Field Release of a Rust Fungus, *Puccinia jaceae* var. *solstitialis* (Uredinales), For Biological Control of Yellow Starthistle, *Centaurea solstitialis* (Asteraceae)

DRAFT

Environmental Assessment

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Proposed Action: The California Department of Food and Agriculture proposes to release the non-indigenous rust fungus, *Puccinia jaceae* var. *solstitialis*, for biological control of yellow starthistle, *Centaurea solstitialis* (Asteraceae), under permit from the USDA, Animal and Plant Health Inspection Service.

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1.0 Purpose and Need for the Proposed Action

The California Department of Food and Agriculture (CDFA) proposes release of the non-indigenous rust fungus, *Puccinia jaceae* var. *solstitialis*, for biological control of yellow starthistle (YST), *Centaurea solstitialis* L. (Asteraceae), under permit from the USDA, Animal and Plant Health Inspection Service (APHIS). YST is an exotic weed that has become one of California's worst pests. Since its introduction near San Francisco prior to 1860, it has spread steadily throughout California and other western states (Maddox 1981). It infests rangelands, orchards, vineyards, pastures, parks, and natural areas. From 1958 to 1985 its range in California expanded at a roughly exponential rate, increasing from 1.2 to 7.9 million acres (Maddox and Mayfield 1985). This is an estimated increase of over 650% in 27 years. A survey in 1997 by the California Department of Food and Agriculture found YST occurring in 42% of the legal townships within the state (Pitcairn et al. 1998). Uncontrolled, YST invades and eventually dominates the local plant community, becoming the single most-abundant plant in the community. It is favored by soil disturbance, but is clearly capable of invading areas that have not been disturbed by humans or livestock for years, and has invaded a number of relatively pristine nature preserves (J. Randall, Exotic Weed Coordinator, The Nature Conservancy, unpublished report; J. Sigg, Chair of the Exotic Weeds Committee, California Native Plant Society, personal communication).

The cost of YST to public and private landowners includes: 1) Reduction in rangeland productivity. Cattle and sheep avoid the spiny flower heads. As the YST infests new areas, productivity is reduced and more land is needed to feed the same number of animals. Public and private landowners have incurred increasing control costs simply to maintain productivity in rangelands. 2) Toxicity to horses. Ingestion of YST causes brain lesions that, eventually, can kill the animal. It is not toxic to cattle or sheep (Corby 1978). 3) Fire hazard. High-density stands become a fire hazard along roadsides and irrigation canals and have resulted in higher vegetation management costs for irrigation districts and county, state and federal highway departments. 4) Reduction in visits to infested state and federal recreational areas. Hikers are unwilling to venture into areas infested with YST, because of its spiny flowers. 5) Need for constant monitoring. YST can invade pristine areas and eventually dominate the native plant community. This threat requires constant vigilance and local eradication efforts of newly discovered infestations. This has increased costs of the vegetation management in wildlife areas and nature preserves.

Several control methods are being developed to control YST in California. These include mowing (Vassieres 1993; Benefield et al. 1999), timed grazing by sheep, goats, and cattle (Thomsen, et al. 1993), competitive planting of grasses and clovers to prevent seedling recruitment (Thomas 1996, 1997; Nader and Conner 1997), large-acre prescribed burns (Hastings and DiTomaso 1996; DiTomaso et al. 1999a), and pre- and post-emergent herbicides (Lanini et al. 1994; DiTomaso 1997; DiTomaso et al. 1999b). Each of these approaches has its own cost, but because of the seed bank, each must be applied for several years before a significant reduction in plant abundance is observed. Development of biological control is expected to provide significant reductions in control costs and possibly provide a permanent reduction in plant abundance and impact.

Biological control of YST is being pursued currently in a cooperative effort by The United States Department of Agriculture (USDA) and the CDFA. To date, five exotic insect bioagents have become established and three have become widespread: *Bangasternus orientalis* (Capiomont) (Coleoptera: Curculionidae), *Urophora sirunaseva* (Hering) (Diptera: Tephritidae), and *Eustenopus villosus* (Boheman) (Coleoptera: Curculionidae) (Balciunas and Villegas 1999). All five insects attack the seedheads of YST. However, because of the large number of seeds produced by this weed, seed destruction by these insects alone is insufficient and is not likely to suppress YST (Pitcairn et al. 2000). The other approaches to YST control are very expensive and may damage the environment.

