Vinca major, V. minor

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Common periwinkle.
Photo by Dan Tenaglia, Missouriplants.com, Bugwood.org

AUTHORSHIP AND CITATION:
Stone, Katharine R. 2009. Vinca major, V. minor. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2010, February 8].

FEIS ABBREVIATION:
VINSPP
VINMAJ
VINMIN

NRCS PLANT CODE [106]:
VIMA
VIMI2

COMMON NAMES:
bigleaf periwinkle
big periwinkle
greater periwinkle
large periwinkle
periwinkle
vinca

common periwinkle
lesser periwinkle
periwinkle
vinca

TAXONOMY:
The genus name for periwinkles is *Vinca* L. (Apocynaceae). This review summarizes information on the following periwinkle species [29,42,61,78,113]:

Vinca major L., **bigleaf periwinkle**
Vinca minor L., **common periwinkle**

In this review, species are referred to by their common names, and "periwinkles" refers to both species.

Numerous periwinkle cultivars are available [30,66].

SYNONYMS:
None

LIFE FORM:
Vine-forb

FEDERAL LEGAL STATUS:
None

OTHER STATUS:
Information on state-level noxious weed status of plants in the United States is available at Plants Database.

DISTRIBUTION AND OCCURRENCE

SPECIES: Vinca major, V. minor

- GENERAL DISTRIBUTION
- HABITAT TYPES AND PLANT COMMUNITIES

GENERAL DISTRIBUTION:
Bigleaf periwinkle is native to Mediterranean Europe [1,4], Asia Minor [1], and northern Africa (review by [10]). **Common periwinkle** is native across all of continental Europe as far north as the Baltic States [86]. Both **bigleaf** [51,55,92,107] and **common** [29,42,50,55,97,100,103,117] **periwinkle** are frequently planted in North America and escape from cultivation. Periwinkles may also spread with the dumping of yard waste ([17,37], review by [10]). A review of 19th-century floras documented periwinkles in the United States by the late 1700s [112].

In the United States, **bigleaf periwinkle** has a U-shaped distribution from New York and Massachusetts in the east, south to Georgia, west to California, and north to Washington. Exceptions to this distributional pattern include Connecticut, Rhode Island, New Jersey, West Virginia, Florida, Oklahoma, and Nevada. **Bigleaf periwinkle** does not occur in the majority of the states in the Northern Great Plains or Northern and Central Rockies. **Common periwinkle** occurs in every state in the eastern United States from Minnesota south to Louisiana. It is discontinuously distributed in the western United States, occurring in Nebraska, Kansas, Texas, Arizona, Utah, Oregon, Washington, and Montana. The Plants Database provides a map of **bigleaf** and **common periwinkle** distributions in North America.

HABITAT TYPES AND PLANT COMMUNITIES:
Plant community descriptions are given below for bigleaf periwinkle and common periwinkle.

Bigleaf periwinkle: Plant community descriptions for **bigleaf periwinkle** are organized into eastern and western regions of the United States. In both regions, **bigleaf periwinkle** is most problematic to managers in riparian or canyonbottom habitats (see Impacts).

Eastern:
Along the Potomac River in Virginia, **bigleaf periwinkle** occurred in a riverbank forest dominated by white oak (*Quercus alba*), southern red oak (*Q. falcata*), northern red oak (*Q. rubra*), and white ash (*Fraxinus americana*) as well as several nonnative herbaceous species [112]. Along the Ohio River in Ohio, **bigleaf periwinkle** occurred in the understory on a floodplain terrace beneath boxelder (*Acer negundo*) and hackberry (*Celtis occidentalis*) [4].

Western:
In California, **bigleaf periwinkle** occurred in redwood (*Sequoia sempervirens*) forests throughout redwood's distribution in the state [87]. In the northern Diablo Range, **bigleaf periwinkle** occurred in oak (*Quercus* spp.) woodlands and coastal shrub communities that contained the federally threatened pallid manzanita (*Arctostaphylos pallida*) [107]. **Bigleaf periwinkle** may develop as a local dominant in riparian woodland communities containing willows (*Salix* spp.), cottonwoods (*Populus* spp.), sycamores (*Platanus* spp.), alders (*Alnus* spp.), maples (*Acer* spp.), ashes (*Fraxinus* spp.), and oaks [71].

On the Marin Peninsula of California, **bigleaf periwinkle** occurred in an annual grassland-coastal scrub mosaic dominated by nonnative grasses. Patches of coyote bush (*Baccharis pilularis*), silverleaf cotoneaster (*Cotoneaster pannosus*), narrowleaf plantain (*Plantago lanceolata*), evergreen blackberry (*Rubus laciniatus*), and poison hemlock (*Conium maculatum*) were also present [75].

