants. These are in turn infected, and the cycle is repeated until all the Douglas-fir is infected and deteriorates and is replaced by tolerant climax species. There seems to be no information on variation in pathogenicity among different genotypes of *P. pini*. The decay is a white pocket rot with little change in strength properties into the intermediate stages. In the incipient stages the wood undergoes a red discoloration, the basis for the common names red ring rot, red rot, or red heart. The fungus is not a primary invader of dead wood and quickly dies out in cut lumber. The decay does not continue in wood in service.

##### Specific Information Relating to Risk Elements—

###### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—*Phellinus pini* is described in the literature as the most widely distributed and damaging heart rot fungus on larch species in Siberia and the Soviet Far East. It definitely should be expected to be one of the organisms that will inevitably be present in conifer logs imported from that region.
- 2) Entry Potential—High for vegetative stages of the fungus. Incipient decay may be difficult to detect, and decay pockets in logs may not show on cut ends. Conks are generally apparent and easily detected but very small; viable and sporulating conks could escape a casual inspection.
- 3) Colonization Potential—If logs with conks are imported, the conks could still be viable if the time between harvesting and importation is short. If sporulation occurred, infection of native hosts is possible. The likelihood of this taking place is highly

unlikely because the conks must be positioned with the tubes containing basidia in a perfectly vertical alignment as on the standing tree for any spore release to occur. For this reason colonization by spores from conks on imported logs is not a serious potential problem. The potential for colonization from infected wood is even more remote, especially if logs are processed in the mill soon after importation. The fungus dies out quickly in cut lumber and other wood products, and dissemination of the vegetative mycelium by vectors is not known to occur.

- 4) Spread Potential—If native hosts are colonized by *P. pini*, the probability of eventual spread is high. However, there would be a substantial time lag before development of conks and production of basidiospores on native hosts. The potential long range dispersal of these spores presents the possibility of infections by introduced genotypes being established at localities far from the source. Spread potential from vegetative mycelium or decayed wood is low because the fungus does not produce any asexual spores and the mycelium in wood dies out quickly after the logs are processed. In all probability, East Asian genotypes have already been introduced into North America countless times by basidiospores airborne from conifer forests in Kamchatka and other coastal localities to hosts in Alaska conifer forest ecosystems.

#### B. Consequences of Establishment

- 1) Economic Damage Potential—*Phellinus pini* is already a major cause of volume loss in the United States and Canada, particularly in old-growth stands. However, *P. pini* is not likely to cause significant volume losses in second-growth stands managed on short rotations. The main concern would be that Asian genotypes might act differently, have different host preferences, and be more pathogenic than native American strains of the fungus. This is only a possibility, and there is no evidence that any greater economic loss would be probable.
- 2) Environmental Damage Potential—*Phellinus pini* is already one of the major factors in decline and deterioration of old-growth conifer stands preserved in wilderness and natural areas. From an ecological standpoint, this is a natural function and an essential role in the cyclic nature of stand succession that characterizes dynamic forest ecosystems. The potential for environmental damage is very low.
- 3) Perceived Damage (Social and Political Influences)—The effects of *P. pini* are cryptic and not readily perceived by the lay public or politicians. Therefore, the potential for it causing any problems in this region is extremely remote.

Estimated Risk for Pest—There is a high probability that *P. pini* would be introduced as vegetative mycelium in decay in larch or other conifer logs from Siberia and Eastern Asia. There is a low probability that viable conks could also be present on imported logs. The probability that any of these would release spores on horizontal logs is virtually nonexistent. Because *P. pini* does not produce any asexual spores, there would be no readily disseminated propagules, and the colonization and spread potential would be extremely low. Also, the fungus dies out quickly in lumber and other wood products, and decay and damage essentially does not continue after harvest and processing. Because of the biological characteristics of *P. pini*, it will almost certainly be introduced, but the probability of colonization of native hosts and spread from the point of introduction is very low. The fact that it is a native pathogen and has apparently been widely distributed in all North American conifer forest ecosystems for millions of years also mitigates any potential risk from introduction of this organism.

Additional Remarks—Rigorous inspection procedures to remove basidiocarps from logs prior to importation, and especially debarking of imported logs, would virtually eliminate any potential introduction of alien genotypes.

In the past, records on geographic distribution and host relationships of *P. pini* have been combined with those of *Phellinus chrysoloma*, a similar, sympatric species. The biology of *P. chrysoloma* is similar to that of *P. pini*, but it is associated more with *Abies* and *Picea*. It was commonly considered a variety of *P. pini* until about 20 years ago.

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## Staining / Vascular Diseases

Scientific Name of Pest—*Ophiostoma* spp. / *Leptographium* spp.

Scientific Name of Host(s)—*Larix* spp., *Pinus* spp., *Picea* spp., *Abies* spp., *Tsuga* spp., and *Pseudotsuga menziesii*

Assessor—Donald J. Goheen

Specialty Team—Pathology

### Pest Risk Assessment (Including References)

#### Summary of Natural History and Basic Biology of the Pest—

Fungi in the genus *Ophiostoma* belong in the Division Eumycota, Subdivision Ascomycotina, Class Pyrenomycetes, Order Sphaeriales, and Family Ophiostomataceae. There are over 100 known species with anamorphs in the genera *Leptographium*, *Verticicladiella*, and *Phialocephala* (Harrington, 1988). They are characterized by having a unique cell-wall chemistry, a high tolerance to cycloheximide, and vector relationships with subcortical insects. Virtually all bark beetles (family Scolytidae) as well as some Cerambycids, Curculionids, Diptera, predatory beetles, mites, and nematodes have one or more *Ophiostoma* spp. associates (Francke-Grossman, 1963; Whitney, 1982; Harrington, 1988). *Ophiostoma* spp. form fruiting bodies (both perfect and imperfect types) in insect galleries under bark or in wood. Spores are produced in sticky masses, and these adhere to emerging insects. The insects carry the spores with them and inoculate the fungi into new hosts when feeding or constructing galleries. Some bark beetle species have specialized fungus-carrying structures (mycangia) while others carry spores passively on their exoskeletons or in their digestive tracts. Spores may be carried long distances by the vectors.

#### Effect of Pest on Host—

Some *Ophiostoma* spp. are saprophytes, but many are pathogenic to varying degrees. Most of those that are associated with Scolytids are involved with their vectors in tree killing. When introduced into a host by the bark beetles, these fungi invade the sapwood, occlude water conducting vessels, and contribute to killing the tree. They assist their vectors in a mutualistic fashion by stopping host defense reactions and creating conditions conducive to brood production (Graham, 1967; Dowding, 1984). A few species, notably *O. polonicam* and *O. dryocoetidis*, have been shown to be highly pathogenic, capable of forming rapidly expanding lesions that can girdle and kill a tree with extreme rapidity (Molnar, 1965; Horntvedt, 1983; Christiansen, 1985). In addition to contributing to tree death, bark beetle-associated *Ophiostoma* spp. usually cause additional economic loss by staining the sapwood of affected trees and substantially reducing their salvage value.

A few *Ophiostoma* spp. with *Leptographium* anamorphs are root pathogens (Alexander et al., 1988; Wingfield et al., 1988). One pathogen, *L. wagneri* in particular, causes a damaging disease of several conifers in Western North America (Cobb, 1988; Hansen et al., 1988; Morrison and Hunt, 1988). The fungus is vectored by root-feeding bark beetles and weevils but also spreads readily from tree to tree via root contacts and by growing a short distance through soil. It causes rapid tree decline and death in radially expanding disease centers primarily in *Pinus* spp. and *Pseudotsuga menziesii*.

#### Specific Information Relating to Risk Elements—

##### A. Probability of Pest Establishment

- 1) Pest with Host at Origin—There is an extremely high probability that several *Ophiostoma* spp. occur with bark beetles, weevils, and other invertebrates on all of the genera of trees being considered for importation from Siberia and the Soviet Far East. From the lack of references in the literature, it is apparent that *Ophiostoma* spp. have not received much attention to date from scientific investigators in the Eastern Soviet Union. However, numerous *Ophiostoma* spp. have been reported in the Western Soviet

Union (Vanin, 1932; Miller and Cernzow, 1934; Mejer, 1953) and the Scandinavian countries (Lagerberg et al., 1928; Mathiesen-Kaarik, 1953; Kaarik, 1975). In fact, wherever studies have been done, almost all bark beetles have been found to have one or more *Ophiostoma* spp. associates; it is virtually certain that some if not most of the numerous Scolytid species reported on larch, pine, fir, and spruce in Siberia and the Soviet Far East do as well. The probability is also great that *Ophiostoma* species from the Eastern Soviet Union will be different from those currently found in Western North America. Logs from previously healthy trees that are decked in the woods have a high likelihood of being colonized by insects and associated *Ophiostoma* spp. Logs from trees that were infested by bark beetles before felling have an even higher probability of having been colonized.

