WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
(Updated June 2008)

Scientific Name: *Chondrilla juncea* L.

Common Name: rush skeletonweed, gum succory, nakedweed

Family: Asteraceae (Compositae)

Legal Status: Class B:

(a) regions 1 and 3
(b) region 2 except Kitsap County
(c) region 4, except all areas of Stevens County south of Township 29
(d) Kittitas and Yakima counties of region 5, and Adams County, except those areas lying east of Sage Road, the western border of Range 36
(e) Asotin County of region 6

Description and Variation:

Overall Habit:
Rush skeletonweed belongs to the chicory tribe of the sunflower family. This herbaceous perennial ranges from 1 to 4 feet tall, with a long taproot. Rush skeletonweed overwinters as a basal rosette. The mature plant consists of a nearly leafless flowering stem with many aerial branches. The stem and aerial branches support few leaves. The basal rosette is absent at this stage.

There are hundreds of biotypes of rush skeletonweed (Martin 1996) and they are sometimes differentiated by leaf morphology, height, branching patterns or flowering times. Three biotypes are known to exist in the Pacific Northwest (Boerboom 1993; Prather 1993). The tall, late flowering Spokane, WA biotype can reach 50 inches tall, is sparsely branched and it flowers in August. The short, early flowering Post Falls, ID biotype ranges from 25 to 35 inches tall, with extensive branching, and it flowers in mid-July. The short, early flowering Banks, ID biotype is very similar in appearance and flowering times, but this type is susceptible to *Puccinia* rust, a biological control agent (Boerboom 1993). Biotype forms in southern Australia are differentiated by leaf shape - narrowleaf, intermediate-leaf and broadleaf (Heap 1993; Cullen and Groves 1977 *in* Chaboudez 1994; Hull and Groves 1973 *in* Chaboudez 1994). A recumbent form is known from Greece (Martin 1996).

Roots/Rhizomes: Mature plants have a taproot that reaches down 7 feet, or more. Seedlings have long, thin taproots. The roots exude a white latex sap when cut.

Stem: The mature plant consists of a dark green, nearly leafless flowering stem, 1 to 4 feet tall, with many aerial branches. A distinguishing characteristic of rush skeletonweed is the presence of coarse, downward pointing brown hairs near the base of the stem. The stems exude a white latex sap when cut.

Leaves: Rosette leaves are hairless, basal leaves that are 2 to 5 inches long and ½ to 2 inches wide and broader at the tip. The lateral lobes point back toward the base - very similar to a dandelion. They also exude latex if the surface is cut (Schirman and Robocker 1967). Mature leaves are narrow and linear and mostly entire.

Flowers: The flower heads, about ½" in diameter, grow along the stem in the leaf axil or at the branch tips, and they are found individually or in clusters of 2 to 5. Each flower head has 7-15 (usually 11) ray flowers, with yellow ligules resembling petals. These yellow ligules are strap shaped with small teeth across the blunt end.

Fruits and Seeds: The immature seeds are greenish-white, and they gradually darken to a yellow-brown or olive-green in the 13-15 days it takes to mature. Seed color can be used as an indication of maturity, with light colored seeds showing low germination rates (Old 1981). Each seed has a pappus, which is capable of carrying seeds along wind currents up to 20 miles (Cuthbertson 1967 *in* McLellan 1991; Schirman and Robocker 1967 *in* McLellan 1991).

Habitat: Rush skeletonweed prefers well-drained soils in climates with cool winters and summers that are hot and dry, though without extended drought (CDFA 2004 in NatureServe). In the Pacific Northwest, it prefers two soils types: the sandy to gravely and well drained soils typical in the glacial lobe soils of Spokane, and the shallow soils over bedrock, typical in the channeled scablands. Roadside populations of rush skeletonweed are established when the seed is moved along transportation routes. Plant fragments can develop in areas not conducive to seedling establishment, with contaminated cultivation machinery responsible for the majority of this type of spread (Old 1981). Openings made by animals, such as badgers, can also create suitable habitat for rush skeletonweed establishment (L. Kinter, Personal observation 2005 *in* Kinter et al. 2007). This plant does not typically invade native communities (APRS 2001 in NatureServe 2008).

Precipitation can range from 10 to 40 inches per year. Winter temperatures range from areas with little to no frost, to areas with temperatures below -4 degrees F (Martin 1996).