In Arizona, **bigleaf periwinkle** occurred near dwellings, covering steep banks and rock walls in a riparian canyon bottom. Dominant trees along the stream included Arizona alder (*Alnus oblongifolia*), Arizona sycamore (*P. wrightii*), and Fremont cottonwood (*Populus fremontii*). The riparian area was closely bordered by ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and several species of oaks (Arizona white oak (*Q. arizonica*), shrub live oak (*Q. turbinella*), Gambel oak (*Q. gambelii*), and Emory oak (*Q. emoryi*)) [70]. In the Huachuca Mountains, **bigleaf periwinkle** occurred in a mixed-broadleaf riparian forest with Arizona sycamore, bigtooth maple (*A. grandidentatum*), velvet ash (*F. velutina*), and gray oak (*Q. grisea*) [83]. **Bigleaf periwinkle** occurred in a canyon bottom at The Nature Conservancy's Ramsey Canyon Preserve. It was restricted to the "shade zone" provided by a riparian tree canopy dominated by Arizona sycamore (Gebow 2009 personal communication [41]).

Common periwinkle: Descriptions of plant communities in which **common periwinkle** occurs are organized into the following regions of the United States: Northeast, Great Lakes, Southern Appalachian, and Southeast. Forested and nonforested plant community descriptions are presented where available. Though not problematic to managers throughout its range, **common periwinkle** establishment may negatively impact native plants in forest understories, particularly in the Great Lakes region (see Impacts).

Northeast:
Forested: In New York County, New York, **common periwinkle** occurred in successional forests of yellow-poplar (*Liriodendron tulipifera*), northern red oak, and white oak [67]. Near Washington, DC, **common periwinkle** occurred but was not particularly problematic in deciduous forests and along forest edges. Common canopy trees included

American beech (*Fagus grandifolia*), white oak, northern red oak, southern red oak, chestnut oak (*Q. prinus*), black oak (*Q. velutina*), yellow-poplar, bitternut hickory (*Carya cordiformis*), pignut hickory (*C. glabra*), and mockernut hickory (*C. tomentosa*) [37]. At Mt Vernon, Virginia, **common periwinkle** occurred on ravine slope communities with American beech, pawpaw (*Asimina triloba*), witch-hazel (*Hamamelis virginiana*), and wild hydrangea (*Hydrangea arborescens*) [112]. In northeastern West Virginia, **common periwinkle** occurred in an eastern hemlock (*Tsuga canadensis*) forest; American beech, black cherry (*Prunus serotina*), ashes, yellow birch (*Betula alleghaniensis*), northern red oak, white oak, red maple (*Acer rubrum*), sugar maple (*A. saccharum*), cucumber-tree (*Magnolia acuminata*), and yellow-poplar also occurred in the overstory [9].

Nonforested: In New York County, New York, **common periwinkle** occurred in successional fields with honeysuckle (*Lonicera* spp.), Asiatic day-flower (*Commelina communis*), and Japanese wisteria (*Wisteria floribunda*) under a sparse canopy of plumleaf crab apple (*Malus prunifolia*) and northern red oak [67]. At the Richmond National Battlefield Park in Virginia, **common periwinkle** was found on a former landfill site dominated by broomsedge bluestem (*Andropogon virginicus*), with scattered clumps of sericea lespedeza (*Lespedeza cuneata*) and black raspberry (*R. occidentalis*). **Common periwinkle** also occurred along a roadside with the nonnative Japanese stiltgrass (*Microstegium vimineum*) [48].

Great Lakes:

Forested: In southeastern Ohio, **common periwinkle** was a "frequent" species in mesic ravines, stream terraces, and young woods (<30 years since canopy closure), The mixed-mesophytic forests contained red maple, sugar maple, shagbark hickory (*Carya ovata*), American beech, green ash (*F. pennsylvanica*), yellow-poplar, black cherry, and northern red oak [47]. In Michigan, **common periwinkle** occurred in large patches in a dune successional forest dominated by mature American beech, black maple (*Acer nigrum*), and northern red oak [28]. On the eastern shore of Lake Michigan, **common periwinkle** occurred in a dune successional forest dominated by American beech, sugar maple, and black maple. Black cherry and northern red oak were also present [17]. In southwestern Illinois, **common periwinkle** occurred in mature forest comprised of mostly white oak, bitternut hickory, mockernut hickory, and shagbark hickory [88].

