CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Cronartium ribicola J. C. Fisch. 1872

white pine blister rust

Current Pest Rating: B
Proposed Pest Rating: B

Kingdom: Fungi, Phylum: Basidiomycota,
Class: Pucciniomycotina, Subclass: Pucciniomycetes,
Order: Pucciniales, Family: Cronartiaceae

Comment Period: 01/04/2023 through 02/18/2023

Initiating Event:

This pathogen has not been through the current pest rating process. The risk to California from *Cronartium ribicola* is described herein and a permanent rating is proposed.

History & Status:

Background:

White pine blister rust (WPBR) is caused by fungus *Cronartium ribicola*, a pathogen of central-eastern Eurasian origin. It was introduced into the west coast of North America via Europe in the early 1900s on infected eastern white pine seedlings (Geils and Vogler, 2011; Hunt, 2009). The impacts on white pine forests have been so severe that blister rust ranks as one of the worst tree disease epidemics in modern history (Campbell and Antos, 2000). All nine of the five-needled white pines native to North America (Genus *Pinus*, Subgenus *Strobus*) are susceptible to this stem rust and are attacked at all ages, but to varying degrees (Hoff et al., 1980). There is white pine diversity is in California with six of the ten North American species distributed across the State's coastal and interior forests, from low elevation to subalpine ecosystems. All six species are host to *Cronartium ribicola*. The disease has been present in the state for around 80 years and continues to spread and intensify throughout the range of its hosts in the western United States and now poses a threat to five-needled pines in the Southwest and Mexico. Also, there is a compounding effect on tree mortality with WPBR and the mountain pine beetles (*Dendroctonus ponderosae*) (Dudney et al., 2020).

Cronartium ribicola is a macrocyclic rust requiring two different hosts to complete its life cycle. The aecial hosts are five-needled pines, and the telial hosts are *Ribes* spp. (currants and gooseberries: Grossulariaceae). Several species of *Pedicularis* and *Castilleja* (Orobanchaceae) are also hosts that can support telial production and subsequent infection of pine (Zambino, 2010).

Western white pine, also called silver pine and California mountain pine (*Pinus monticola*,) is native to mountain ranges of northwestern North America. This species is highly susceptible to WPBR with mortality rates of up to 90% (Fins et al., 2001). Sugar pine (*P. lambertiana*) and eastern white pine (*P. strobus*) are also very susceptible. This loss of the western white pine has resulted in a major shift in historic forest succession pathways. Western white pine has largely been replaced by Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*), which are also susceptible to a variety of pests (Samman et al., 2003).

Government-managed and publicly supported blister rust control programs existed for many years and focused on eradicating cultivated European black currant first, and then wild native *Ribes*. Eradication was easier and relatively more effective in eastern North America than in western regions because of differences in *Ribes* biology. More than $100M was spent in the 1900's attempting to control WPBR in the western United States, mainly through widescale *Ribes* eradication. *Ribes* eradication was carried out for nearly 40 years, but was discontinued in 1965, when it was determined that an acceptable level of control could not be achieved because it was impossible to remove all the plants, the roots left behind could resprout, and seed might lie dormant for many years before germinating and producing new plants (Benedict 1981).

Hosts: The main hosts are five-needle white pines and stone pines (*Pinus* spp., subgenus *Strobus*), and currants and gooseberries (*Ribes* spp.). There are close to 20 susceptible species of *Pinus* and over 40 susceptible *Ribes* species plus a few non-*Ribes*.

Aecial hosts: *Pinus albicaulis, P. aristata, P. armandii, P. ayacahuite, P. balfouriana, P. cembra, P. cembra* var. *sibirica, P. flexilis, P. flexilis* var. *reflexa, P. koraiensis, P. lambertiana, P. monticola, P. parviflora, P. peuce, P. pumila, P. sibirica, Pinus* sp., *P. strobiformis, P. strobus, P. sylvestris, P. taiwanensis,* and *P. wallichiana.*

Telial hosts: *Castilleja miniata Grossularia cynosbati, G. reclinata G. rotundifolia, Grossularia* sp., *Pedicularis apodochila, P. bracteosa, P. euphrasioides, P. japonica, P. oederi, P. racemosa P. resupinata P. resupinata* var. *ramosa P. schistostegia, P. spicata, P. yezoensis, Peridermium kurilense, P. strobi, Ribes acuminatum, R. alpinum, R. altissimum, R. ambiguum, R. americanum, R. atropurpureum, R. aureum, R. binominatum, R. bracteosum, R. cereum, R. coelesta, R. coloradense, R. cruentum, R. cynosbati, R. diacanthum, R. dikuscha* var. *appendiculata, R. divaricatum, R. divaricatum* var. *inerine, R. emodense, R. erythrocarpum, R. fasciculatum, R. fasciculatum* var. *chinense, R. floridum, R. formosanum, R. fragens, R. fuscescens, R. glaciale, R. glandulosum, R. griffithii, R. grossularia, R. himalensis, R. hirtellum, R. hispidulum, R. howellii, R. hudsonianum, R. inerme, R. integrifolium, R. irriguum, R. japonicum, R. klamathense, R. lacustre, R. latifolium, R. laxiflorum, R. lobbii, R. magellanicum, R. mandshuricum, R. marshallii, R. maximowiczianum, R. maximowiczii, R. meyeri, R. missouriense, R. moupinense, R. nevadense, R. nigrum, R. niveum, R. odoratum, R. orientale, R.*

