



# Oriental bittersweet

*Celastrus orbiculatus*

Oriental bittersweet is an invasive, non-native vine that is native to China, Japan and Korea. It was introduced into the United States around 1860 as an ornamental plant. Its fruiting stems are cut in fall and used for decoration, which unfortunately facilitates its spread. Hybridization with the native American bittersweet has been observed in the laboratory but it is not clear how commonly this occurs in the wild.

Oriental bittersweet poses a significant threat to native plant communities. It grows rapidly and can shade out the vegetation that supports it. It girdles trees and shrubs, cutting off the flow of water and nutrients. Weakened trees, burdened with the weight of massive woody vines and leaves, are particularly vulnerable to damage from ice and windstorms. Oriental bittersweet can spread from tree to tree in the forest canopy. When one tree falls or is cut down, attached trees may be pulled down, also.

Although it is most productive in full sun, bittersweet germinates readily in low light. It responds to increased light and maximizes stem growth to reach the forest canopy.

## Identification

### Habit:

Oriental bittersweet is a deciduous, woody, twining vine that may reach 30 m (98.5 ft) in length and 18 cm (7 in) in diameter. It climbs by coiling around trees, shrubs and any other available support. It has a deep, extensive root system.

### Leaves:

Oriental bittersweet's leaves are alternate, glossy and finely toothed. They are often rounded but are variable in shape. They range from 5 to 13 cm (2 to 5 in) long and have pointed tips. They turn yellow in fall, and retain their leaves late in the season.



Chris Evans, River to River CWMA, Bugwood.org

### Bark/Stems:



Max Williamson, USDA FS, Bugwood.org

Bittersweet's stems are light or medium brown, with white pith. They often have noticeable light horizontal marks. Stems may climb up to 18 m (60 ft) high in trees. Roots are a bright orange.



James R. Allison, Georgia DNR, Bugwood.org

### Flowers:

Oriental bittersweet has small, greenish yellow, five-petaled flowers that are clustered in the leaf axils. Male and female flowers usually occur on separate plants and sometimes male flowers are at the tip of the branch. They bloom in May and June.



Nancy Loewenstein, Auburn University, Bugwood.org

### Fruits/Seeds:



James R. Allison, Georgia DNR, Bugwood.org

Bittersweet has conspicuous bright fruits. The yellowish-orange outer skin covers a fleshy scarlet aril, with 3 to 6 seeds. The fruits are clustered in leaf axils of female plants and persist through winter.

### Habitat:

Oriental bittersweet occurs in grasslands, open woods, woodland edges, closed-canopy forest, roadsides and fence rows. It also has become a problem on beaches and dunes in some states. Although it is most productive in full sun, its seedlings are extremely shade-tolerant.

## Similar species

### American bittersweet

The native American bittersweet (*Celastrus scandens*) has elliptical rather than rounded leaves. The flowers and fruit of the female plants occur in a single clump at the tips of the stems rather than spread along the stems. Male flowers of the native may occasionally occur along the stems but will not produce fruit.



American bittersweet can also be distinguished from Oriental bittersweet by its leaves when they are just beginning to emerge from the bud. Oriental bittersweet leaves are folded flat along the midvein. American bittersweet leaves curl along the edges toward the midvein and look like a rolled up scroll in cross-section.

American bittersweet is protected under the Natural Resources and Environmental Protection Act 451 of 1994, Section 324, Part 529. It cannot be cut or transported without a bill of sale or proof of ownership under Michigan law. It is also listed as a Species of Special Concern in Michigan.

### Bristly greenbriar



Bristly greenbriar (*Smilax tamnoides*) and other members of the *Smilax* genus have leaves with conspicuous parallel leaf veins, running the length of the leaf. They lack sharp teeth. Their fruits are dark purple and arranged in a ball. Many have thorns or

bristles (at least at their bases) and attach with fine tendrils.

## Reproduction/Dispersal

Oriental bittersweet reproduces by seed and vegetatively by spreading underground roots that form new stems. Large clones can develop from one or a few seedlings. Bittersweet also sprouts from the root crown, and even small root fragments can regenerate. Most plants bear either male or female flowers but a few will also produce perfect flowers with both male and female parts. Plants mature quickly, and both male and female plants can produce flowers at two years of age. Mature female plants produce prolific fruit, and fruit production is highest in full sun.