Geographic Distribution: Worldwide, rush skeletonweed has spread to Australia, Argentina, Italy, Lebanon, New Zealand, Portugal, Spain, the United States and the former Yugoslavia (Parsons and Cuthbertson 1992 *in* Sheley).

Rush skeletonweed was introduced to Australia prior to 1910 as a contaminant from European grapevine stock, and as a contaminant in fodder from the United States in 1914 (McLellan 1991). Rush skeletonweed was identified in 1918 in Australia, centered near New South Whales. It has since spread throughout the Australian wheat belt.

Northern U.S. populations of rush skeletonweed are spreading into Western Canada and occupying grazing lands (Ceska 1997).

Native Distribution: Rush skeletonweed is native to Eurasia, where it is found in central Asia, from southern Russia to North Africa. It is also found in the Mediterranean Basin of Europe, from

France and Portugal to Turkey and Iran (Emge 1977). The Balkans are considered near the center of distribution (Old 1981).

Distribution in North America: Rush skeletonweed was identified in the northeastern seaboard of the United States, in Maryland, New York and West Virginia, during the 1870's. It was discovered in Idaho and Oregon in the 1960's (Sheley; McLellan 1991), and in California in 1965 (McLellan 1991). Oregon traced the majority of their rush skeletonweed infestations to an 80-acre gravel pit (Old 1981). It currently has some level of noxious weed classification in Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, South Dakota, Washington (PLANTS 2008) and British Columbia, Canada (Kinter et al. 2007). It infests several million acres in Idaho, California and the Pacific Northwest (Callihan and Miller 1999 *in* NatureServe 2008), although it is uncommon in California (CDFA 2004 *in* NatureServe 2008). It is present, but not listed, in 10 states in the Midwest and northeastern seaboard, as well as Ontario, Canada (PLANTS 2008).

History and Distribution in Washington: Rush skeletonweed was first identified in the Pacific Northwest from Spokane County, WA in 1938. In 1960, visiting Australian scientists interested in wheat production noticed weedy populations in wastelands of Eastern Washington. They relayed the impacts that rush skeletonweed has had on their homelands (Old 1981).

Biology:

Growth and Development: The fall rains induce both seed germination and vegetative growth from rootstock, each producing an overwintering rosette of basal leaves. Taproots tend to produce more rosettes as they age (Schirman and Robocker 1967). Rosettes may appear at other times of the year from roots that have been mechanically injured (Schirman and Robocker 1967). However, a 1996 field survey from the Okanogan Valley area of British Columbia reports the absence of these overwintering rosettes (Martin 1997). Seedlings are present in the fall and winter. The increasing day lengths of spring induce the flowering stem(s) to bolt, producing many aerial branches. Small leaves are sparsely found along the stems and branches. At this time, the rosette of basal leaves begins to wither, and later disappears when the plant is in flower. Photosynthesis takes place in the green stems (Martin 1996). The summer development of flower heads on a basically leafless stem with thin aerial branches gives the appearance of a "skeletonweed". The flowering shoots die back in October or November.

In our region, the flowering time of rush skeletonweed depends on the biotype. The tall late flowering Spokane, WA biotype is predominant, and it flowers in August and lasts until frost (Boerboom 1993). Each flower head remains open for one day. The seeds mature, and are shed, in about 14 days. The pappus of each seed acts as a parachute, and seeds are commonly dispersed by wind.

Lateral roots can branch from the taproot, with the capability of spreading several feet and producing daughter rosettes, particularly in sandy and gravely soils. Shoots develop from root buds found in the top 2-4 inches on the main root, and from buds found along surface lateral roots of undisturbed plants (Rosenthal et al. 1968 *in* Old 1981; Ross and Taylor 1935 *in* Old 1981). However, when rush skeletonweed is mechanically injured, shoots can form from any part of the main root, from the lateral roots, and from root fragments at least 4 feet deep. Vegetative sprouting following injury is especially vigorous (Cuthbertson 1972; Panetta and Dodd 1987; A. Hild and N. Shaw, personal observation 2007; *all in* Kinter et al. 2007). Root fragment regeneration depths varied with fragment size and soil type, with sandy soils producing regeneration from greater depths than clay soils (Old 1981). A one-centimeter length of root section is capable of regeneration (Cuthbertson 1963 *in* Erickson 1979). Root fragments are viable until they desiccate.