oxyacanthoides, R. oxyacanthoides var. *hirtellum, R. palczewskii, R. pallidiflorum, R. pauciflorum, R. petraeum, R. pinetorum, R. procumbens, R. prostratum, R. roezlii, R. roezlii* var. *cruentum, R. rotundifolium, R. rubrum, R. sachalinense, R. sanguineum, R. sativum, R. setosum, R. sinanense, Ribes sp., R. spicatum, R. sylvestre, R. tenue, R. triste, R. triste* var. *albinervium, R. uva-crispa, R. velutinum, R. vilmorinii, R. viscosissimum, R. viscossissimum, R. vulgare, R. warszewiczii, R. watsonianum,* and *R. ×odoratum-sanguineum* (Farr and Rossman, 2022).

Symptoms: On pines, branches are 'flagged' with dead foliage, or tops will die back distal to swollen, rough-barked cankers on branches or stems. Affected branches and stems produce resin flow from orange-margined cankers. Young trees may be stunted, discolored and die. Younger cankers on branches are elongated, spindle-shaped or diamond-shaped on stems, and the cankers can have an orange margin. Cankers can be perennial. Conspicuous, orange aecia develop in spring from the cankers, followed by oozing pycnia. On *Ribes* or other alternate hosts, small orange-yellow spots appear on leaves in early summer, becoming erumpent pustules producing large numbers of urediniospores. In late summer, leaves show more-developed spots and necrotic areas and may be curled. Telial columns are visible in brownish spots on the lower *Ribes* leaf surface (CABI-CPC, 2022).

Transmission: The life cycle of white pine blister rust may take 3–6 years to complete. It begins in late summer or early autumn when basidiospores from the telial host (*Ribes*) are wind and rain dispersed, entering pine needles through their stomata. Basidiospores are carried in wind currents, and can move several kilometers, but dry out easily. In spring, 3–4 years after the initial infection, pale yellow or cream-colored blisters (aecia) rupture through the bark of active cankers. They release powdery, yellow spores (aeciospores) that are carried in the wind over very long distances to the alternate host and cause infection. Within a few weeks, pustules form on the alternate host leaf underside and release spores that repeatedly infect the same plant or other *Ribes* in the vicinity. This repeating stage serves to increase the levels of inoculum. In late summer, small, brown, hairlike structures appear on the under-side of the *Ribes* leaf. Eventually, basidiospores are produced and wind dispersed back to susceptible pines in the vicinity.

Long distance movement can occur with infected nursery stock of either host. Insects, slugs, and squirrels are attracted to pycnia produced by the pine stem cankers. The fluid they are suspended in contains many sugars, including high concentrations of glucitol and ribitol (Wicker et al., 1976). Insects may affect cross-transfer of genetic material, producing multi-genotype cankers (Hamelin, 1996).

Damage Potential: The impacts on white pine forests have been so severe that blister rust ranks as one of the worst tree disease epidemics in modern history (Campbell and Antos, 2000). The main impact is the death of young white pines, along with the girdling cankers on branches of older trees. Infection of *Ribes* causes early defoliation and a reduction in fruit yield (Zambino, 2010). Native mountain pine beetle (*Dendroctonus ponderosae*) may preferentially select trees weakened by blister rust infections often resulting in more rapid mortality than caused by blister rust alone (Shanahan et al., 2016). WPBR will likely continue to increase in higher elevations, threatening subalpine white pines in the southern Sierra Nevada (Dudney et al., 2020).

Worldwide Distribution: This disease is found in a circumpolar belt in the Northern Hemisphere wherever a pair of alternating hosts occur within spore dispersal range.
Americas: *Canada, United States of America* (Arizona, California, Colorado, Connecticut, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming). Asia: *Bhutan, China, India, Iran, Japan, Democratic People's Republic of Korea, Korea, Republic, Nepal, Pakistan, Taiwan*. Europe: *Austria, Belarus, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom* (EPO, 2022; CABI, 2022).