Bittersweet fruit is eaten by birds and small mammals. Although it is nutritious, it is not eaten until late in winter. The seed is retained in the gut of birds for a long time, aiding in long-distance dispersal of the species. In one Japanese study, the seed remained in the gut of birds for 14-42 days. Humans are also a significant vector for dispersal when they

plant the species or compost ornamental wreaths composed of its fruiting stems.

The seed is able to germinate under conditions with very low light levels. Plants growing in shade persist until a little more light becomes available and then rapidly grow up to reach the forest canopy before producing much fruit. Once they have access to increased light levels, fruit production increases accordingly.

Germination rates may be higher on mineral soils or sites with sparse leaf litter but a thick leaf litter will not prevent all germination. Areas with exposed mineral soils such as beaches or newly burned sites are particularly vulnerable. Plants growing in open areas can form dense clones and spread over relatively large areas.

Most seed germinates within one year. Because so much of the seed germinates immediately, there is only a short-lived seedbank, although there are conflicting reports regarding this in the literature. Because seeds are retained in birds' stomachs for so long they can disperse relatively long distances and plants up to a kilometer away can easily provide a seed source for re-invasion.

## Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing both the scope of the problem and any available resources is a critical first step:

- Map known populations. Is the species widely distributed throughout the region? Or is it just beginning to appear?
- Does it occur on high value sites? Important hunting or recreational lands? High quality natural areas? Sites with high cultural value?
- How is it distributed? Is it sparsely scattered in otherwise native vegetation? Does it cover large expanses of low quality habitat?
- Is there evidence of hybridization?

Given this information, develop a strategy for control:

1. Prioritize high value sites where success can be achieved for treatment.
2. Choose appropriate control methods, given site conditions and available resources.
3. If using herbicide, be sure to read the product label before finalizing plans. Is there potential for harm to non-target species? Have you made adequate provisions to minimize damage?
4. Do these control methods require any permits (i.e. herbicide application in wetlands, prescribed burning)?
5. Prevent further spread; focus on mature plants, particularly plants in full sun with abundant fruit.
6. Eradicate smaller satellite populations.

7. Treat larger core infestations of lower value as resources permit.
8. Monitor treated sites to prevent re-invasion.
9. Adapt management to improve success.

### **Best survey period**

Oriental bittersweet is easiest to locate for mapping or control in late fall. Its leaves turn a conspicuous yellow and persist into November, after the leaves of most native species have fallen. Monitoring should encompass an area up to a kilometer or more from the focal area of management, because of this species' potential for long distance dispersal. The fruit on female plants is also conspicuous.

### **Documenting occurrences**

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species Information Network (MISIN) has an easy-to-use interactive online mapping system. It accepts reports of invasive species' locations from users who have completed a simple, online training module for the species being reported. MISIN can also accept batch uploads of large quantities of data for any species.

Herbaria also provide an authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example.

When Oriental bittersweet is first encountered in a county where it had not been known previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

## **Control**

Preventing seed production and dispersal is critical in controlling this species, but stopping its destructive impacts on the trees and shrubs that support it is also extremely important. A combination of mechanical and chemical methods are useful in meeting all of these goals.

In addition, because of this species' potential for long distance spread, monitoring lands within at least a kilometer surrounding the managed site to determine the location of source populations is highly recommended. Where abundant seed sources are present nearby and cannot be eradicated, monitoring may be required indefinitely.

### **Mechanical control**

Mechanical controls alone will not eradicate established Oriental bittersweet infestations but can effectively prevent further damage to the trees and shrubs that support its vines at least temporarily. In combination with herbicide treatment, they can provide effective control of established populations over time.

### **Hand-pulling/Digging**

Hand pulling established Oriental bittersweet can be difficult, particularly with the largest vines. Roots run long distances with stems emerging along the way, even in young plants. It can be hard to remove most of the root, especially in some soils. Repeated hand pulling in an area will eventually achieve control, but requires commitment and follow through.

Oriental bittersweet seedlings are easiest to remove when the soil is moist and the population is small. Pull steadily and slowly to minimize soil disturbance and tamp down the soil afterwards. In small infestations, larger plants can also be removed by digging if care is taken to remove all roots. This is not practical for larger infestations, however.