Seeds can germinate from a depth of ¾" or 1", but deeper seed burial appears to impede germination (Moore 1964 *in* Schirman and Robocker 1967; Schirman and Robocker 1967). Seeds are sensitive to shade, and will suffer complete mortality at 98% shading, while 50% shading prevents plants from flowering (McVean 1966 *in* Schirman and Robocker 1967). Some shading can be achieved by growing legumes, such as subterraneum clover, *Trifolium subterraneum* (Schirman and Robocker 1967). Schirman and Robocker (1967) grew rush skeleton weed with several crop plants in a greenhouse study. They found that when crops emerged at the same time as rush skeletonweed, the weed was not able to get past the 3-leaf stage when paired with oats, though it was able to thrive when grown with alfalfa. When the crop emerged prior to the rush skeletonweed, the weed was prevented from getting past the 3-leaf stage.

Kinter et al. (2007) assessed seed germination in burned and unburned plots in the Snake River Plain in Idaho and observed that most seeds came up in the one wet spring that occurred during the study. They suspect that notable seedling recruitment of rush skeletonweed may occur when wet springs follow dry, wildfire-prone falls.

Mature, vigorous plants can produce 1,500 flower heads, with the capability of producing 20,000 seeds.

Depending on the plant biotype and the growing conditions, a mature plant can produce 1500 flower heads, each with (usually) 10-12 flowers. Each flower produces one seed (Cheney et al. 1981; Old 1981). 90% of seeds germinate. Lee (1986 *in* Martin 1996) reports that seed viability is less than 18 months, while other sources suggest that some seeds may remain viable in the seed bank for up to 5 years (APRS 2001 *in* NatureServe 2008). Seed dormancy ranges from none to less than three weeks, depending on the biotype (Panetta 1988 *in* McLellan 1991).

New populations establish when seeds from established infestations are carried to a suitable site that supports seedling growth. The mature plant then produces satellite plants - the daughter rosettes from lateral root formation. This potentially leads to colonization of an area by one rush skeletonweed plant.

Seeds, often carried on wind currents, land far from the original seed source. These individual plants evolve in isolation to form genetically distinct biotypes. Over 300 recognized biotypes are found in southern Europe (Martin 1996). Hybridization is rare, but random mutation may produce new strains of rush skeletonweed (Cuthbertson 1972 *in* McLellan 1991; Panetta and Dodd 1987a *in* McLellan 1991).

Reproduction: Reproduction is by seed and vegetative growth. Rush skeletonweed is described as an herbaceous, somewhat long-lived perennial, outside of its native range. In its native range, it is described as a biennial, or short lived perennial (Old 1981; Rees et al. 1996). Flowers are produced in the first year, and each plant can support flower buds, blooming flower heads and mature seed heads at the same time.

Rush skeletonweed is an obligate apomict, meaning it produces seed without fertilization. This self-fertilization produces clones of the parent plant, resulting in the well-adapted biotypes that can dominate an infested area (Old 1981; Martin 1996).

Vegetative spread is possible from shoot buds found along lateral roots, and from shoot buds found near the top of the main taproot. Vegetative spread is also possible when a root fragment, as deep as 4 feet down, is left in the ground. When the plant stem or root is mechanically injured, vegetative growth is initiated.

Control:

Prevention: Subterranean clover creates a dense canopy and will shade young seedlings so that they are not able to establish. Grazing management and fertilization on rangeland may prevent establishment of the weed (CDFA 2008).

Response to Herbicide: Different forms, or biotypes, of rush skeletonweed may affect the susceptibility rates of herbicides. Rush skeletonweed is a deep-rooted, rhizomatous perennial, considered tolerant to herbicides (Prather 1993). Control with herbicides requires an aggressive follow-up program with repeated applications. Site-specific conditions must be taken into consideration. Check rates and applications with the PNW Weed Control Handbook.

Treating plants less than 5 years old had a better response to herbicide application than older plants, because of the root system. Field trials indicate that late fall applications of Transline, after the first frost in November, showed 95% effective control rate. However, plants did show up 3-5 years later (Personal notes from 4/7/98 meeting).