Nonforested: In southeastern Ohio, **common periwinkle** occurred in grassy meadows along roadsides and in fields. These communities were dominated by grasses (*Agrostis* spp., *Panicum* spp., *Poa* spp., orchardgrass (*Dactylis glomerata*)), poverty rush (*Juncus tenuis*), sedges (*Carex* spp.), plantain (*Plantago* spp.), and clover (*Trifolium* spp.). Approximately 40% of the species were nonnative [90].

Southern Appalachians:

Forested: In Tennessee, **common periwinkle** formed dense mats in the understory of a second-growth oak-hickory (*Carya* spp.) forest that contained maples [32]. Also in Tennessee, **common periwinkle** occurred in upland oak-hickory forests containing white oak, post oak (*Q. stellata*), southern red oak, northern red oak, mockernut hickory, pignut hickory, black cherry, black tupelo (*Nyssa sylvatica*), and sweetgum (*Liquidambar styraciflua*). Some upland forests were dominated by shortleaf pine (*Pinus echinata*), Virginia pine (*P. virginiana*), and loblolly pine (*P. taeda*) [60]. In an uneven-aged suburban forest near Atlanta, Georgia, **common periwinkle** occurred with overstory yellow-poplar, white oak, hickories, loblolly pine, American beech, and northern red oak [40].

Southeast:

Forested: **Common periwinkle** occurred in upland island and dike areas of the Savannah River Refuge in South Carolina. Dominant trees of the islands included live oak (*Q. virginiana*), water oak (*Q. nigra*), sweetgum, pignut hickory, sugarberry (*Celtis laevigata*), and loblolly pine. Dominant vegetation of the dikes included chinaberry (*Melia azedarach*), tallowtree (*Triadica sebifera*), and black willow (*S. nigra*) [36]. In southwestern Georgia, **common periwinkle** was a rare species in open forests containing oaks, hickories, shortleaf pine, loblolly pine, and flowering dogwood (*Cornus florida*) [100].

Nonforested: **Common periwinkle** occurred on coastal dunes of southern Florida. Characteristic dune species included reindeer lichens (*Cladonia* spp.), armored spikemoss (*Selaginella armata*), live oak, tallow wood (*Ximenia americana*), inkberry (*Ilex glabra*), erect prickly-pear (*Opuntia dillenii*), coastal plain staggerbush (*Lyonia fruticosa*), wild allamanda (*Urechites lutea*), groundsel-tree (*Baccharis halimifolia)*, palafoxia (*Palafoxia* spp.), avocado (*Persea americana*), banana (*Musa paradisiaca*), and scrub oaks [24].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Vinca major, V. minor

- GENERAL BOTANICAL CHARACTERISTICS
- SEASONAL DEVELOPMENT
- REGENERATION PROCESSES
- SITE CHARACTERISTICS
- SUCCESSIONAL STATUS

GENERAL BOTANICAL CHARACTERISTICS:

- **Botanical description**
- **Raunkiaer life form**

Botanical description: The following descriptions cover characteristics that may be relevant to fire ecology and are not meant for identification. Keys for identification are available (e.g., for **bigleaf periwinkle**: [29,42,51,78,113]; for **common periwinkle**: [29,42,78,97,113]).

Periwinkles are vines [42,113] with scrambling or trailing stolons up to 3 feet (1 m) long and vertical stems 1 foot (30 cm) high [72]. The succulent stems become somewhat woody at the caudex [72]. **Bigleaf periwinkle** leaves are semievergreen [78], have a waxy cuticle [10], and are heart-shaped to triangular. They are 1.5 to 2.5 inches (4 to 6 cm) long [72]. **Common periwinkle** leaves are evergreen [113], narrow, elliptic, and 0.8 to 1.8 inches (2 to 4.5 cm) long [72].

Periwinkle flowers are violet to blue-lavender, with 5 petals radiating pinwheel-like at right angles from floral a tube. Flowers are infrequently white. The flowers of **bigleaf periwinkle** are larger than those of **common periwinkle** [72].

Periwinkle fruits are slender, cylindrical follicles up to 2 inches (5 cm) long [72]. Follicles dry, split, and release 3 to 5 seeds (review by [72]). Periwinkle seeds are naked and without a coma [29].

Common (left) and bigleaf (right) periwinkle flowers.
Photo by Barry Rice, sarracenia.com, Bugwood.org

Periwinkles are "fairly deep-rooted" (review by [79]). **Common periwinkle** plants in western Montana exhibited fibrous roots ranging from 1 to 3 inches (3-8 cm) long [96]. Further descriptions of roots were unavailable as of 2009.

