Management and Control Methods for *Cynanchum rossicum*:
IUCN SSC Invasive Species Specialist Group

Manual/Mechanical Management:

*Cynanchum rossicum* can rapidly re-grow from buds on the root crown, rendering mowing, tillage, clipping, and other frequently used control strategies less effective against these perennials. Mowing can contain invasive populations of the swallow-worts when timed to suppress seed production, but must be repeated for the duration of the growing season as plants tend to re-grow more rapidly than non-mowed plants and produce seed at a more immature stage of growth than is typical. Averill *et al.* (2008) found that clipping of *C. rossicum* stems once annually at the beginning of summer (June) led to a 44% reduction in cover at an infested site in northern New York over a 2-year period (Douglass *et al.*, 2009; McKague & Cappuccino, 2005).

Prescribed burning alone is not effective in reducing populations of *C. rossicum*. A large infested area was burned at Montezuma National Wildlife Refuge in late spring 1999 to reduce woody debris. The plants recovered and grew and reproduced as usual the following season. The root crown is generally at least a centimeter or more below the soil surface, and is thus protected from the heat of a rapid burn. Burning may be useful after herbicide control of mature growth to control the less-established seedling layer. Seedlings of *C. rossicum* lack the well-developed root crown of more
mature plants. Flame burners might be used for controlling these seedlings but should be tested before use on a large scale (Lawlor, 2009). Grazing is of mixed utility in controlling *C. rossicum*. Cattle will suppress the species but infestations can rebound swiftly when pastures are abandoned. Horses do not eat *C. rossicum* and may encourage it by reducing competition from other plants. White-tailed deer appear to avoid it as well. Grazing impacts require study (Lawlor, 2009).

**Chemical Management:**
There are several herbicides that provide relatively effective control of *C. rossicum* when applied post-emergence (Averill *et al.*, 2008b; Weston *et al.*, 2005). Foliar applications are generally more difficult to apply than cut stem applications because of the intertwining growth habit of the swallow-worts and high patch densities at maturity, but are generally more effective (Lawlor & Raynal 2002). Furthermore, Lawlor and Raynal (2002) found that foliar applications were significantly more effective at controlling plants in shaded plots than drier, full sun plots. In particular, the most effective chemical treatments were glyphosate (10.4 kg ai ha$^{-1}$) applied at an early stage of flowering and triclopyr (2.6 kg ai ha$^{-1}$) applied at early fruit formation, both of which resulted in a 73% reduction in cover, decreased densities, and a loss of apical dominance (Lawlor & Raynal 2002). Recent work has demonstrated that glyphosate applied at a much lower rate (1.79 kg ai ha$^{-1}$) was equally as effective (77% reduction in cover when applied in late June) as a higher rate, and more effective overall than triclopyr alone or combinations of triclopyr and 2,4-D or dicamba and 2,4-D (F. Lawlor, unpublished data in Weston *et al.* 2005). Similarly, Averill *et al.* (2008)
found that triclopyr applied at a lower rate (1.9 kg ae ha$^{-1}$) reduced $C.\ rossicum$ stem densities by 80% 2 years after a single June application. In any case, an adequate surfactant must be included in postemergent foliar applications so that uptake is maximized, particularly because of the waxy cuticle present on the leaf surfaces and stems of both swallow-wort species (Radosevich et al. 1997), (Douglass et al, 2009). Foliar spray applications of glyphosate (3.1 and 7.8 kg ae ha$^{-1}$) and triclopyr (1.9 kg ae ha$^{-1}$) were more effective than cut-stem applications of the herbicides (3.1 kg ae ha$^{-1}$ glyphosate, 1.4 kg ae ha$^{-1}$ triclopyr). There were no statistical differences in effect among the foliar spray applications. Response to cut-stem application of glyphosate (3.1 and 6.2 kg ha$^{-1}$) and triclopyr (1.4, 2.8, and 5.6 kg ha$^{-1}$) in the following year indicated glyphosate to be more effective than triclopyr at all concentrations tested. To effect long-lasting control, all treatments require additional herbicide application (Lawlor & Raynal, 2002).