It is important to verify whether young shoots are actually seedlings or sprouts from an established plant with extensive roots. If it is the latter, chemical control methods should be used if the entire plant cannot be readily removed by digging.

Once the initial bittersweet infestation is eradicated, hand pulling may be used to remove seedlings discovered during routine monitoring.

### **Cutting/Mowing**

Cutting bittersweet will not provide effective control as it stimulates resprouting. It will, however, reduce its destructive effects on the trees and shrubs it is growing on for a while. Vines that are left hanging in the canopy will deteriorate and eventually fall down in two or three years.

In general, mowing will stimulate root sprouting in Oriental bittersweet. If it is repeated weekly, it may eventually exhaust the plant's energy reserves. Cutting only two or three times a season, however, will stimulate resprouting and increase the extent of the infestation.

### **Chemical control**

In most cases, effective control of established Oriental bittersweet populations requires the use of herbicide. Factors that should be considered when selecting an herbicide for use on a particular site include proximity to water or wetlands, presence or absence of desirable native vegetation, potential for erosion and the effectiveness of the herbicide under consideration on bittersweet. Because its leaves persist much later than many native species, fall treatment may minimize damage to desirable broadleaf plants.

### **General considerations**

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The certification process is administered by the Michigan Department of Agriculture and Rural



Development and a link to their website is included in the “Online Resources” section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A link to their website is included in the “Online Resources” section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes. Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated and making spills on clothing or equipment apparent. Some premixed herbicide include them or they can be added to others. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the “Online Resources” section.

**Read the entire pesticide label before use. Follow all directions on the label.**

### Herbicide specifics

Glyphosate (e.g., Roundup®, Rodeo®, Accord®) can provide effective control of bittersweet both as a foliar spray and for cut surface treatments. It is most effective for cut surface treatment while plants are fully leafed and actively growing. It should not be used in spring, while leaves are emerging and sap is flowing upward as it is not effective at this time. Glyphosate is not selective and will kill desirable non-target species.

Triclopyr provides effective control of broad-leaved plants but does not kill grasses or some conifers. It is available in both amine (e.g., Garlon 3A®) and ester (e.g., Garlon 4 Ultra®) formulations. The amine formulation can be safely used in wetlands. Some authors note that it results in better root kill than glyphosate.

Triclopyr can be used as a foliar spray once Oriental bittersweet is fully leafed out in spring until just before it changes color in fall. The ester formulation should be used with a vegetable oil based multi-purpose adjuvant (e.g. Spray-

Tech® Oil) and the amine formulation should be used with a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).

Triclopyr can also be used in conjunction with cut surface treatments. Treatments may be applied throughout the year including when snow is present, however control may be reduced in early spring when the sap is beginning to flow or during periods of drought in summer.

Ester formulations are particularly effective for root or stem-sprouting species such as bittersweet because the triclopyr persists in the plant until it dies. The ester formulation should be used with a penetrating oil (e.g., AX-IT®), which improves effectiveness and increases the amount of time after cutting in which treatment can occur. Penetrating oil also facilitates absorption in basal bark treatment.

In non-target plants, triclopyr residues in the soils can damage non-target species via root uptake. Use caution in high-quality forests.

In wetlands or other sensitive areas, the amine formulation of triclopyr may be used for cut-surface treatments but must be painted onto the cut surface immediately. It can also be used for injection techniques.

### Foliar application

Foliar application of herbicide can be useful on sites with extensive bittersweet clones and few desirable natives. It is also useful for treating resprouts, where bittersweet vines have been cut early in the season to prevent fruiting.

Herbicide should be applied after spring sap flow to actively growing plants, although during periods of drought or other stress, it may not be effective. It can be applied to bittersweet foliage with squirt bottles or backpack sprayers.

Herbicide labels contain information on specific weather conditions, application modes, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting

equipment to produce large droplets can help compensate for this. In general, follow all directions on the label of the specific herbicide being used, in order to prevent damage to non-target vegetation or water bodies.

### **Cut-stump**

Cut-stump treatment may be used in any season except during periods of heavy sap flow in spring, when sap is flowing upwards. Some chemicals are less effective at lower temperatures or when plants are dormant. Refer to the herbicide label for specific details. Product labels list what adjuvants may be used to increase effectiveness of the herbicide; penetrating oils only work with ester formulations, for example. Similarly, dyes, which are useful in keeping track of which stems have been treated, work with specific herbicide formulations.