- 2) Entry Potential—Entry potential for *Ophiostoma* spp. is very high. These fungi survive well for some time in cut logs (more than a year with favorable temperatures and moisture regimes). They would be favored by the conditions that could be expected to prevail during transport of the logs (many logs packed close together in an enclosed, moist environment). Bark removal would not prevent survival in transit, and, in fact, mitigation of these fungi would require a type of treatment that would kill hypae occupying the entire sapwood cylinder of the logs. *Ophiostoma* spp. fruit prolifically in insect galleries, bark or wood cavities, and on the undersides of logs, bark, or wood scraps, especially in moist situations. The likelihood of spores being produced in or on untreated colonized logs once they have been delivered to ports in Oregon, Washington, or northern California is extremely high.
- 3) Colonization Potential—Colonization potential would depend on the ability of Siberian *Ophiostoma* spp. to infect North American conifers and the efficacy of vectors in spreading the fungi here. While some *Ophiostoma* spp. do appear to be quite host specific, many are known to affect a number of tree species, especially if they are in the same or closely related genera (Harrington, 1988). Given the similarity of conifer genera in the Eastern Soviet Union and Western North America, the probability that host cross-over could occur seems great. The probability of effective vectoring also seems substantially high. Even if exotic vectors are prevented from accompanying the *Ophiostoma* spp., it is very likely that native insects would fill the vector role. An example in which this has already occurred in North America with a closely related fungus involves the native bark beetle *Hylurgopinus rufipes* and the introduced fungus *Ceratocystis ulmi*.
- 4) Spread Potential—If established, *Ophiostoma* spp. have great potential to spread rapidly and far. Fungi associated with insect vectors are not limited in their spread by their own growth rates. Rather, the distances travelled by their insect associates are the critical factors. Bark beetles and Cerambycids are capable of flying distances of several miles and can be carried even further by winds. Some of these insects have two or more generations per year, so it is possible that there could be two or more increments of vector spread annually. Also, spread of *Ophiostoma* spp. and associated insects can be increased substantially by human transport of harvested logs and firewood.

## B. Consequences of Establishment

- 1) Economic Damage Potential—Economic damage could take several forms: (a) If a Siberian *Ophiostoma* spp. and its exotic vector are introduced together, there could be a new kind of tree-killing beetle-fungus association established. In addition to tree killing, there would also be sapwood staining caused by the fungus. The amount of damage would depend on the host affected, the aggressiveness of the vector insect, and the virulence of the fungus. It is believed that most bark beetles require their

fungal associates to successfully infest and kill trees, so introduction of the fungi is as important as introduction of the insects, and, indeed, the two cannot usually be separated (For economic importance ascribed to introduction of Scolytid and Cerambycid beetles from the Eastern Soviet Union, see entomological sections of this evaluation); (b) If a Siberian *Ophiostoma* spp. is introduced without its exotic vector and a native insect develops a vector relationship with the fungus, the new association could contribute to increased amounts of tree killing by that native insect. This would happen if the introduced *Ophiostoma* sp. was more pathogenic than any fungal associate that the North American vector insect had previously carried; (c) Although it is much less likely than either of the scenarios in (a) and (b) above, it is also possible that a virulent *Ophiostoma*-caused root disease similar to the black stain root disease incited by *L. wagneri* could be introduced on imported logs. We do not know if any such pathogen occurs in the Soviet Far East, but it is certainly possible. Such a disease would be vectored into new areas by insects but once established could cause substantial tree killing by itself.

Precise economic damage potential figures are impossible to provide with our current knowledge of *Ophiostoma* spp. in the Soviet Far East. Damage would certainly involve timber loss through mortality and degrade because of wood staining. One thing to remember when considering risk associated with *Ophiostoma* spp. is that introduction of a number of different species with different vector potentials and host ranges is very likely if effective mitigating measures are not employed.

- 2) Environmental Damage Potential—Because bark beetles and associated *Ophiostoma* spp. as well as *Ophiostoma*-caused root diseases tend to kill trees of one or several closely related species in groups, they could be responsible for tree species shifts. Type or magnitude of any such shift cannot be predicted without additional information on specific fungi and insects that might be involved.
- 3) Perceived Damage (Social and Political Influences)—Tree mortality caused by a bark beetle-*Ophiostoma* spp. association has the potential to be rather spectacular and thus evident to the public and interest groups. If a new tree-killing beetle-fungus association were established in the Pacific Northwest, there would certainly be political implications. Damage by some *Ophiostoma* spp. and associated bark beetles tends to be especially great on offsite plantings. Thus, ornamental plantings and Christmas tree plantations might be at higher risk to damage from some of these beetle-fungus associations than forest stands.

Estimated Risk for Pest—High.

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**APPENDIX J**  
**Assessment of Timber Economic Impacts**  
**of Potential Defoliators Associated**  
**With Siberian Logs**

Summary of Workshop Data

**Potential Pests—Nun Moth and Asian Gypsy Moth (Hitchhikers)**

Growth loss	15 to 25 percent decade growth loss over the 77.1 million acres of susceptible host type in the West.
Mortality	60 percent for conifers (other than Douglas-fir and larch) every 10 years. 30 percent for hardwoods, Douglas-fir, and larch every 10 years.
Defect	The nature of defoliation does not impart defects per se.
Premature cutting	There will be losses due to premature cutting that involve early harvest to preclude major economic impacts. However, no estimate of the economics of such actions can be made.
Species	The colonization, establishment, and spread of the introduced gypsy moth in oak-hickory and hardwood forests of the Eastern United States over the long term will cause species shifts.

Assumptions Developed in Workshop for Assessment of Impacts on Timber Resources in the West

**Growth Loss**

As a defoliator of mostly spruce, fir, and larch (see table J-1 for the area and volume of unreserved forest in the Western United States with the potential for defoliator loss), the nun moth represents a potential threat to approximately 77.8 million acres of forest in the American West. The gypsy moth type is more restricted to larch and hardwoods for all larval instars; a mixture of these species with fir and spruce is essential for early larval establishment—later instar larvae then move to fir and spruce. Experts predict that pine would be the only conifer not at risk, because neither the nun moth nor the gypsy moth uses pine as a primary host. Some 50 percent of Douglas-fir, 100 percent of spruce fir, 100 percent of hemlock-Sitka spruce, 50 percent of other softwoods, and 100 percent of hardwoods could serve as acceptable hosts. Conifers will exhibit 15 to 25 percent growth loss and hardwoods 10 to 20 percent growth loss. We assumed no time frame for colonization. Although both defoliators could potentially spread east, this scenario was not analyzed because of the difficulty of predicting such a spread and distinguishing the effect from that of the existing gypsy moth infestation in the East.

**Table J-1. Area and Volume of Unreserved Forest in the Western United States and Potential Losses From Attack Due to Soviet Defoliator Insects, All Ownerships<sup>a</sup>**

Forest type	Forest Type					
	Douglas-fir	Fir/ Spruce	Hemlock Sitka Spruce	Larch	Other Softwoods	Western Hardwoods
M acres	35,487	23,083	5,520	2,633	4,287	25,973
% acres attack	50%	100%	100%	100%	50%	100%
Acres attacked	17,743	23,083	5,520	2,633	2,143	25,973
Net vol MMBF	510,030	279,339	134,905	34,388	17,290	74,336
Annual growth MMBF	10,200	5,587	2,698	688	346	1,487
Annual growth at- tacked MMBF	5,100	5,587	2,698	688	173	1,487
Annual growth loss %	2%	2%	2%	1.5%	2%	1.5%
Annual growth loss MMBF @ t=10	102	112	54	10	3.5	22
Annual mortality %	3%	6%	6%	3%	6%	3%
Annual Mortality MMBF @ t=10	7,650	16,760	8,094	1,032	1,037	2,230

<sup>a</sup> USDA, 1987.