A very similar two year herbicide and clipping study in an old field (OF) and adjacent forest understory (FU) was conducted on $C.\ rossicum$ at a site near Ithaca, NY. The effects of seven treatments were compared during two growing seasons on stem density and percent cover in these two habitats. Treatment plots measured 4 by 4 m and vegetation in all plots was mowed to a height of 5 cm in mid-June of both years. There were seven replicate plots for each treatment resulting in a total of 49 plots in each habitat. The seven treatments were: (1) glyphosate (Roundup Pro®) at 4.87 and 2.44 kg ai/ha in OF and FU, respectively; (2) triclopyr triethylamine salt (Brush-B-Gone®) at 0.93 and 0.46 kg ai/ha in OF and FU, respectively; (3) triclopyr triethylamine salt (Garlon® 3A) at 4.87 and 1.70 kg ai/ha in OF and FU, respectively; (4) triclopyr butoxyethyl ester (Garlon® 4 Ultra) at 2.99 and
0.43 kg ai/ha in OF and FU, respectively; (5) triclopyr butoxyethyl ester (Garlon® 4 Ultra) at 4.87 and 2.27 kg ai/ha in OF and FU, respectively; (6) an untreated check; and (7) a second mowing at the time of herbicide application. Pre-treatment assessments of PSW stem number and percent cover, in a 1 by 1m sub-plot, were made a few days prior to mowing (mid-June). The herbicides were applied in late August using a CO2 back-pack sprayer pressurized at 100 kPa. Post-treatment measurements for 2008 applications were made in mid-June 2009 and for the 2009 applications will be recorded in mid-June 2010. Thus, data (percent cover) resulting from only the first year of treatments (2008) are presented. By mid-June 2009, treatment effects differed in the two habitats. In the old field, the highest reductions in C. rossicum cover relative to pre-treatment levels were observed for the glyphosate (46%) and triclopyr butoxyethyl (41%) (Garlon® 4 Ultra - 4.87 kg/ha)-treated plots. Plots treated with triclopyr butoxyethyl at 2.99 kg/ha resulted in only a 9% reduction. Cover of C. rossicum in triclopyr amine (Brush-B-Gone®)-treated plots at 0.93 kg/ha increased by 17%. Mowing plots twice in 2008 resulted in a 281% increase in C. rossicum cover. In the forest understory, C. rossicum cover was reduced in all treatments including plots mowed twice (16%). The highest reductions in cover (56%) were achieved in the glyphosate and triclopyr butoxyethyl (0.43 kg/ha)-treated plots. The lowest reductions in cover (30%) were observed for plots sprayed with triclopyr butoxyethyl at 2.27 kg/ha. Data collected in June 2010 sampling will confirm whether the effects observed following control during this single season will be maintained. However, it is likely that observed differences in the efficacy of treatments between the old field and forest understory habitats will not change. If so, these findings suggest that management of C. rossicum using herbicides and
mowing may vary depending on the habitat being managed. Land managers should be aware of these possible differences in efficacy to ensure successful control of this invasive vine (DiTommaso et al, 2010).

**Integrated Management:**
A two year study evaluating the effectiveness of triclopyr and/or clipping against *C. rossicum* found that cover was lower in plots treated with triclopyr (20 ± 5%) compared with plots subjected to clipping-only (56 ± 6%) or unmanaged controls (76 ± 6%). Stem densities were also lower in triclopyr-treated plots (25 ± 5 stems/m2) than in clipping-only (188 ± 9 stems/m2) and control (178 ± 10 stems/m2) plots across three different sample dates. Seedling densities were lower in triclopyr-treated plots (160 ± 50 seedlings/m2) relative to clipping-only (1,120 ± 180 seedlings/m2) and control (960 ± 50 seedlings/m2) plots. The cover of other plant species was negatively correlated with swallow-wort cover and was higher in triclopyr-treated plots (75 ± 3%) than in clipping-only (5 ± 1%) and control (7 ± 4%) plots. Across both years, *C. rossicum* in control and clipped plots produced follicles, but not in triclopyr-treated plots. Regardless of clipping frequency, clipping in June or July was not effective in reducing swallow-wort stem density, cover, or follicle production. Although a single application of triclopyr provided considerable suppression of *C. rossicum* after two growing seasons, application of triclopyr in subsequent years is likely required to achieve long-term control (Averil et al, 2008b).

**Biological control:**
Classical biological control of *C. rossicum* in North America is being pursued. Finding a suitable control agent has proven difficult (Bon et al,
The seasonal assemblage of phytophagous arthropods found feeding and developing on *Cynanchum* in New York was evaluated. Of them, 10 polyphagous, ectophagous species of native and exotic arthropods were identified, exclusively from the leaves or stems, which could develop to the adult stage and in most cases complete at least one generation. Unfortunately, their densities were low throughout the season and very little to no damage was observed on the plants (Mibrath, 2010).

The noctuid moth *Hypena opulenta* which was discovered feeding on *C. rossicum* in forests of southeastern Ukraine is under evaluation as a potential biological control agent. It was found to oviposit eggs in *C. rossicum* where larvae develop through five instars. Feeding by two larvae per plant caused reductions in aboveground biomass to *C. rossicum* resulting in decreased reproductive output affecting flower, seedpod, and seed production. The results of this study indicate that *H. opulenta* is a promising agent against forested populations of *C. rossicum* and warrants completion of host specificity testing and examination of population dynamics of *H. opulenta* (Weed & Casagrande, 2010).