Cut-stump treatment is useful for species like bittersweet that normally resprout after cutting. After the stems have been cut, they are painted with concentrated herbicide, using a squirt bottle or wicking applicator. Small stems can be cut several inches above the ground so that both the sides and the cut surface may be treated. On larger stems, only the cambium—the thin layer where active growth occurs, just inside the bark—should be treated.

Treated plants should be monitored for at least a year as they may still resprout. New stems may be treated with a foliar spray, or cut and retreated.

### **Basal bark**

Basal bark treatment can be used on stems that are less than one inch in diameter at any time of year except during heavy sap flow in spring. It should not be used when snow or water prevent herbicide from being applied at the ground level or when stems are saturated. It is most useful during the dormant season. Typically, ester formulations of triclopyr are used with penetrating oils. Some herbicide formulations may already include basal oils or dyes—refer to the product label for specifics.

In basal bark treatment, concentrated herbicide is applied to a band of bark around stems extending up 18 inches from the ground. Basal bark treatment is most effective on younger stems with thin bark.

### **Injection**

Injection techniques may be useful on larger stems, particularly on sensitive sites. They can be used any time of year except during spring sap flow. Specialized injection tools are available to inject herbicide pellets below the bark. They are precise and require little preparation or clean-up. They are expensive, however and may be unwieldy in dense brush.

Because concentrated herbicide is used, it is very easy to exceed the annual per acre amount that is allowed for a given product. Consult the product label for specifics.

## **Prescribed burning**

In fire-adapted communities, prescribed burning may enhance control of Oriental bittersweet, but should be considered as part of an integrated site management plan.

### **General considerations**

A permit is required before implementing a prescribed burn. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the “Online Resources” section. In the Southern Lower Peninsula, contact the local Fire Marshall for permits and more information. Some municipalities require insurance coverage before a permit is issued, to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed burning, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of control lines, ignition pattern, equipment and personnel needed, contingency plans, and important phone numbers. The burn plan is essentially the “prescription” for how to conduct the burn safely while accomplishing the management objectives.

If other invasive species that are stimulated by burning are present on the site, planning should incorporate additional control methods to eradicate them.

### **Prescribed burning specifics**

Prescribed burning alone will not control Oriental bittersweet, as it can resprout from the root crown. Increased light levels and nutrient flush following a burn will actually stimulate its growth, and provide exposed mineral soils, enhancing germination. Bittersweet can act as a ladder and carry fire up into forest canopy.

In fire-adapted communities, prescribed burning is still a useful management tool, when adequate fuels are present. It top kills even large vines and can reduce fruit production in the canopy. Vigorous root sprouting makes foliar herbicide treatment at the ground level more accessible and effective. Oriental bittersweet control should be initiated prior to implementing a program of prescribed fire.

## **Biological control**

No biological controls have been reported for Oriental bittersweet in the United States to date.



## Disposal of plant parts

If fruit is not present, cut vines can be left in place to decay. Stems and roots that have been pulled can also be left on site as long as the roots are left in a position where they will dry out and have no chance of re-rooting, e.g., draped over a branch. Fruit should be incinerated or bagged and disposed of in a landfill.

Although landscape waste cannot generally be disposed of in landfills, Michigan law permits the disposal of invasive species plant parts. See the "Online resources" section for a link to the relevant legislation.

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## Online resources:

### CDMS - herbicide labels:

<http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=>

### Fire Effects Information System, *Celastrus orbiculatus*

<http://www.fs.fed.us/database/feis/plants/vine/celorb/all.html>

### Invasive.org, Oriental bittersweet

<http://www.invasive.org/browse/subinfo.cfm?sub=3012>

### Invasipedia at BugwoodWiki, *Celastrus orbiculatus*

[http://wiki.bugwood.org/Celastrus\\_orbiculatus](http://wiki.bugwood.org/Celastrus_orbiculatus)

### Invasive Plant Atlas of New England, Oriental bittersweet

[http://www.eddmaps.org/ipane/ipanespecies/vines/Celastrus\\_orbiculatus.htm](http://www.eddmaps.org/ipane/ipanespecies/vines/Celastrus_orbiculatus.htm)