**Notes:**

- (1) Decade Outbreaks—Evidence shows that outbreaks for similar defoliators occur approximately every 10 years in the United States. Therefore, an outbreak could be expected to occur 10 years after introduction of defoliators ( $t = 10$ ). Evidence shows that the spread rate of similar pests is approximately 20 kilometers per year.
- (2) Annual Growth—Annual growth rates are estimated to be 2 percent by volume. This was figured by using tables 7, 8, and 28 of *Forest Statistics of the United States, 1987*, Net Volume of Hardwood and Softwood Growing Stock, and Net Annual Growth of Growing Stock.
- (3) Annual Growth Losses—Predicted to be 15 to 20 percent per decade and calculated on an annual basis by volume, depending on species.
- (4) Annual Mortality—Mortality primarily occurs during decade outbreaks. Losses are spread out on an annual basis. Mortality was predicted to be between 30 and 60 percent per decade by volume, depending on species for the worst case scenario, and 5 percent per decade for the best case scenario.



## **Mortality**

It was assumed that outbreaks of defoliators would occur every 10 years, last for 2 years, and that tree, stand, and economic impacts would be similar to those from native pests such as the western spruce budworm and Douglas-fir tussock moth. Outbreaks of the native Douglas-fir tussock moth in Oregon grand fir and Douglas-fir stands have resulted in mortality rates ranging from 5 percent in moderately defoliated areas to 72 percent in heavily defoliated areas (Wickman, 1978). The proportions of total infested area suffering from heavy defoliation in tussock moth outbreaks in Oregon and California range from 14 to 25 percent (Wickman et al., 1973). Mortality to spruce and fir could be greater when defoliated by nun moths or gypsy moths since they would be introduced pests and may not be affected by the natural controls of native pests. The mortality estimates for each 10-year outbreak period are reflected as loss in volume in the infested region by reduction in stand basal area. Mortality rates of 60 percent for conifers (except Douglas-fir and larch) and 30 percent for Douglas-fir, larch, and hardwoods would occur if the introduced defoliators were more damaging than the native defoliators.

## **Defect**

Not applicable to the damage produced by these two defoliators.

## **Premature Cutting**

Due to the major effect of defoliation to conifer mortality and past historical investment in management practices in the Pacific Northwest forests, premature harvesting would be expected to exceed comparable gypsy moth defoliation (management) in hardwood forests of the Eastern United States.

## **Species Conversion**

Based upon more than 100 years of defoliating episodes in the hardwood forests of the Eastern United States, significant changes in species composition have occurred. Because the trees most susceptible to defoliation tend to suffer the highest mortality, the oaks tend to be eliminated, while the numbers of other less preferred species, such as red maple, have increased. There is no scientific reason to expect anything different for the long-term defoliation effects on Pacific Northwest coniferous forests by these defoliators. Depending upon the tree species and site, three scenarios are possible.

- (1) **Worst Case** — Complete loss of a forest type (for example, high-elevation spruce and fir could be converted to no forest cover).
- (2) **Reversion of Type** — Tree defoliation and subsequent mortality will revert to a more pioneer species (for example, conifer to aspen and alder).
- (3) **Accelerated Succession** — Elimination of most preferred conifers will speed up to a late successional stage (western hemlock and Sitka spruce to pure western hemlock).

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## Appendix K

### Potential Economic Impact of Larch Canker in the Western United States

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#### Background

European larch canker (*Lachnellula willkommii*) is common in Europe and the Eastern United States. It attacks only members of the larch (*Larix*) genus, including western larch (*Larix occidentalis*) and several species commonly planted as ornamentals (Smerlis, 1973). Larch canker has never been reported in the Western United States, but it is widely distributed in Siberia and the Soviet Far East. Because the pathogen survives in dead wood and bark, it could be introduced into the Western U.S. forests via shipments of imported logs. However, it is not known whether the disease could gain a foothold in forests containing western larch.

*Lachnellula willkommii* causes permanent cankers on branches and main stems up to 10 cm (3.9 inches diameter at breast height [d.b.h]), often resulting in girdling of the tree or tree branches. Damage is most prevalent on 10- to 25-year-old trees (Sinclair et al., 1987). Killing infections have been observed on trees up to 25 cm (9.6 inches d.b.h). Infection can be thorough; surveys in New Brunswick have shown 60 percent of eastern larch in a large sample to be infected, affecting up to 100 percent of the trees in individual stands (Magasi and Pond, 1982). Indeed, in some areas of Europe, larch has been almost completely eliminated. The pathogen spreads on windblown spores, but can also be spread on trucks and ships, as on shipments of ornamental larches or raw logs. Experience in New Brunswick (Ostaff, 1985) with eastern larch (*Larix laricina*) has shown that the disease can spread about 4 miles per year.

Control of *Lachnellula willkommii* consists of killing and disposing of all infected trees, including larger trees that harbor the pathogen but are not killed or even substantially damaged by it. But even with such radical measures, the disease is difficult to control. The disease was thought to be eradicated in Eastern North America in 1965, but it reappeared in 1980 and now occurs throughout New Brunswick, Nova Scotia, and coastal Maine. Infected stands are converted to nonsusceptible species either through deliberate silvicultural activity or natural succession. With the potential to eliminate larch in future rotations, this disease could seriously alter the species composition of western forest ecosystems.

Western larch (*Larix occidentalis*) is an important commercial forest tree and plays a significant part in the functioning of forest ecosystems in the intermountain region of the United States. Larch is a deciduous conifer and a subclimax species maintained by periodic fire. There are almost 2 million acres of commercial forest land in larch type (more than 50 percent larch) in the West (table K-1). In addition, larch is found on a variety of range sites and is often associated with ponderosa pine (*Pinus ponderosa*); grand fir (*Abies grandis*); western hemlock (*Tsuga heterophylla*); western white pine (*Pinus monticola*); and at higher elevations, Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). Most western larch occur in Idaho, Montana, eastern Washington, and Oregon. Most (1.8 million acres) of the larch type is available for commercial harvesting in the timber management (table K-1) that is not in reserved or deferred status. About 44 percent of the total acreage is in the seedling/sapling and pole timber size classes, which are presumably at the greatest risk from attack by larch canker (table K-2). Most of the pure larch type (1.5 million acres) is in the National Forest System. The largest concentration of private ownership (165,000 acres) is in Montana (table K-3).

There are 6 billion cubic feet of larch growing stock in pure larch and other forest types (table K-4). Seventy-seven percent of this volume is publicly owned. About 90 percent is in unreserved land class. About 26 percent is in trees 10 inches or less in diameter, which would be susceptible to loss from larch canker (table K-5). The portion of this volume that is in pure larch stands is most vulnerable.

**Table K-1. Area of Commercial Timberland in Western Larch Forest Type by Land Class**

State	Area (thousand acres)		
	Unreserved	Reserved and Deferred	Total
Montana	577.40	95.7	673.1
Idaho	656.60	66.0	722.6
Washington	467.00	44.0	511.0
Oregon	92.00	0.0	92.0
Total	1,793.00	205.7	1,998.7

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

**Table K-2. Area of Commercial Timberland in Western Larch Forest Type by Stand-Size Class and State**

State	Area (thousand acres)				Total
	Sawtimber	Poletimber	Sapling/ Seedling	Non-stocked	
Montana	404.7	106.0	152.4	10.0	673.1
Idaho	375.8	166.2	173.4	7.2	722.6
Washington <sup>a</sup>	265.7	117.5	122.6	5.1	511.0
Oregon <sup>a</sup>	47.8	21.2	22.1	0.9	92.0
Total	1,094.0	410.9	470.5	23.2	1,998.7

<sup>a</sup> Estimated from percentage distribution by size class in Montana and Idaho.

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

**Table K-3. Area of Commercial Timberland in Western Larch Forest Type by Ownership Class and State**

State	Area (thousand acres)				Total
	National Forest System	Other Public	Forest Industry	Other Private	
Montana	468.8	38.4	115.1	50.8	673.10
Idaho	594.5	46.1	36.0	46.0	722.60
Washington	396.0	53.0	43.0	19.0	511.00
Oregon	74.0	4.0	11.0	4.0	92.00
Total	1,533.3	141.5	205.1	119.8	1,998.70

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

**Table K-4. Net Volume of Growing Stock of Western Larch on Commercial Timberland by Ownership Class and State**

State	Net Volume (million cubic feet)				Total
	National Forest System	Other Public	Forest Industry	Other Private	
Montana	1,503.8	138.6	394.8	141.5	2,178.7
Idaho	778.8	221.1	191.2	231.7	1,422.8
Washington	701.0	483.0	177.0	146.0	1,507.0
Oregon <sup>a</sup>	771.0	22.0	65.0	40.0	898.0
Total	3,754.6	864.7	828.0	559.2	6,006.5

<sup>a</sup> Includes 34 MMCF in western Oregon.