Picloram can be applied to rosettes prior to or during bolting, from late fall to early spring. 2,4-D application is recommended on the rosette prior to or during bolting in the spring (William et al. 1998). 2,4-D at lower rates will suppress rush skeletonweed enough to allow harvest of grains, but the lower rates will not kill a perennial root system.

Application of nitrogen fertilizer reduces the density of rush skeletonweed by increasing the competitiveness of beneficial plants. However, it also increases the size of the remaining rush skeletonweed plants. This method is effective in wheat and pasture lands with high moisture (Myers and Fitzsimon 1965 *in* Sheley).

Response to Cultural Methods: Using beneficial forage species for competition will not suppress the dominance of rush skeletonweed. A more integrated approach using both plant competition and biological control agents often results in better control than either method used separately

(Groves and Williams 1975 *in* Prather 1993; Prather 1993). Continual grazing as a control method decreased the populations of rush skeletonweed when seed production was prevented, but rotational grazing increased the plant densities (Kohn and Cuthbertson 1975 *in* McLellan 1991). Fire may stimulate growth of the plant by killing pathogens in the soil that otherwise keep it in check; deep-rooted perennials that can spread vegetatively are also likely to have a higher tolerance of fire (Kinter et al. 2007).

Response to Mechanical Methods: Any mechanical damage to the plant stimulates new growth, often resulting in satellite plants. Root fragment regeneration depths varied with fragment size and soil type, with sandy soils producing regeneration from greater depths than clay soils. Cultivation as a control method can be considered on seedlings less than 36 days old, as they are unable to develop roots from root fragments (Old 1981).

Frequently mowing rush skeletonweed plants infested with and impacted by the gall mite (*Eriophyes chondrillae*) may decrease the rate of spread of this plant (McLellan 1991).

Biological Control Potential: The biological control agents are very specific to biotype.
In Australia, a biological control program was successful in controlling rush skeletonweed in cultivated wheat lands, and over most of its range. The same biological control agents were released in the Pacific Northwest, offering some control. The interior areas of Oregon, Washington, Idaho and Montana, with their cooler temperatures, do report the establishment of biocontrol agents. However, rush skeletonweed continues to spread through range and forested lands. In 1995, a program was implemented to research rush skeletonweed's native Eurasia for more effective biocontrol agents for these cooler climates (Markin and Quimby 1997).

Biological control agents released in Australia in 1971 included a gall midge (*Cystiphora schmidti*), a mite (*Aceria chondrillae*, syn. *Eriophyes chondrillae*) and a rust (*Puccinia chondrillina*). This rust, from southern Italy, effectively controls only the narrow-leaf biotype form of rush skeletonweed. This led to population increases of both the intermediate and broad-leaf forms of rush skeletonweed in Australia (Chaboudez 1994). All three of these biocontrol agents have since been released in the United States and are established in a number of locales (Milan et al. 2006).

The gall midge (*C. schmidti*) was introduced to California in 1975, and is established throughout the Pacific Northwest. The gall midge impacts the rosette and flowering stems of all biotypes in this region, and affected stands are often a noticeable purple to reddish color (Martin 1996; Rees et al. 1996). To infect a patch of rush skeletonweed with the gall midge, collect stems from an infected patch, and remove the seedheads. Arrange the stems in a teepee form in the center of the un-infected patch (CDFA 2008).

The rust fungus, *P. chondrillina*, was introduced to Washington in 1978. Healthy stems of rush skeletonweed can be infected with the rust by spraying them with water and then placing infected stems against them (CDFA 2008). Unfortunately, the early-flowering rush skeletonweed biotype in Washington and Idaho, and the late-flowering biotype in Oregon are resistant to this rust (Martin 1996; Rees et al. 1996).