The fungus, *P. jaceae* var. *solstitialis*, is a good candidate for use in biological control of YST. It is an obligate parasite of YST and was obtained from its native habitat in Eurasia. It causes non-systemic foliar infections that can reduce fresh and dry weights of inoculated YST in controlled studies (Shishkoff and Bruckart 1993). An exhaustive examination of host specificity among closely related plants was performed and no other plant is likely will to serve as host for this rust. A few non-target species developed symptoms but none was damaged by the infections and the fungus could not be maintained even artificially on any of them (Bruckart 1989; Shishkoff and Bruckart 1993). None of the symptomatic plants was listed Federally as Threatened & Endangered (T&E). Use of *P. jaceae* var. *solstitialis* is expected to complement insect biological control agents that already attack seedheads, and thus, ultimately, cause long-term reduction (and control) of YST populations.

1.1 APHIS must decide:

- **1.1.1** To deny the permit application (no action)
- **1.1.2** To Issue the permit as submitted
- **1.1.3** To issue the permit with management constraints or mitigation measures.

1.2 Issues arising from the field release of *P. jaceae* var. *solstitialis* are:

- **1.2.1** Will *P. jaceae* var. *solstitialis* attack non-target plants within and outside of the area infested with YST? The pathogen has never been reported on plants other than its original host and is not likely to attack and damage plants other than YST. Extensive tests of several commercially important plants, including safflower, have been performed in laboratory and greenhouse settings. The data document the lack or limited infection of other plant species. A field test in Greece on the susceptibility of safflower substantiated findings from these greenhouse studies.
- **1.2.2** Will *P. jaceae* var. *solstitialis* affect a Federally listed threatened or endangered species or other species of special concern? No detrimental effect toT&E plant species is expected, based on data from extensive tests with many natives, including all the Federally listed *Cirsium* thistles from the United States. These plants were not susceptible, even under optimal greenhouse and laboratory test conditions.
- **1.2.3** What are the ecological consequences resulting from the reduction of YST populations? Some seed-feeding birds and small mammals (mice and voles) feed on YST seed. One bird species, Laurence's gold finch, is a species of special concern as its numbers have declined over the last few decades due to habitat destruction. While this species may feed on YST and another related noxious weed, *Centaurea melitensis* L., populations are limited by lack of nesting habitat and not food quantity. Thus, no negative impact is expect for this species. Dense stands of YST provide protection for mice and voles from avian raptors and high rodent populations can occur under these stands. However, dense stands also shade out recruitment for next year's YST plants so the occurrence of dense stands do not reoccur at the same location. Reduction of YST may result in a lack of rodent concentrations due to the absence of dense stands. Commercial beekeepers value YST as it flowers

profusely during June through September when many other plants have ceased flowering. While reduction of YST is the goal, it will not be eradicated and will likely remain a common plant throughout California's Central Valley. Those plants remaining should be adequate to support the demands of commercial bees. Native bees do not rely on YST flowers to sustain populations as their tongues are too short to effectively harvest nectar from this plant (G. Frankie, UC Berkeley, pers. comm.).

1.3 The pending application for release of this biological control agent into the environment (PPQ 526 No. 47497, dated 5/30/00) was submitted by the CDFA in accordance with APHIS' regulations in 7CFR part 330 regarding the movement of plant pests (while the host range of *P. jaceae* var. *solstitialis* has been shown to be limited to YST, it causes foliar infections in a plant, which means this fungus is within the scope of part 330's definition of plant pest and is thus subject to the permitting and other requirements of those regulations) and the provisions of the Plant Protection Act of 2000 (7 USC 7701 *et seq.*). This environmental assessment (EA) was prepared by APHIS in compliance with the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) as prescribed in implementing regulations adopted by the Council on Environmental Quality (40 CFR 1500-1509), by USDA (7 CFR 1b), and by APHIS (7 CFR 372).

2.0 Alternatives Including the Proposed Action

2.1 This chapter will explain the alternatives available for control of YST, including no action, and summarize the potential environmental consequences of the alternatives.