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

Larch sawtimber volume is 27.7 billion board feet (table K-6), 78 percent of which is in public ownership (table K-7). The biggest concentration of larch sawtimber in pure larch types is in Montana and Idaho; eastern Washington and Oregon have 42 percent of the sawtimber volume, where larch occurs more frequently in other forest types.

**Table K-5. Net Volume of Growing Stock of Western Larch by Diameter Class (Inches at Breast Height) and State**

State	Volume (million cubic feet)					Total
	5.0-10.9	11.0-16.9	17.0-22.9	23.0-28.9	29+	
Montana	547.2	601.6	506.0	320.0	203.9	2,178.7
Idaho	416.1	451.4	290.3	142.3	122.7	1,422.8
Washington	406.0	487.0	233.0	264.0	115.0	1,507.0
Oregon <sup>a</sup>	119.0	265.0	157.0	184.0	93.0	898.0
Total	1,488.3	1,805.0	1,186.3	910.3	534.6	6,006.5

<sup>a</sup> Includes 34 MMCF in western Oregon.

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

**Table K-6. Volume of Western Larch Sawtimber on Commercial Timberland by Diameter Class (Inches at Breast Height) and State**

State	Volume (million board feet, international ¼ inch)					Total
	<10.9	11.0-16.9	17.0-22.9	23.0-28.9	29+	
Montana	925.1	3,235.30	2,722.6	1,792.8	1,156.2	9,832.0
Idaho	757.8	2,560.10	1,529.0	753.6	622.9	6,223.4
Washington	731.0	2,623.00	1,339.0	1,555.0	622.0	6,870.0
Oregon	400.0	1,503.00	1,027.0	1,220.0	617.0	4,767.0
Total	2,813.9	9,921.40	6,617.6	5,321.4	3,018.1	27,692.4

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

**Table K-7. Volume of Sawtimber, International ¼-Inch Rule of Western Larch by Ownership Class and State**

State	Volume (million board feet)				Total
	National Forest System	Other Public	Forest Industry	Other Private	
Montana	6,534	740	2,025	533	9,832
Idaho	3,401	906	954	962	6,223
Washington	3,274	2,366	756	525	6,921
Oregon <sup>a</sup>	4,283	115	239	130	4,767
Total	17,492	4,127	3,974	2,150	27,743

<sup>a</sup> Includes 188 million board feet in western Oregon.

Sources: Green et al., 1985; Benson et al., 1985; Bassett and Oswald, 1981; Gedney, 1982; Farrenkopf, 1982.

### Impacts of Larch Canker

Larch canker could have several impacts:

1. Loss in financial value of timber stands now containing western larch (see Timber Impact section below). In the long run the elimination of larch would severely reduce silvicultural options in the intermountain region.
2. Loss of a species that is relatively resistant to the insects and diseases that currently plague western forests. Conversion to other tree species could predispose the forest to greater damage from pine beetles, spruce budworm, root rot, and other problems. Larch is also quite fire resistant relative to these other species.
3. Loss in aesthetic quality of western forests. Larch's contribution to forest beauty and tourism stems from its unique form and dazzling fall coloration.
4. Reduction in the biodiversity of western forests. Possible impacts could involve:
  - a. disruption of nutrient cycling patterns;
  - b. long-term reduction in snag recruitment for cavity-nesting birds, especially the pileated woodpecker;
  - c. loss in habitat for other endangered species associated with larch;
  - d. imbalances in hydrologic processes.
5. Loss in value of ornamental larches in urban forests, residential areas, and commercial nurseries plus direct removal costs in urban areas, might encourage replacement with other less preferred species. Loss in commercial nursery production for a number of larch species could cause dislocation, as nurseries reduce production and shift to other species. Customers close to infected areas would shift to nurseries in uninfected regions.
6. Costs of direct control in forest and urban areas. Forest disease control would involve removing and disposing of infected trees of all sizes. Some of this volume would have salvage value, but the rest would represent a direct control outlay. Intensified logging and disposal via mechanical methods or burning

could have negative environmental effects. Eradication programs in urban or rural/urban interface areas could be costly and politically difficult to implement. Even then eradication may not be entirely effective in reducing the disease's spread, as was shown in the Eastern United States and Europe.

7. Increased fire hazard from many acres of dead and dying larch.
8. Uncertain political ramifications, including possible losses in credibility for allowing the introduction of a known pest and international tension with Canada that could arise from exposing its substantial larch forests.

Most of the impacts described above could not be quantified in the time allowed for this assessment. The analysis below addresses only the potential financial impacts on the timber resource. Estimates are based on a number of assumptions about the biological interactions between canker and host, economic relationships, silvicultural regimes, and managerial responses of various levels of infection. The team treated the introduction and spread of larch canker as certain. The probability distributions of introduction and level of severity of an outbreak are under study by other teams.

### Financial Impacts on Timber

Timber impacts can be described as (a) direct losses, (b) indirect losses, and (c) control costs.

Direct losses include:

- (a) **Unsalvageable mortality**—The larch canker can infect merchantable timber, even though it does not usually kill sawtimber trees. Mortality can result from predisposition to insects and other diseases or from attempts to eradicate the disease through sanitation logging.
- (b) **Reduction in stumpage prices**—Prices for salvaged logs would decrease because of reduced wood quality. Although we assumed that cankers on branches would be removed in a normal bucking and limbing process, the wood quality of young trees infected by the canker could be diminished in the future. However, no references to such a reduction in quality were evident, and there were no quantitative estimates of this.
- (c) **Reduced yield in the present rotation**—Even if larch in the present stands survives the infection, final harvest yields would probably be reduced. In mixed stands the larch component could be lost, thereby reducing the yield to what the remaining species, e.g., ponderosa pine, Douglas-fir, lodgepole pine, or white pine, could provide. In many stands a conversion (either natural or artificial) to another species might occur (see indirect effect, below).

Faced with a larch canker infection, the manager's choices are two: allow the remnants of the damaged stand to finish the rotation or replace the stand with another species. Keeping the stand could involve a loss in yield, an increase in the length of rotation, or both, representing a loss in value in any case. The choice would depend on the degree of infection, the age of the stand, response by the undamaged portion, and the prognosis for other pest damage on the remaining species.

Indirect losses include:

- (a) **Premature conversion** (assuming conversion to a species similar in yield and value)—Replacing a canker-infected stand requires an immediate brush disposal, site preparation, and reforestation cost. In addition, the yield of the damaged stand would be foregone; any harvest would be delayed by the length of the new rotation. The discounted present value of this converted stand is almost always less than the present value of finishing out a healthy stand already 30 to 60 years along. The difference in the present values between the healthy and converted stands is an

estimate of the conversion impact. Note: A financial benefit could be attributed to the disease if it forced conversion of stands that are older than a financially optimum rotation age. This represents a forced divestiture of society's "opportunity costs" in preferring long rotation forestry and can complicate the financial impact. However, this impact did not prove to be important in our analysis of larch canker because the disease attacks young stands. This benefit could be a factor in control efforts that remove older trees.

- (b) **Species conversion**—In a stand conversion, the "new" species could adversely affect yields, rotations, or stand maintenance costs. The new species can also present greater risk of losses due to insects and disease. In larch, the problem could be quite serious, since conversion species have broad arrays of serious insect and disease problems.
- (c) **Disruptions in the harvest schedule**—Stand-level losses can be partially mitigated at the forest level in the harvest rescheduling process. The present value of the entire harvest schedule incorporates the fact that trees harvested in the salvage and sanitation program are substituted in the allowable cut. At the same time, however, the schedule can be affected by yield reductions caused by removal of larch in the growing stock. These effects change the allowable cut calculations or may stimulate managerial modifications in the harvest scheduling goals.
- (d) **Reductions in market stumpage prices**—Local excess supplies of salvage logs could depress prices for larch and larch substitute species such as Douglas-fir. Under some control strategies, infected logs may be quarantined, which would aggravate oversupply problems. On a more aggregate level, however, the loss of larch would represent a reduction in timber supply, and hence overall increases in timber prices.

Control costs include:

- (a) **Removal of infected trees**—Some larger trees could be salvaged, but many others would have to be cut and left, because their low per acre volumes would not allow economically feasible logging. Some of the growing stock would be premerchantable. Some on-site chipping to help defray control costs might be feasible but we did not have information on costs and returns for chipping on larch stands.
- (b) **Premature conversion and/or species conversion in control stands**—Stands that would be infected but not killed would be subject to control measures.
- (c) **Administrative costs** of implementing the control program—Additional staff, contracting, and supervisory costs would be necessary.