### Midwest Invasive Species Information Network, Oriental Bittersweet

<http://www.misin.msu.edu/facts/detail.php?id=19>

### The Michigan Department of Agriculture and Rural Development—Pesticide Certification

[www.michigan.gov/pestexam](http://www.michigan.gov/pestexam)

### The Michigan Department of Environmental Quality—Aquatic Nuisance Control

[www.michigan.gov/deq/inlandlakes](http://www.michigan.gov/deq/inlandlakes)

[http://www.michigan.gov/deq/0,4561,7-135-3313\\_3681\\_3710---,00.html](http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html)

### Michigan Department of Natural Resources—Local DNR Fire Manager contact list

[http://www.michigan.gov/dnr/0,4570,7-153-30301\\_30505\\_44539-159248--,00.html](http://www.michigan.gov/dnr/0,4570,7-153-30301_30505_44539-159248--,00.html)

### Michigan's Invasive Species Legislation

Natural Resources and Environmental Protection Act 451 of 1994, Section 324.4130

<http://legislature.mi.gov/doc.aspx?mcl-324-41301>

### Michigan Legislation—landscape waste, disposal of invasive species plant parts

Natural Resources and Environmental Protection Act 451 of 1994, Section 324.11521, 2 (d)

<http://legislature.mi.gov/doc.aspx?mcl-324-11521>

### The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas

<http://www.invasive.org/gist/handbook.html>

### University of Michigan Herbarium - Michigan Flora Online

<http://michiganflora.net/>



## Quick reference - Oriental bittersweet

This chart has been provided as a convenience, to summarize the pros and cons of each herbicide and to present details on adjuvants, concentrations, etc. that do not fit into the discussion in the preceding sections. Although every attempt has been made to ensure accuracy, the product labels for the listed herbicides are the ultimate authority for their usage. Where there are conflicts, always follow the label directions. Techniques are listed in order of general preference by MDNR Wildlife Division staff but not all are suitable for wetlands or sensitive sites. Site conditions vary—choose a method that is best suited to conditions on the site being treated.

Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. Concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

	<b>Herbicide</b>	<b>% A.I.</b>	<b>Adjuvant</b>	<b>Timing</b>	<b>Pros</b>	<b>Cons</b>
<b>Basal Bark</b>	<b>Triclopyr ester</b> (e.g., Garlon 4 Ultra®)	27%	Use a penetrating oil (e.g., AX-IT <sup>®</sup> ), unless it is already included in product, e.g. Michigan blend.	For plants LESS than 1 inch in diameter.  Use any time of year, including winter months EXCEPT during heavy spring sap flow  OR when snow or water prevent application at ground level  OR when stems are saturated.	Relatively selective herbicide and technique.	Since stems have a small diameter, the sides must be treated so that enough herbicide will be absorbed.  Not approved for use in wetlands.
<b>Cut-stump</b>	<b>Triclopyr ester</b> (e.g., Garlon 4 Ultra®)	27%	Use a penetrating oil (e.g., AX-IT <sup>®</sup> ), unless it is already included in product, e.g. Michigan blend.	For plants GREATER than 1 inch in diameter cut stems about 6 inches high and apply to outside of stem also.  Use any time EXCEPT spring, while sap is flowing upward.	Relatively selective herbicide and technique.	Labor intensive.  Not approved for use in wetlands.
<b>Injection</b>	<b>Triclopyr amine</b> (e.g., Garlon 3A®, Renovate®)	27%		Use any time EXCEPT during spring sap flow.  (Inject 5 ml into cambium at 3-4 inch intervals around entire stem at any convenient height.)	Extremely selective herbicide and technique.  Safe for use in wetlands, sensitive areas.	Somewhat labor intensive.
<b>Foliar Spray</b>	<b>Triclopyr amine</b> (e.g., Garlon 3A®, Renovate®)	2-3%	Some products already contain a surfactant—if not, add one (e.g. Cygnet Plus®, Nu-Film IR®).	After spring sap flow while plant is actively growing but before leaves change color.	Safe for use in wetlands.  Broad-leaf specific—will not harm sedges and grasses.	Since it must be used during the growing season, it is not a suitable technique for high-quality sites with many broad-leaf natives.