2.2 Description of the alternatives.

2.2.1 Alternative 1 - No Action: Under this alternative, APHIS would not issue a permit to CDFA for the field release of *P. jaceae* var. *solstitialis* to control YST in California. Release of this biological control agent would not take place.

2.2.2 Alternative 2 - Issue the Permit (preferred Alternative): Under this alternative, APHIS would issue a permit to CDFA for the field release of *P. jaceae* var. *solstitialis* for the control of YST in California. This permit would contain no special provisions or requirements concerning release procedures, post-release monitoring, or mitigating measures.

2.2.3 Alternative 3 - Issue the Permit with Specific Management Constraints and Mitigating Measures: Under this alternative, APHIS would issue the permit to CDFA for the field release of *P. jaceae* var. *solstitialis* for the control of YST in California. However, the permit would contain special provisions or requirements concerning release procedures, post release monitoring, or mitigating measures.

2.3 The following alternatives were considered but are not being evaluated except as consequences of the "No Action" alternative. The following alternatives are not alternatives for decisions to be made by APHIS, but are presently being used to control YST by public and private concerns in California.

2.3.1 Chemical Control: The use of herbicides, especially Clopyralid, can be very effecting in controlling YST and is currently the method of choice by land managers. However, the cost is high ($15-30/acre) and the treatments are only partially selective. Clopyralid will not harm grasses but will damage legumes and other Dicotyledons. The objective for any control effort against YST is to stop seed production. YST has a short-live seed bank and once seed input has stopped, less than 5% of the seed bank will remain after three years as most seed are highly germinable and will quickly leave the system. Any control method, whether chemical, burning, or mowing, must be applied for at least three years to result in a significant reduction of YST populations. For a statewide control effort, two scenarios were developed to clarify the estimated cost of a chemical control and reseeding program (Klonsky 1999). Cost ranged from $683 million to $2.4 billion for the use of Clopyralid at two levels of intensity over a 12-year period, estimated to be the minimum time for the program to work. Such programs are expected to bring YST infestations to manageable levels, but will not eradicate the plant. This means that additional effort will be needed to maintain YST at acceptable levels. Therefore some maintenance program will be needed for as long as YST remains a pest.

2.3.2 Mechanical Control: Mowing is a moderately effective control method when timed appropriately and repeated several times during a season and over several years. This method is limited to flat, somewhat smooth ground. The repeated expense and physical limitations of this method restrict its use to limited areas. Hand pulling individual plants before flowering is effective also, particularly in small populations. This requires frequent survey and removal campaigns throughout a season, and without volunteer crews, this option is very expensive and not feasible over large areas.Cultural Control: Prescribed burning has produced mixed results. When timed properly (June, @ 2% flower) burning can prevent flowering of extant plants. YST populations just beginning to flower are still green and will not carry a fire, thus, the dry annual grasses in the community are needed to carry the fire. If a poor grass cover is available, then control is spotty or absent. Burning has little impact on the seed bank and seedling recruitment the following year can be high. Thus, repeated annual burns (3 years minimum, see above) are required to significantly reduce populations. Other problems with burning include air pollution from smoke, elimination of desirable non-target plants, and the short-term nature of control (YST rebounds a few years after the burn), and the potential for soil erosion. Burning may improve biodiversity among the natives without fully controlling YST. Burning a grassland requires a large number of trained personnel to keep the fire contained, making this option expensive over large areas. In 1999, a YST control burn by USDI-BLM got out of control and burned several thousand acres and destroyed several homes near Weaverville, CA. Burning options are also highly regulated due to air pollution concerns

2.3.3 Livestock grazing, particularly with sheep, goats, and cattle, can be effective under highly controlled conditions. This requires critical timing, management, and efforts must be repeated for several years. Impacts of grazing are similar to mowing: it can suppress YST growth, but will not eliminate the plant. Grazing also is not selective, and affects both desirable and non-desirable species.

Biological Control with Insects: Five exotic seedhead feeding insects are established on YST. Despite considerable pressure on seed production by the insects, YST populations have not been effectively controlled to date. The most effective biological control agent is the weevil, *Eustenopus villosus*. This insect has one generation per year and is active from June through August. In California, YST plants flower from June through October and can outgrow the earlier damage caused by the weevil. In those areas where YST has a shorter growing season (e.g. Idaho), seed destruction by the weevil may lead to significant reductions to plant populations.