## Methods

We limited our analysis to three financial impacts:

1. Reduced yields in present larch stands
2. Premature conversion of larch to other tree species
3. Direct control costs, consisting of
  - a. Stumpage value lost in unsalvageable mortality in salvage and sanitation operations.
  - b. Direct costs of further disposal, including piling, burning, or activities in excess of normal silvicultural treatment.

Time and resources did not permit us to address:

1. Wood quality
2. Harvest scheduling and allowable cut effects

3. Species conversion
4. Stumpage market adjustments (local or aggregate)
5. Control stand conversion impacts
6. Administrative control costs

To complete this analysis, the following estimates were developed.

1. Develop three alternative scenarios composed of different levels of infection and extent of control.
2. Estimate the acres of susceptible larch (host) type (see table K-2 and assumptions below) for each scenario. Larch in this area is completely killed in each scenario. Its base is the acreage in seed/sap and poletimber size classes. Acres that are reserved or deferred are not included.
3. Estimate the sawtimber volume of nonsusceptible larch that is affected in a direct control program (see table K-6 and assumptions below) for the scenario. Part of this volume is salvageable at current market prices for stumpage; the rest is unsalvageable mortality. The volume that occurs as reserved or deferred timberland is not included.
4. Estimate a combined yield reduction/conversion impact for the host acreage.
  - a. Estimate a per acre yield reduction impact for infected stands that are assumed to finish the rotation.
  - b. Estimate a per acre stand conversion impact for infected stands that are converted immediately after infection.
  - c. From a. and b., calculate a weighted average per acre impact based on an estimated relative frequencies of the two situations.
  - d. Multiply the average loss c. by the number of host acres infected in the scenario, adjusting for unreserved acres.
5. Estimate the direct control cost-plus-loss.
  - a. Estimate the value of the merchantable-size larch that are cut during control but are not sold, multiplying stumpage prices by the portion of the standing sawtimber volume. That portion is specified by each scenario. (See table K-6 and assumptions below.)
  - b. Estimate the disposal costs not included in a., above, by multiplying some assumed net cost per MBF by the unsalvaged volume.
  - c. Add 5a. and 4b., and adjust to the unreserved volume.
6. Add 4d. and 5c. for an estimate of the total impact for the estimated duration of the disease epidemic.
7. Calculate the discounted present value of the impact in 6.
  - a. Divide the total impact by the number of years in the epidemic (see assumptions below.)
  - b. Apply formula for the present value of an annuity to the annual impacts calculated in 6.

### Scenarios

1. High infection level. No control program.
  - 100 percent of the susceptible host acreage is affected.
2. Medium infection level. Medium control intensity.
  - 50 percent of the host acreage is affected.
  - 25 percent of the sawtimber volume in nonsusceptible larch is cut.
3. Light infection. High control intensity.
  - 25 percent of the host acreage is affected.
  - 50 percent of the volume in nonsusceptible larch is salvaged and sanitation cut.

## Assumptions

### Biological Assumptions

1. Larch canker disease will spread completely through the larch resource in 25 years. The area occupied by larch is fairly contiguous. We assumed conditions favorable for rapid development of the fungus, including spread assisted by vehicular traffic and lofting winds.
2. Larch forest types in the seedling/sapling and poletimber size (up to 9 inches mean diameter) are susceptible. Montana and Idaho resource inventories showed that 47 percent of the commercial larch acreage falls in this group. Accurate estimates of the area exposed in Washington and Oregon were not available. We applied the Idaho and Montana proportion to the Washington and Oregon larch acreage. We subtracted 10 percent of the acreage as reserved. Our final estimate was 793,000 acres at risk.
3. The average age of the susceptible larch stand is 30 years. For calculation simplicity we assumed that all stands are exactly 30 years old.
4. The larch component of other forest types (less than 50 percent larch stocking) will be killed by the disease, but the stands will undergo no yield reduction. Our estimates of the acreage distribution of larch in these stands, not to mention their relative predisposition to attack, was so uncertain that we chose the conservative assumption described here, recognizing that larch is prevalent in mixed stands, especially in eastern Oregon and Washington. This assumption, however, does not rule out unsalvageable mortality in forced control programs, because those estimates are based on total larch volume, not acreage by forest type class.

### Silvicultural Assumptions

1. Larch stands will be replaced with Douglas-fir, which will be grown under a management regime with costs, rotation length, yields, and values identical to the larch regime. No significant increase in insect and disease damage will be experienced in the new stands. Actually, larch would be naturally replaced by, or converted to, a number of species, including ponderosa pine, white pine, lodgepole pine, and in some cases, grand fir. All have serious health problems. More extensive analysis could explore the tradeoffs implied in these possibilities.
2. The basic management regime is as follows:

Activity	Age	(Cost)/Revenue
(a) Site Preparation	1	(\$150)
(b) Planting	1	(\$100)
(c) Precommercial thinning	20	(\$100)
(d) Commercial thinning	50	\$150 (3 MBF/acre @ \$50/MBF)
(e) Final harvest	100	\$2,100 (30 MBF/acre @ \$70/MBF)

Note: The higher final harvest stumpage value is based on higher quality and lower cost logging. See financial assumptions.

3. In two-thirds of the infected host acreage, there will be enough residual growing stock in conversion species to finish out the rotation. In the other third, immediate conversion will be necessary.

4. In infected host acreage, all of the merchantable sawtimber volume will be sold at current (projected) stumpage prices identical to those of green larch. Furthermore, the volume salvaged is identical to what would have been harvested in planned commercial thinnings. Therefore, the kill of any merchantable volume does not contribute to any value loss.
5. In stands that are allowed to finish the rotation, yields will be reduced by 1/3 from 30 MBF per acre to 0 MBF/acre at 100 years.

### **Control Program Assumptions**

1. The larger larch (above 11" d.b.h.) in all forest types will be removed. No control will be needed in the infected seedling and sapling larch stands, because 100 percent mortality was assumed.
2. The only value loss from the control program is the unsalvageable mortality, which is 25 percent of the current sawtimber volume, international ¼-inch of the > 11" d.b.h. trees. We calculated no loss from premature conversion or reduction in yield in stands containing this volume, because we had no estimate of their acreage and species composition. Further analysis could use data from resource inventories to better quantify this effect.
3. Control costs, net of the logging costs included in the unsalvaged mortality, are \$10 per MBF of unsalvageable volume cut in the control program.
4. Stumpage values for larch removed in the control program are identical to prices for green uninfected larch.
5. The control program cost-plus-loss is only applicable for the volume in unreserved status. We assumed that the proportion of volume that was unreserved in a State was equal to the general proportion of commercial forest land unreserved for that State.

### **Financial Analysis Assumptions**

1. Current stumpage prices for green larch are assumed to be \$70/MBF. This represents the average stumpage price paid for larch on National Forest System sales in the Northern and Pacific Northwest Regions for the years 1985-89 (Warren, 1990a, b). The range of larch prices was \$32.90 to \$132 with prices being generally higher in the PNW Region. We assumed that with Douglas-fir, our conversion species sold for the same stumpage price. Actual averages are PNW: \$71.77 larch/\$71.36 Douglas-fir, and Northern region: \$60.22 larch/\$56.37 Douglas-fir.
2. Real discount rate is 4 percent. All funds during the cash flow will be reinvested at the same rate.
3. Rate of inflation for all costs is 3 percent per year.
4. Real timber price increase is 1 percent per year.
5. Present rotations are financially optimum. None of the stands in the susceptible size is financially overmature.
6. The total financial impact from premature conversion and yield reduction is the sum of the stand-level estimates for the assumed acreage infected. We estimated no allowable cut adjustments.
7. The premature conversion effect is calculated with the formula:

$$\text{Value Change} = \text{PNW}^{\text{wo}} - \text{PNW}^{\text{w}}$$

where  $PNW^{wo}$  is the discounted present value of the present rotation and all future rotations without larch canker and  $PNW^w$  is the discounted present value of the present and future rotations with the larch canker.

8. The form of  $PNW$  used in this analysis combines the present value of the remaining rotation with the soil expectation value (SEV) of an infinite series of rotations after the stand is converted. The SEV component is discounted to the present from its starting point, which is 70 years hence for stands in which the current rotation is allowed to finish.
9. The annual control cost-plus-loss is the total control impact divided by 25 years. Because the disease spreads uniformly over the acreage during the period, the impact is the discounted present value of a stream of 25 equal annuity payments, using the 4-percent rate. (We assumed no real net of inflation increase in stumpage prices in the control impacts.)
10. Income and distribution effects are not estimated, with the exception of the distribution of financial impacts according to the relative proportions of the western larch resource in each state. Distributional impacts by income and other categories are not calculated.
11. Secondary economic and employment effects were not estimated.
12. Financial losses were not calculated for acres and volumes that were in reserved or deferred status, because they have no market value as timber.