The gall mite, *Aceria* (syn. *Eriophyes*) *chondrillae* was introduced to Washington in 1979, and it is considered the most effective biological control agent available, to date. This mite is effective against all biotypes of rush skeletonweed. The visible impacts to flowering buds are leaf-like galls, up to 2” in diameter, which can reduce or prevent seed production. The gall mite also affects the roots carbohydrate reserves, preventing the formation of satellite plants. The seedlings and satellite plants often die. To introduce the gall to an un-infected patch of rush skeletonweed, gall-infected stems, sans seeds and flowers, can be placed against un-infected stems, and the mite will likely transfer (CDFA 2008). It is not a perfect biocontrol, though. Bud production is stimulated when the mites feed on them (Prather 1993). Soil disturbance associated with cultivation in croplands interferes with the life cycle of the mite, and as a result, there is a reduction in the persistence of gall mite infestations to rush skeletonweed (Martin 1996; Rees et al. 1996). The cold, continental winters appear to pose a problem for the mite, as well; they may not be able to tolerate the below-freezing temperatures (or lack adequate shelter from them) and they might also suffer from a lack of food in the winter (Milan et al. 2006). Certainly, in southwestern Idaho, the efficacy of the mite is limited by winter mortality, which exceeds 90%. Rosettes may provide some shelter for the mites in the winter, and rosettes are 3.4 times more likely to occur on south-facing slopes than on north-facing slopes (Milan et al. 2006). In Milan et al. (2006), the few plants that were harvested in November that had mites but no rosettes had dense hyphal mats of a fungus, *Alternaria* sp. The fungus may be providing shelter and/or food to the mites. If the fungus could be introduced in greater numbers, it may be able to increase overwintering survival of the mite. However, the fungus had disappeared from the plants by January. Another possibility is to search the native range of the mite for a location that resembles the cold, continental climate of the intermountain west, and collect insects for introduction from that location (Milan et al. 2006). In any case, rush skeletonweed often remains the dominant species in gall-infested populations.

A root-boring moth, *Bradyrrhoa gilveolella* Treitschke, was released in Australia along with the other three biocontrol agents, but never got established (Cullen 1980 *in* Milan et al. 2006). It was only recently released in the U.S. (H. Prody, Montana State University, unpublished data *in* Milan et al. 2006).

Economic Importance:

Detrimental: Rush skeletonweed is a threat to irrigated lands of the Columbia Basin, to the sandy soils of dry land wheat areas (Old 1981), and it is a threat to rangelands.

Rangeland infestations impact the cattle industry when rush skeletonweed displaces native or beneficial forage species grazed by livestock and wildlife. Forage production is lowered when rush skeletonweed successfully outcompetes beneficial species for limited resources, particularly nitrogen. Often, the cost of herbicide control is not economical due to low productivity of the land (Sheley).

Rush skeletonweed spreads from rangeland to croplands by seed. Once established on roadsides adjacent to croplands, mechanical injury to the plant can produce shoots from any part of the main root, from the lateral roots, and from root fragments at least 4 feet deep (Old 1981). Once established in wheat-fallow systems, cultivation is the major factor of spread. Crop yields are also reduced as a result of rush skeleton-weed outcompeting grain for soil moisture and nitrogen. Grain harvest is difficult because of the wiry stems, and the latex sap of rush skeletonweed gums up harvesting machinery. In Australia, crop yields were reduced by 50-70%, with some fields later converted to rangeland.

Rush skeletonweed establishment is also spurred on by higher incidences of wildfires. Fires may kill soil pathogens that would otherwise keep the plant in check, allowing for increased seed germination during the next wet spring. Plant density increases as new plants emerge from the root sprouts of the existing plants. Under these conditions, a few plants can build up a dense stand over the course of a decade (Kinter et al. 2007).

Native plants are also negatively impacted, as water (APRS 2001) and nutrients (CDFA 2004) are less available to native plants. This, in turn, may reduce the diversity of the plant community; native plants may also have difficulty germinating due to competition with rush skeletonweed (APRS 2001).

Beneficial: Sheep graze the rosette and early flowering plant (Cuthbertson 1967 *in* Sheley). Cattle will also graze the tips of flowering stems early in the season, before lignified stems grow (Daly 1935 *in* McLellan 1991).

Rationale for listing:

As a Class B noxious weed in Washington, the goal is to contain the existing populations of rush skeletonweed and prevent the further spread. Rush skeletonweed is a threat to irrigated lands of the Columbia Basin, the sandy soils of dry land wheat areas and rangelands. Initially, rush skeletonweed spreads by seed, with the ability to travel long distances on wind currents. It spreads from roadside to croplands when the plant is mechanically injured. Once established in wheat-fallow systems, cultivation is the major factor of spread, and control is no longer feasible. Crop yields are reduced, and grain harvest is difficult due to the latex sap.

Rush skeletonweed biotypes adapt to outcompete beneficial species for limited resources, including moisture and nitrogen. The biological control agents are very specific to plant biotypes, making long-term biocontrol programs difficult to manage.

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