Raunkiaer [82] life form:

Chamaephyte
Hemicryptophyte

SEASONAL DEVELOPMENT:
Bigleaf periwinkle generally flowers from March to June [4,29,42,78] but may bloom year-round in north-central Texas [29]. In the Carolinas **bigleaf periwinkle** produces fruit in June and July [78].

Common periwinkle generally flowers from between March and June depending on location [4,29,42,45,50,78,97]. In Georgia, most **common periwinkle** flowering occurs in early March, though flowering was observed as early as 28 February [40]. **Common periwinkle** fruits are produced from May to July in the southeastern United States ([78], review by [72]).

REGENERATION PROCESSES:

- **Vegetative regeneration**
- **Pollination and breeding system**
- **Seed production**
- **Seed dispersal**
- **Seed banking**
- **Germination**
- **Seedling establishment and plant growth**

Most periwinkle reproduction occurs through vegetative spread. Seeds are rarely produced [7,45,113], and seedlings are rarely observed in the field ([21], review by [7]).

Vegetative regeneration: Vegetative regeneration is very important to the establishment and spread of both **bigleaf** ([74,113], reviews by [81,111]) and **common** ([66,88], review by [81]) periwinkles. **Bigleaf periwinkle** spreads with "great rapidity" by arching stolons, which root at the tips (review by [7]). Periwinkles form mats and extensive infestations even under forest canopies ([32], review by [72]). Given their ability to spread with the dumping of yard waste ([17,37], review by [10]), it is likely that periwinkles establish from plant fragments.

Stolons and roots of **common periwinkle**.
Photo by Katharine Stone, Rocky Mountain Research Station

Bigleaf periwinkle grows in patches around the bases of trees or spreads up and down drainages through vegetative spread (review by [7]). In Belgium, **common periwinkle** distribution was not significantly clumped within forest patches despite its inability to disperse long distances (P>0.05) [56]. See Impacts for more information about vegetative rate of spread in periwinkles.

Pollination and breeding system: Periwinkles are cross-pollinating plants [38].

Seed production: One review states that **bigleaf periwinkle** does not reproduce by seed in the wild in California [7], though occasional seedlings have been found [21]. **Common periwinkle** rarely produces seeds [45,113].

Seed dispersal: No information is available on the dispersal of **bigleaf periwinkle** seeds. **Common periwinkle** seeds are dispersed by ants in its native range [54,56]. Some authors suggest that **common periwinkle** has no active dispersal mechanism [44]. One review states that **common periwinkle** does not spread to new areas by seed in its nonnative range [81].

Seed banking: There is limited information on seed banking in periwinkles. Though **bigleaf periwinkle** was the most abundant species in riparian areas in the Huachuca Mountains of Arizona, it was a minor component of the soil seed bank. Perennial, herbaceous native species dominated soil seed bank samples [83].

Germination: As of 2003, periwinkle seed viability in the field was unknown (review by [72]). In laboratory studies, **common periwinkle** seeds exhibited an "extended dormancy period"; 70% germination occurred after 30 days using a combination of acid scarification and 90-day cold stratification. No germination occurred after 30-day stratification-scarification treatment or scarification treatment alone [110].

Seedling establishment and plant growth: Documentation of periwinkle establishment by seed is rare. **Bigleaf periwinkle** seedlings were found in riparian areas in California [21], though seedlings are rarely found in the field (review by [7]). Documentation of **common periwinkle** seedlings was not found in the literature as of 2009.

Limitations to periwinkle growth have been infrequently documented. **Bigleaf periwinkle** growth is limited by dry or cold temperatures, and hot, dry weather may cause death (review by [7]). **Bigleaf periwinkle** was limited to shady areas of a riparian canyon bottom at the Ramsey Canyon Preserve (Gebow 2009 personal communication [41]).

SITE CHARACTERISTICS:

General site types: Bigleaf periwinkle occurs in riparian areas ([6,21,29,33,34,49,71,112], reviews by [81,111]), forests ([29], reviews by [72,111]), grasslands, and coastal dunes (review by [111]). **Bigleaf periwinkle** is also associated with sites linked to human activities, including old homesites ([74,78,94], review by [72]), gardens [55], roadsides [55,92], "waste" areas ([55,78], review by [72]), and other highly disturbed areas [55].