### Results

The impact of larch canker will be a loss of \$129 million in timber and forestland value (table K-8). This figure represents the net present value of a stream of impact over the 25-year period of spread. It is the average impact of the three infection/control scenarios, which ranged from \$99 million to \$166 million.

Half of this impact would come from yield reduction and conversion in present stands, and half from control costs and unsalvageable control mortality. These estimates are conservative in that they do not include the ecological impacts described in Chapter 6 and do not estimate the secondary economic impact of eliminating larch as a commercial timber species.

Under the high infection scenario, 100 percent of the impact would come from yield reduction and stand conversion. By contrast, under the low infection/high control scenario, 81 percent of the impact would come from control cost-plus-loss. A worst case scenario would include a high infection level in spite of an intensive control program, producing a value reduction of  $\$99 + \$141 = \$240$  million.

The impact would be greatest in Montana and Idaho (\$75 million) (table K-9). Under the high infection scenario, Idaho would suffer the largest loss (\$38.7 million) because of its relatively large acreage of susceptible forest type. Under the low infection/high control scenario, Montana would suffer the greatest loss (\$55 million) because of its high volume of larch in the target control sizes.

**Table K-8. Financial Loss From Larch Canker on Western Larch Under Three Scenarios, Four Western States**

Scenario	Financial Loss (present value in millions of dollars for 25-year period)		
	Yield Reduction/ Stand Conversion	Control Cost/ Loss	Total Impact
1. High infection/No control	99.2	0	99.2
2. Medium infection/Medium control	49.7	70.6	120.3
3. Low infection/High control	24.9	141.4	166.3
Average Impact	57.9	70.7	128.6

**Table K-9. Financial Loss From Larch Canker on Western Larch for Three Scenarios, by State**

State	Financial Loss (present value in millions of dollars of impact over a 25-year period)			
	High Infection/ No Control	Medium Infection/ Medium Control	Low Infection/ High Control	Average Impact
Montana	27.8	31.9	54.9	38.2
Idaho	38.7	31.1	40.8	36.9
Washington	27.3	26.8	41.7	31.9
Oregon	5.4	13.0	28.8	15.7
Total Impact	99.2	102.8	166.2	122.7

Tables K-10, K-11, and K-12 show the distribution of impacts by impact component. These results raise questions about the tradeoffs between infection and control that are assumed in the calculations. That is, why would a control program costing \$48 million in Montana (table K-12) be implemented to hold the yield/stand conversion losses at \$7 million? One answer is that the additional benefit from containing the infection (assuming it was biologically effective) would be in foregone negative economic and ecological effects not measured in this rough analysis. Further research using a range of assumptions, better information on the canker, growth-yield models, and more highly resolved economic data could help answer many of the questions raised in this analysis.

**Table K-10. Financial Loss From Larch Canker on Western Larch for High Infection/No Control Scenario by Impact Component and State**

State	Financial Loss (present value in millions of dollars for 25-year period)		
	Yield Reduction/ Stand Conversion	Control Cost/ Loss	Total
Montana	27.8	0	27.8
Idaho	38.7	0	38.7
Washington	27.3	0	27.3
Oregon	5.4	0	5.4
<b>Total</b>	<b>99.2</b>	<b>0</b>	<b>99.2</b>

**Table K-11. Financial Loss From Larch Canker for Medium Infection/Medium Control Scenario, by Impact Component and State**

State	Financial Loss (present value in millions of dollars for 25-year period)		
	Yield Reduction/ Stand Conversion	Control Cost/ Loss	Total
Montana	13.9	23.9	37.8
Idaho	19.4	15.6	35.0
Washington	13.7	17.4	31.1
Oregon	2.7	13.7	16.4
<b>Total</b>	<b>49.7</b>	<b>70.6</b>	<b>120.3</b>

**Table K-12. Financial Loss From Larch Canker on Western Larch for Low Infection/High Control Scenario, by Impact Component and State**

State	Financial Loss (present value in millions of dollars for 25-year period)		
	Yield Reduction/ Stand Conversion	Control Cost/ Loss	Total
Montana	7.0	47.9	54.9
Idaho	9.7	31.1	40.8
Washington	6.8	34.9	41.7
Oregon	1.4	27.4	28.8
Total	24.9	141.3	166.2

### Calculations

- Estimated acreage in host type (seedling/sapling and poletimber) = 881,000 acres from table K-2 for 100 percent infection level, 793,000 of which is in unreserved status.
- Estimated volume (< 11" d.b.h.) subject to control = 24.9 billion boardfeet from table K-6 for 100 percent control level.
- Yield Reduction/Conversion Impacts  
PNW of susceptible stands without larch canker (average age = 30 years), per acre.
  - PNW of present stand at 100 years = \$292.72
  - SEV of future rotations (discounted 70 years) = (\$8.68)
  - Total of a) minus b) = \$284.04
- PNW of susceptible stands with larch canker that are allowed to finish the rotation, per acre.
  - PNW of present stand (age = 30) at 100 years = \$195.15  
(yield reduction of 1/3)
  - SEV of future rotations = (\$8.68)  
(discounted 70 years)
  - Total of a) minus b) = \$186.47
- PNW of susceptible stands with larch canker that are converted immediately, per acre.
  - SEV of future rotations = (\$124.95)
- Yield reduction effect, per acre  
 $3c - 4c =$  \$97.57
- Stand conversion effect, per acre  
 $3c + 5a =$  \$408.99
- Weighted average impact, per acre  
 $2/3 (\$98) + 1/3 (\$409) = \$200.63$  \$200/acre
- Present = \$200 (# unreserved acres in scenario) \* (annuity factor for 25 years @ 4% or 15.622) value 25 years

### Control Cost Plus Loss

1. Unsalvageable mortality (U.M.) lost in sanitation cutting  $\$70 * .25$  (U.M.%) \*  
(unreserved sawtimber volume removed in the scenario)
2. Disposal cost  
 $\$10/\text{MBF} * .25$  (unreserved sawtimber volume removed in the scenario)
3. Total cost-plus-loss  
Sum of 1 and 2 above for the scenario
4. Present value = #3 above \* (annuity factor for 25 years @ 4% or 15.622) 25 years



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**Appendix L**  
**Report on the Site Visit to the**  
**Soviet Union**  
**June 28 to July 16, 1991**

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**Introduction**

On June 28, 1991, a team of specialists from the U.S. Department of Agriculture (USDA) traveled to the U.S.S.R. The objective of the site visit was to ensure that the information developed for the pest risk assessment on the importation of larch from Siberia and the Soviet Far East was current and valid. The USDA team included specialists from the Forest Service (FS) and the Animal and Plant Health Inspection Service (APHIS):

- Borys M. Tkacz, Team Leader, Pest Risk Assessment Team, FS
- James F. Fons, Team Leader, Management Practices Team, APHIS
- William E. Wallner, Entomologist, Pest Risk Assessment Team, FS
- Donald J. Goheen, Plant Pathologist, Pest Risk Assessment Team, FS
- Robert D. Housley, Forester/Economist, Pest Risk Assessment Team, FS

From June 28 to July 16, 1991, the USDA team met with Soviet scientists and foresters to discuss the pest risk assessment and viewed forest pests, forest harvesting practices, and log handling procedures in the Soviet Far East and Siberia. Along with hosts from the U.S.S.R. State Forestry Committee and the Siberian Branch of the Academy of Sciences, the USDA team visited export facilities at the ports of Nakhodka and Vostochniy in the Soviet Far East, and specific cutting, upper landing, lower landing, processing, and shipping areas near Lesosibirsk, Shira, and Krasnoyarsk in Siberia. The USDA team also met with forest entomologists and pathologists at the V.N. Sukachev Institute of Forestry and Wood, the Siberian Technological Institute in Krasnoyarsk, and the Far Eastern Forestry Research Institute in Khabarovsk. The following trip report summarizes the findings of the USDA team about the pest risks associated with the importation of logs from the Soviet Far East and Siberia to the Western United States.