2.3.4 Summary of Consequences

Consequences	No Action	Issue Permit	Issue Permit with Conditions
Effects on Non-Target Organisms	Non-selective herbicides, mowing and prescribed burning, may cause indiscriminant harm to non-target and native plants. Detrimental effects on ground cover may raise the potential for erosion. Such approaches may increase pollution of soil, water, and air.	None Expected	None Expected
Effects on Threatened and Endangered Species	Raises the potential for exposure of T&E spp. to effects of herbicides and burning as well as increasing the potential for disturbance of critical sites to mechanical controls. T&E species also subject to displacement by encroachment of YST.	None Expected	None Expected

3.0 Affected Environment

3.1 YST infests very large areas of several states in the Western U.S. Habitats vary considerably from dry rangeland agriculture to high mountains (under 7,000 feet elevation). It is less commonly encountered in desert, high mountain, or moist coastal sites. Several crop plants and native relatives occur in this range of habitats. Each is likely to be exposed to *P. jaceae* var. *solstitialis* following release. This area also contains several major waterways, numerous lakes, and ocean shores. Human populations range from large cities to very rural settings. Non-target species outside the distribution of YST are likely to be exposed to airborne inoculum from *P. jaceae* var. *solstitialis*.

3.1.1 The risk assessment of *P. jaceae* var. *solstitialis*, conducted under optimal environmental conditions for infection, included inoculation of plants from 65 species in 10 plant families. Of these, a few species in only four genera (*Amberboa, Carthamus, Centaurea* and *Cirsium*) developed symptoms after inoculation. Each of the species is a member of the tribe Cardueae within the Asteraceae. Most are not native, including *Amberboa moschata* and nearly all the *Centaurea* species. Limited infections occurred on two native

Cirsium species, but this could not be repeated in subsequent inoculations. Also, *P. jaceae* var. *solstitialis* could not be maintained on these species in the greenhouse under optimal conditions for infection. Extensive studies were made on safflower, and it was determined that modern cultivars were very resistant and *P. jaceae* var. *solstitialis* could not be grown on them, even in the greenhouse.

3.1.2 There are several Federally listed Threatened and Endangered (T&E) species (plants, animals, etc.) in and around areas where the agent will be released. This is because both the YST infestation is so large and *P. jaceae* var. *solstitialis* is not likely to be contained following release. Exposure to these species will occur in the same way that these species are exposed to many other rust fungi already present in North America.

Although exposure is probable as a result of this action, none of these species is likely to be adversely affected under natural conditions. The pathogen clearly affects only plants. Within the plant kingdom, it can cause symptoms only on a few species, all in four genera, and infection requires optimal greenhouse conditions. Control of YST without the use of herbicides or other approaches is likely to be beneficial to survival of T&E species.

3.1.3 Minority and low-income human populations are likely to be exposed to *P. jaceae* var. *solstitialis*, but they should not be affected. Like other rust fungi common in North America, *P. jaceae* var. *solstitialis* does not adversely affect humans or animals that come into contact with it. This includes children. Potential control of YST without the use of herbicides or other strategies is likely to be beneficial to human populations.

4.0 Environmental Consequences

4.1 This chapter will analyze the potential environmental consequences of each alternative on the resources described in Chapter 3.

4.2 Effects of Alternative 1 - No Action

4.2.1 Effects on Non-Target Organisms: A no action course will leave the current control strategies in place. However, the current options for control of YST are inadequate; YST continues to spread despite attempts to control it. Natural areas will continue to be affected as expanding YST populations invade and overwhelm native plant communities. Forage quality will continue to decline for both wildlife and agricultural species. Humans, animals and plant species will continue to be exposed to herbicides. Options available for chemical control of YST are only partially selective and their use is, therefore, likely to affect beneficial species as well as YST. Burning and mowing also are not selective. All options require repeated annual treatments for at least 3 years. Even if YST were being effectively managed by one of these strategies, treatment of YST stands would be required indefinitely (for as long as YST remains a pest). No Action (*i.e.*, ineffective measures) also means that non-target organisms are more likely to be displaced by YST over time. The only way that YST can be brought under control using currently available options is through a projected, intense program of chemical treatments and reseeding that will require an estimated

12 years to complete. It is difficult to predict the direct, indirect, and cumulative effects of such an intense program for the extended period projected for success. Intensity and extent of these treatments over a very long period of time only will serve to exacerbate any negative effects on non-target organisms. There are likely some indirect effects from use of chemicals or other approaches, such as pollution of air, soil, or water, which may affect plants, animals, and other organisms even somewhat removed from treated areas. These non-target effects from other strategies are likely to be subtle, and prediction of the ultimate extent of these effects is not really possible.