Official Control: *Cronartium ribicola* is on the USDA PCIT's Harmful Organisms list for China, Colombia, Ecuador, and Mexico. It is on the EPPO's A1 list for Uruguay, Comunidad Andina (CAN) and the Inter-African Phytosanitary Council (IAPSC), and a quarantine pest in the United States. *Ribes* spp. are regulated by USDA. All propagules except seeds from all countries except Canada are not authorized pending pest risk analysis (NAPPRA). Foreign currant and gooseberry plants cannot enter the United States unless they are first tested for viruses and other disease agents by protocols determined by the USDA APHIS at the National clonal germplasm repository in Corvallis, Oregon. The following states have some form of restrictions or prohibitions against domestic movement of *Ribes* spp.: Maine, Massachusetts, Michigan, New Hampshire, New Jersey, Ohio, Rhode Island, and Virginia (National Plant Board, 2023, https://www.nationalplantboard.org/state-law--regulation-summaries.html). Phytosanitary certification is required for shipments between Canada and the United States of *Ribes* plants and foliage or seedlings of susceptible pines.

California Distribution: Most official detections have been made from *Ribes* spp. in nurseries in the following counties: Alpine, Contra Costa, San Bernardino, San Luis Obispo, Santa Barbara, Santa Clara, Santa Cruz, and Tehama. WPBR is found infecting five needle pines in the North Coast and Klamath regions, the northern Sierra Nevada, and in the mid and higher elevation forests of Yosemite, Sequoia, and Kings Canyon National Parks.

California Interceptions: none

The risk *Cronartium ribicola* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**
   Temperature and moisture are both important to rust spread. Inoculation of *Pinus* species by basidiospores generally requires cool temperatures (9-15°C). Moist air is critical, but droplets on leaf surfaces can cause spore clumping and bursting (Hansen and Patton, 1977).

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: **2**
- Low (1) Not likely to establish in California; or likely to establish in very limited areas.
- Medium (2) may be able to establish in a larger but limited part of California.
- High (3) likely to establish a widespread distribution in California.

2) Known Pest Host Range: The host list includes many species of *Pinus* and *Ribes*.

Evaluate the host range of the pest.

Score: 2
- Low (1) has a very limited host range.
- Medium (2) has a moderate host range.
- High (3) has a wide host range.

3) Pest Reproductive Potential: This pathogen has multiple aerial spore stages, some that can travel long distances.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 3
- Low (1) does not have high reproductive or dispersal potential.
- Medium (2) has either high reproductive or dispersal potential.
- High (3) has both high reproduction and dispersal potential.

4) Economic Impact: This disease has damaged or killed millions of pine trees. It is a quarantine pest in the United States and many other countries. Pines and *Ribes* need to be separated to prevent large epidemics.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, D
A. The pest could lower crop yield.
B. The pest could lower crop value (includes increasing crop production costs).
C. The pest could trigger the loss of markets (includes quarantines).
D. The pest could negatively change normal cultural practices.
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: 3
- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- High (3) causes 3 or more of these impacts.

5) **Environmental Impact:** As the white pines of the western states are killed, the associated ecosystems also decline, altering the forest landscapes. There are nine white pine species native to the United States that are at risk, and these include some of the oldest, and ecologically or culturally significant pine species. *Cronartium ribicola* threatens the stability and survival of white pine ecosystems in 40 states. Dramatic declines caused by WPBR and other agents have resulted in the listing of whitebark pine (*Pinus albicaulis*) as an IUCN endangered species, and as a candidate species for protection under the Endangered Species Act in the United States (U.S. Fish and Wildlife Service 2011).

Evaluate the environmental impact of the pest to California using the criteria below

Environmental Impact: A, B, C, D, E

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 3
- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Cronarium ribicola:* High

Add up the total score and include it here. 13
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Evaluation is 'high'.

Score: -3
-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).

-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 10***

Uncertainty:

There are other rust pathogens with potentially overlapping host ranges so identification of telial hosts between *C. ribicola* and others including *C. occidentale* and *C. quercuum* should be made by expert diagnosticians. On pines, the fungal pathogens *Atropellis pinicola* and *A. piniphila* can cause cankers on branches which could be confused with WPBR.

Conclusion and Rating Justification:

WPBR is the subject of federal and state quarantines. Continued regulation of both hosts in nurseries may reduce the spread of WPBR to new areas and reduce the movement of novel genotypes into areas where the disease already occurs. Based on the evidence provided above the proposed rating for *Cronartium ribicola* is B.

References:

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Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 1220 N St Rm 221, Sacramento, CA 95814 Phone: (916) 654-1017, permits[@]cdfa.ca.gov.

***Comment Period: 01/04/2023 through 02/18/2023**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: B