**Consultations With Soviet Scientists**

Soviet scientists were provided in advance with a list of the pests assigned priorities according to whether they would be hitchhikers on the bark, in the bark, or in the wood. Dr. Vladimir Yanovsky (V.N. Sukachev Institute of Forestry and Wood, Krasnoyarsk) and Dr. Galina Urchenko (Far Eastern Forestry Research Institute, Khabarovsk) both indicated that there were no major gaps in the insect species selected. Dr. Yanovsky indicated that there are exceptionally few monophagous insects of larch. The one exception is *Xylotrechus altaicus*. Therefore, many of the insect pest species considered principally for larch could also be considered under other coniferous species. This underscores the validity of the approach taken by the Pest Risk Assessment Team, because similar pest problems would likely occur on pine, spruce, and fir. Dr. Yanovsky also indicated that of the 82 species of Scolytidae noted to infest conifers, 50 occur on larch. Of those that he considers technical pests, that is, those that destroy the quality of the wood, *Monochamus* spp. and Siricidae are the most important. Dying or dead trees are hosts for various *Ips* spp., *Tetropium* spp., and Buprestidae, such as *Phaenops guttatata*. On recently cut trees and seedlings, *Hylobius* and *Pissodes* spp. are expected to be the greatest problem. In his experience, during the growing season (late April to September) one can expect to find Siricidae and Cerambycidae attacking the tree within 1 hour after trees have been felled and yarded. This infestation starts principally in the upper yarding area, but proceeds after the trees have been moved to the lower yard. Members of the team consistently encountered adult Cerambycidae, as well as *Ips* spp., in both upper and lower landings and milling areas. Dr. Yanovsky also indicated that, because of the similarity in the climates of the Soviet Far East and the Pacific Northwest, several insect species in the Soviet Far East would be particularly dangerous if inadvertently introduced into the United States. He speculated

that in addition to the known pest species identified by the Pest Risk Assessment Team and reaffirmed by his observations, several other species could also be important. Uncommon pest species in Siberia and the Soviet Far East that could become potential problems if they were inadvertently introduced and became established in North America would include *Dryocoetes* spp., *Tetropium* spp., *Pissodes* spp., and some Siricidae. According to Dr. Yanovsky, there are no reports of nematode-insect relationships on larch in Siberia and the Far East. Attempts have been made to determine whether *Monochamus urussovi* vectored nematodes, but this relationship could not be established. However, Dr. Yanovsky stated that this borer was capable of vectoring *Ceratocystis* fungi. This commonly occurs when maturing adults feed on twigs in the upper crown, where the pathogen is introduced and kills the small branches.

Dr. Galina Urchenko had an opportunity to review the list of major pests and indicated no major gaps in the species identified. She did, however, suggest that the coneworm (*Lasiomma* spp.) be added, because part of its life cycle is spent under bark scales as pupae. This species had been eliminated from detailed consideration in the pest risk assessment process because it was concluded that it would be eliminated by surface treatments used for other hitchhikers.

Dr. Urchenko reported that the Soviet Far East has recently had a major outbreak of a budworm (*Choristoneura murianna*) on spruce. North America has at least two species of spruce budworms, but this is indeed a different species. But, like *Lasiomma* spp., any life stages present on the bark would be effectively controlled by proposed mitigation procedures for hitchhikers.

Dr. Yuriy Baranchikov from the V.N. Sukachev Institute of Forestry and Wood discussed problems associated with the larch bud gall midge (*Dasineura laricis*). This insect is very common in the forest-steppe zone of Southern Siberia and causes galls to grow on larch shoots. The midge overwinters in galls of the previous year and could be transported with logs that have attached branches. Trees that have been pruned for cone collection will have gall midge on epicormic branches. Dr. Baranchikov mentioned that the North American tamarack (*Larix laricina*) planted in provenance plantings near Shira was heavily infested with the gall midge, but that the galls did not produce midges.

Dr. Baranchikov also showed the team stands infested with Siberian silk moth (*Dendrolimus sibiricus*) and larch casebearers (*Coleophora* spp.). Although mortality of larch due to *D. sibiricus* is rare, attack by secondary insects can occur after repeated heavy defoliation. The group observed a larch tree killed by *Ips subelongatus* following several years of heavy defoliation by the Siberian silk moth. Some of the trees infested with the moth exhibited pupal cases on the main bole, but Dr. Baranchikov said this was not common. According to him, the probability of transporting larch casebearers on logs would be greater than that of the Siberian silk moth because the adult casebearers overwinter in cases on the main stem at branches. The species of casebearers in Siberia are different from the European one that was previously introduced into North America.

The Pest Risk Assessment Team's impression from examining Soviet forest pathology literature before the trip was that very few tree pathologists have done or are doing work in the Eastern U.S.S.R. Unfortunately, this proved to be true. The team was able to consult with forest pathologists from only two organizations and learned of one additional location where work on tree nematodes is being done (in Vladivostok). The Soviet pathologists the team consulted with believed that (1) knowledge of tree diseases of the Eastern Soviet Union is incomplete and much remains to be discovered; (2) literature on these tree diseases is sparse and difficult to access; (3) tree diseases are nevertheless numerous, widespread, and damaging in Eastern Soviet forests; and (4) many tree diseases could potentially be transferred on untreated logs exported from Siberia and the Soviet Far East to North America.

The first Soviet pathologist visited was Dr. Pavel Aminev, head of the Department of Forest Protection in the Siberian Technological Institute, Krasnoyarsk. Dr. Aminev teaches and does research on forest pathology, entomology, and wildlife biology, though pathology is his principal area of expertise. He is very knowledgeable and has considerable experience in the field of forest pathology and would be an excellent person to involve in cooperative research programs with the aim of filling critical data gaps on Siberian pathogens. After examining the list of pathogens that the team had already prepared for larch species, Dr. Aminev

indicated that the list was quite complete. He suggested that the following listed pathogens were especially likely to be encountered in Siberia: *Meria laricis*, *Melampsorium betulinum*, *Melampsora larici-populina*, *Melampsora larici-tremulae*, *Lachnellula willkommii*, *Fomitopsis officinalis*, *Fomitopsis pinicola*, *Ganoderma lucidum*, *Laetiporus sulphureus*, *Phellinus pini*, *Armillaria* spp., *Heterobasidion annosum*, and *Phaeolus schweinitzii*.

Dr. Aminev suggested adding *Cytospora abietis*, *Leptostroma laricinum*, and *Pholiota adiposa* to the list. He also provided information on what he believes are the most significant diseases of pine, spruce, and true fir in Siberia. The team questioned him about various aspects of the biologies of what we considered to be especially significant larch pathogens in Siberia, and his answers revealed several important points: (1) the root disease pathogens *H. annosum* and *Armillaria* spp., in addition to being widespread and often damaging in Siberia, frequently act very differently there than in North America, suggesting that different biotypes or strains of the fungi may be involved; (2) though little studied and not referred to in the literature, staining fungi (probably *Ceratocystis* spp., *Leptographium* spp., and/or *Ophiostoma* spp.) are common associates of insects on Siberian conifers, including larch; (3) *Fomitopsis pinicola* is commonly encountered on living larch in Siberia; and (4) in Siberia, *Lachnellula willkommii* is rarely encountered on trees more than 20 years old.

At the Far Eastern Forestry Research Institute in Khabarovsk, the team consulted with Dr. Lyudmila Chelysheva and her son Dimitri, forest pathologists working mainly in a seedling and nursery pathology project. They examined the team's list of larch pathogens and, although they believed that it was mainly complete with respect to pathogens of older trees, they suggested adding some seedling pathogens that might be transported in soil on logs. Their list included, on larch, *Phasidium infestans* and, on all conifers, *Fusarium solani*, *F. culmorum*, *F. javanicum*, *F. aquaeductum*, *F. gibbosum*, *F. avenaceum* var. *herbarum*, *F. oxysporum*, *F. oxysporum* var. *orthoceras*, *Cylindrocarpon magnusianum*, *C. destructans*, *C. tenue*, *C. didinum*, *Alternaria alternaria*, *Ulocladium atum*, *U. chartanum*, *Rhizoctonia solani*, *Pestalotiopsis quepinii*, *Phoma pomorum*, *P. herbarum*, *Microsphaeropsis olivacea*, *Torula herbarum*, *Cladosporium cladosporioides*, *C. herbarum*, *Aureobasidium* sp., and *Acremonium roseum*. They further indicated that *Lachnellula willkommii* occurs on trees of all ages in the Soviet Far East, especially in association with scars, and that root diseases are much more common in old stands than plantations in the Far East. Also at the Far Eastern Forestry Research Institute, the team was able to examine an extensive collection of decay fungus sporophores made by the institute's founder. The collection also confirmed the occurrence of many of the team's listed pathogens in the Soviet Far East.