4.2.2 Because current control measures are not stopping the spread of YST, there is increasing likelihood that YST may further the predicament for endangered or threatened species. This would happen if YST occupies or moves into one of these habitats. Chemical or mechanical approaches would likely have the same direct, indirect, and cumulative effects on T&E species as they would on other non-target species.

4.3 Effects of Alternative 2 - Issue Permit

4.3.1 Effects on Non-Target Organisms: No detrimental effects are expected. The potential hazards identified for the pathogen, *P. jaceae* var. *solstitialis*, included certain species of *Centaurea, Cirsium, Carthamus*, and *Amberboa*. However, any potential risk to these species by *P. jaceae* var. *solstitialis* was determined to be extremely low or non-existent. The fungus could not be maintained on any of these species except *Centaurea solstitialis* (YST) and *Centaurea cyanus*, the latter being an introduced weed. Only safflower, among the closely related plants of commercial value, could be infected, but there was never enough inoculum produced on modern safflower cultivars to start a new cycle of infections on safflower in the greenhouse. Furthermore, preliminary (first year) data from a field study in Greece suggest that safflower planted in stands of YST does not develop any rust infections. Indirect effects on non-target species are related to the potential for control of YST. Control of YST expected following release of *P. jaceae* var. *solstitialis* is likely to improve growth and survival of non-target organisms. Control, even if only partial, will release water and nutrients, and it will improve light and space for growth of non-target species. Such benefit would be cumulative, and long lasting. Since any plant reduction will be slow, landowners will have the opportunity to ensure establishment of desirable plants by seeding or other strategies.

4.3.2 Effects on Threatened and Endangered Species: No detrimental effects are expected. All six listed *Cirsium* species (*C. fontinale fontinale*, *C. f obispoense*, *C. hydrophyllum hydrophyllum*, *C. loncholepis*, *C. pitcheri*, and *C. vinaceum*) were included in the risk assessment of *P. jaceae* var. *solstitialis*. No infections were noted on any of these plants. Successful control of YST using *P. jaceae* var. *solstitialis* would include reduced threat to these species from YST spreading into these habitats. Also, there would be a reduction in the use of non-specific approaches to YST, and such would reduce the potential for damage to these listed species. YST is poorly utilized as a food source by T&E animal species so they are not likely to be affected by its control

4.4 Effects of Alternative 3 - Issue the Permit with Specific Management Constraints and Mitigating Measures

4.4.1 Effects on Non-Target Organisms: No specific management constraints or mitigating measures are recommended for the release of *P. jaceae* var. *solstitialis*, because any constraint or mitigation attempted is not likely to be successful. Once *P. jaceae* var. *solstitialis* is released and established, it will be very difficult to control or manage. It is very likely to spread unassisted through YST populations by airborne spores. Furthermore, information regarding risk suggests that mitigation and management constraints are not necessary. Under this alternative, impacts on non-target organisms would be identical to those described in 4.3.1.

Plans are to monitor release sites for the rust on non-target species as standard protocol for post-release assessments. Also, capability has been developed to assess whether suspected non-target infections are caused by *P. jaceae* (including var. *solstitialis*). These are based on the use of molecular approaches to pathogen identification.

4.4.2 Effects on Threatened and Endangered Species: No specific management constraints or mitigating measures are recommended for the release of *P. jaceae* var. *solstitialis*, because the options of constraint or mitigation are not likely to be successfully applied for the same reasons as given in 4.4.1. Therefore, under this alternative, impacts on non-target organisms would be identical to those described in 4.3.2.

4.5 No disproportionate effects are expected to impact low income or minority populations or pose undue risks to children.