Entomologists at the V.N. Sukachev Institute of Forestry and Wood in Krasnoyarsk reported finding associations between staining fungi and tree-attacking beetles in the Eastern U.S.S.R. As mentioned above, a *Ceratocystis*-like fungus was associated with *Monochamus* sp. in causing significant branch mortality of true firs. Entomologists also suggested that the risk of spread of the staining fungi associated with forest insects in the Soviet Far East might be great but was difficult to assess because of the current poor state of knowledge on the subject. Entomologists further suggested that there was a lack of pathology knowledge and research in the Eastern U.S.S.R. and that this was an area where more emphasis should be placed.

Foresters at virtually all locations visited believed that some diseases, especially wood decays, were important in causing losses in the Eastern Soviet Union. They reported losses in all tree species, with the greatest damage in spruce and true fir.

### Pests of Concern

During site visits to forest stands and observations of timber harvesting and transport in Siberia and the Soviet Far East, the team obtained considerable information about pests that potentially could be imported on logs from the Soviet Far East and Siberia. Field observations confirmed that the forest pests of concern identified during the pest risk assessment process were accurate.

## Forest Conditions

Although the team had the opportunity to visit many diverse forest stands, these represented only a small fraction of the vast forested area of Siberia and the Soviet Far East. The most spectacular pest-caused damage observed by the team during travels in Siberia and the Soviet Far East was the defoliation caused by the Asian gypsy moth (*Lymantria dispar*) between Khabarovsk and Nakhodka. Population levels of this moth were exceptionally high near the ports of Nakhodka and Vostochniy. Extensive mortality of Scots pine caused by an undetermined bark beetle was observed near Krasnoyarsk. As mentioned above, the team also visited larch stands infested with the Siberian silk moth and larch casebearer near Shira in Siberia.

The team visited mature forests and plantations in several areas, especially near Black Lake and Shira in Siberia. Mature stands were, in the team's opinion, being seriously affected by several pathogens. Root diseases caused by *Heterobasidion annosum* and *Armillaria* spp. were widespread. In the stands visited, *H. annosum* was causing substantial mortality in true firs. Examination of cut stumps showed that it also was causing significant amounts of butt and stem decay in true fir, spruce, pine, and larch. *Armillaria* sp. was observed killing true fir, spruce, and Scots pine. Cut stumps of true fir and spruce also showed substantial amounts of *Armillaria*-caused butt and stem decay. As reported in the literature and indicated by Dr. Aminev, both root disease organisms appeared to be acting differently in the Siberian stands than their counterparts in Western North America. Indicators (such as fruiting bodies) of heartrot decays were not common on tree trunks in examined stands, but some conks of *F. pinicola* and one of *F. officinalis* were observed. Stem and branch killing caused by a rust fungus (probably *Cronartium flaccidum*) was observed on Scots pine, and fir broom rust (caused by *Melampsorella* sp.) was very common on true fir. A branch flagging that might be caused by a *Cytospora* sp. was also common and widespread on true fir. Foliage pathogens were common but did not appear to be particularly damaging in the stands examined.

Plantations that the team visited appeared to be remarkably healthy. This may be in part the result of the emphasis on stump removal and machine planting in the areas examined. Such procedures could greatly reduce root pathogen inoculum. Dr. Aminev indicated that he had observed plantations in Siberia with considerable root-disease-caused damage. These may have been established in a different fashion. The team did not have an opportunity to examine either very young plantations or plantations over about 25 years of age. Foresters who met with the team reported that in the Eastern U.S.S.R., between 20 and 30 percent of areas harvested are replanted. Other areas are allowed to regenerate naturally (and are often regenerated first with hardwoods). Planning regarding regeneration of units is done in Moscow.

## Pests in Logs

The team had ample opportunities to examine logs at upper and lower landings, at mills, in log rafts, and on railroad cars. The most commonly encountered insects on logs were two bark beetles, *Ips subelongatus* and *Ips sexdentatus*, and two Cerambycids, *Monochamus urussovi* and *M. sutor*. These insects were active as adults and larvae under the bark of logs. These species are considered to be very aggressive in attacking recently yarded or cut timber and are extremely strong flyers, which enables them to infest yarded timber from distances in excess of several kilometers. All of these species were observed in the Krasnoyarsk region infesting principally larch, pine, and spruce logs at the upper landing and lower landing, as well as in stored logs at mills destined for processing. These same species were considered by the pest risk assessment to be among the most important potential pests associated with the bark or in the wood.

The team noted several points about tree diseases:

- (1) Many logs (about 10 percent of those examined) exhibited some amount of heartrot decay, which was frequently extensive.
- (2) The most commonly observed decay was red ring rot (caused by *Phellinus pini*), which was observed on all conifer species and was not associated with fruiting bodies, although punk knots were observed.

- (3) White rot decays caused by *Heterobasidion annosum* and *Armillaria* sp. were also common; the former in logs of true fir, spruce, pine, and larch, and the latter mainly on spruce and true fir logs. The team did not see fruiting bodies of these fungi on logs.
- (4) Brown cubical rot that could have been caused by any of several fungi (especially *Phaeolus schweinitzii*, *Fomitopsis officinalis*, and *F. pinicola*) was also encountered with some frequency. Fruiting bodies of *F. pinicola* were observed on decked logs (orientation of conks indicated that they had been formed after logs were decked).
- (5) Fruiting bodies of *Pholiota* sp. and *Pleurotus* sp. were observed on some decked logs.
- (6) Staining fungi were extremely common on pine logs and processed lumber as well; they were also seen on logs of true fir, spruce, and larch but were not as dramatic (probably because the fungi affecting these species cause brownish rather than blue stains); staining was associated with beetle infestation of logs.
- (7) Though there was considerable variation from place to place, many decked and transported logs had substantial amounts of soil adhering to them and many also had foliage still attached (this was especially true of larch logs—the common formation of very short epicormic shoots on Siberian larch makes removal of all foliage particularly difficult with this species); therefore, a special effort would have to be required to eliminate soil and foliage from logs to be exported to the United States.

### Timber Harvesting and Transport

The timber harvesting procedures utilized by the Soviets are limited by weather conditions. Harvesting during May through August is difficult in many areas because of wet soil conditions. Therefore, much of the harvesting and skidding to upper landings is done from November through April, when soils are frozen. In the case of logging operations some distance from transportation routes, the logs are skidded, with their crowns still attached, and yarded at upper landing areas that may be 500 to 1,000 meters from the cutting unit. Logs can remain at the upper landings all summer and may not be transported down to the lower landing until October or November. Where summer logging is feasible, logs can arrive at the lower landing as soon as several days following cutting. Typical operations will store logs at the lower landing for 2 to 4 months before further processing. Logs are delimbed, scaled, bucked, graded, and sorted at the lower landings.

In the case of operations close to rivers where log rafting is conducted, logs are yarded on the banks of the river and are floated once the ice on the river breaks up. During the winter, some of the timber may be transported on trucks driven down the frozen river for processing.

The Soviet logging and transportation system allows many logs to spend considerable time in decks in the woods, in trains or log rafts in transit, or in log piles at the mill. In many instances, logs will be in the vicinities of many other logs and often close to forests for long time periods. This allows previously uninfested logs to become attacked by insects or diseases during transport and storage. Pests that could infest these logs include bark beetles, borers, and associated staining fungi. Major shipping areas that the team visited in the Nakhodka area are located close to forested areas. Although the logs are sorted by quality before shipment, the team noticed that a great deal of cull material was shipped over long distances for chipping and fuel use. Unfortunately, much of this cull material was sent to areas very close (less than a mile) to the shipping centers. Thus, logs at the seaports still have a high exposure to insects and pathogens. Though the Soviets have their own plant health quarantine service, consultation with their representatives indicated that workload was very high, training level regarding forest pests was low, and emphasis was on keeping pests out of the U.S.S.R. rather than detecting pests on export material. Quality control varies greatly in the Eastern U.S.S.R. The team saw some excellent logs that had been very well handled, as well as logs that were in very poor condition, dirty, and with foliage still attached. No assumptions should be made about the general condition or cleanliness of logs from Siberia and the Far East.

## Conclusions

During the site visit to the U.S.S.R., the USDA team gathered information on the pests associated with logs by consulting with Soviet specialists and foresters as well as by actually visiting forests, landings, mills, and transportation and shipping facilities. Observations and consultations strongly supported the findings and conclusions of the pest risk assessment on the importation of logs from Siberia and the Soviet Far East. The team's findings during the site visit consistently indicated that importing untreated logs from the Eastern U.S.S.R. to the Western United States could indeed pose a substantial risk to the forests of North America because of the probability of introduction and establishment of new or different forest tree insects and pathogens.