4.6 An unavoidable effect of the proposed action would be unsuccessful or partial control of the target pest (YST). The pathogen is very likely to become established, but constraints associated with environment or the host may prevent *P. jaceae* var. *solstitialis* from causing damage sufficient to reduce populations of YST as much as desired. It is likely that it will take several years to reach a manageable density of YST, considering the size of the infestations, seed bank, and the subtle nature of the infections on YST. Success may only be partial, if the range of the YST infestation has areas that are not conducive to damaging levels of disease, of if the YST populations in North America vary in susceptibility to the pathogen, for example. In such cases, *P. jaceae* var. *solstitialis* and other agents might be successfully controlled with lower levels of chemical herbicide or other strategies to achieve the desired control.

4.7 Release of *P. jaceae* var. *solstitialis* is very likely to be an irreversible action. This is the intention of this action. Once *P. jaceae* var. *solstitialis* is released into the environment, it is likely to become established. One scenario is that it could (but is highly unlikely to) move from YST to non-target plants and itself become a pest. Such a shift in host will not easily be reversed. Biological control agents, such as *P. jaceae* var. *solstitialis*, generally spread, even without the agency of man. In principle, therefore, release of this fungus, even at only one site, must be considered equivalent to release over the entire area occupied and potentially occupied by the target and other host plants where climate and other factors are suitable for disease development and survival.

5.0 Agencies and Persons Consulted

5.1 Preparers:

5.1.1 William L. Bruckart, III; USDA-ARS-FDWSRU, 1301 Ditto Ave., Ft. Detrick, Maryland 21702; Phone: 301/619-2846.

5.1.2 Dale Woods; California Department of Food & Agriculture, 5288 Meadowview Rd., Sacramento, California 95832; Phone: 916/262-2048.

5.1.3 Mike Pitcairn; California Department of Food & Agriculture, 5288 Meadowview Rd., Sacramento, California 95832; Phone: 916/262-2048.

5.2 Reviewers:

5.2.1 Douglas R. Luster; USDA-ARS-FDWSRU. 1301 Ditto Ave., Ft. Detrick, MD 21702.

5.2.2 Dana K. Berner, USDA-ARS-FDWSRU. 1301 Ditto Ave., Ft. Detrick, MD 21702.

5.3 Persons Consulted

5.3.1 David Supkoff; Plant Pathologist and Program Supervisor, Pesticide Registration Branch, Department of Pesticide Regulation, California Environmental Protection Agency, 1001 I Street, Sacramento, CA 95814. Phone: 916/324-4185.

5.3.2 Conrad Krass, Primary State Plant Pathologist, CA Department of Food and Agriculture, 1220 N Street, Room A-316, Sacramento, CA 95814.

5.3.3 Barbara Hass, Office of Permits and Regulations, CA Department of Food and Agriculture, 1220 N Street, Room A-305, Sacramento, CA 95814.

5.3.4 Safflower Growers, two meetings with round-table discussions about the feasibility and safety of this proposed action on the safflower industry. Each was attended by approximately 20 individuals, including safflower growers, and representatives of CDFA. Contact: Dan Cohn, Consultant: Phone: 530/756-2508.

5.3.5 Seminars at CDFA, two occasions that included meetings with regulators within the state of California. Each seminar was attended by approximately 50 people.

5.3.6 Elaine Snyder-Conn, US Fish and Wildlife Service (F&WS), 4401 North Fairfax Dr., Rm 420, Arlington, VA 22203. Phone: 703/358-1735.

5.3.7 Technical Advisory Group for Biological Control Agents of Weeds: Al Cofrancesco, Chair, U.S.Army Corps of Engineers, Waterways Experiment Station, ATTN: WESER-A, 3909 Halls Ferry Rd, Vicksburg, MS 39180-0631. Phone: 601/634-3182. Note: Presentation was made to the TAG Annual Meeting at Longbeach, Washington, September 19, 2000, about issues raised by the F&WS and others concerning the proposal.

5.3.8 Don Koehler, Plant Pathologist, Pesticide Evaluation Branch, Department of Pesticide Regulation, California Environmental Protection Agency, 1001 I Street, Sacramento, CA 95814. Phone: 916/324-3950.

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