Common periwinkle occurs in forests or "wooded" areas [29,37,45,57,60,78], including both open ([42,100,115], review by [72]) and closed ([53], reviews by [72,81]) forest. **Common periwinkle** also occurs along forest edges ([37], review by [25]), within second-growth forest [32], and in fields or meadows [77,78,90]. **Common periwinkle** is found along roadsides [3,18,42,47,48,78,94,97,100,115] or trail edges [47], at homesites ([12,35,50,74,84,85,94,103], review by [72]), in gardens [55] or yards [94], cemeteries [57,97], "waste" places [3,55,78,115], and in other disturbed sites [8,55,101,117]. At an "ancient" archeological site in the oak-beech forest region of France, **common periwinkle** was most abundant in disturbed areas including abandoned homesites, enclosures, and agricultural terraces, but was also found to a lesser extent in areas that showed no archeological evidence of human disturbance [35].

Elevation: Periwinkles occur at a range of elevations from sea level to 7,500 feet (2,300 m).

Elevation for sites with periwinkles in their nonnative ranges		
Species	Location	Elevation (feet)
Bigleaf periwinkle	California	7 to 650 [49]
	North Carolina	5 [92]
	Utah	5,000 [113]
Common periwinkle	Florida	0 [24]
	Utah	7,500 [113]
	West Virginia	1,200 to 2,500 [9,18]

Climate: In their nonnative ranges, periwinkles do best in mild climates [4,99]. Few authors report climate data for sites with periwinkles; therefore, the climate data presented here may not represent climatic conditions throughout the nonnative ranges of periwinkles. Both species occur near Washington, DC, where the average daily temperature is 55.0 °F (12.8 °C) [94]. In Arkansas, periwinkles occur in an area with hot summers and moderately cool winters; only 4 days/year have snowfall >1.0 inch (2.5 cm). The first and last frosts in this region occur in early April and late October, respectively [55]. **Bigleaf periwinkle** occurs in the Huachuca Mountains, where mean daily temperatures are 79 °F (26 °C) in July and 48 °F (9 °C) in January [83]. **Common periwinkle** occurs on sites with mean daily temperatures in January as low as -7.8 °F (-22.1 °C) in New York [93], and in July as high as 82.2 °F (27.9 °C) in southwestern Georgia [100].

Annual rainfall is variable across the nonnative ranges of periwinkles.

Average annual rainfall for sites with periwinkles in their nonnative ranges		
Species	Location	Annual rainfall (mm)
Both species	Arkansas	1,080 [55]
	Washington, DC	1,114 [94]
Bigleaf periwinkle	Arizona	400 [83]
	North Carolina	1,417 [92]
Common periwinkle	Georgia	1,211 to 1,367 [100]
	Illinois	963 [88]
	New York	890 [93]
	West Virginia	1,209 [18]

Periwinkles are somewhat drought tolerant; a review suggests that **bigleaf periwinkle** is more tolerant of drought than **common periwinkle** [79]. One review reports that hot, dry weather may cause **bigleaf periwinkle** death [7]. All **bigleaf periwinkles** in a greenhouse died after exposure to drying winds and intense heat (>100° F (38° C) for more than 10 days) [114]. Cold weather may damage **bigleaf periwinkle** (review by [7]), though one population in Ohio survived 2 of "the most severe winters of the past century, those of 1976 to 1977 and 1977 to 1978" [4].

Soils: Periwinkles are found on soils with a range of characteristics.

Parent material: **Bigleaf periwinkle** occurs on soils derived from granite, gneiss, or schist in Georgia [22]. In north-central Texas, it is associated with limestone [29].

Texture: In the Huachuca Mountains, **bigleaf periwinkle** occurs mainly on sandy-loam and sandy clay-loam riparian soils [83]. In its native range, **common periwinkle** is associated with soils of varying textures [35,44,53]. **Common**

periwinkle occurs on silt loams in Ohio [58] and Illinois [88], clayey, loamy, and sandy soils in the Northeast [68], and rocky, sandy soil in Missouri [99].

Other soil characteristics: A review states that **bigleaf periwinkle** grows most vigorously in moist soil with only partial sun but may grow in deep shade with "poor" soil [7]. In Georgia, **bigleaf periwinkle** is associated with acidic clays [22]. **Common periwinkle** prefers moist sites [28,76,88], though it tolerates moderately well-drained soil [68]. While some sources suggest **common periwinkle** prefers fertile soil ([28], review by [25]), one source states that **common periwinkle** tolerates soils of low fertility [68]. In the oak-beech forest region of France, **common periwinkle** occurred on shallow soils ranging from 5.7 to 8.7 inches (14.4-22.1 cm) deep [35]. In its nonnative range, **common periwinkle** occurs on acid soils [18,68,88]. In France, **common periwinkle** occurred on soils with pH ranging from 6.7 to 7.2 [35].

SUCCESSIONAL STATUS:
As of this writing (2009), very little information was available regarding successional relationships of periwinkles. Periwinkles are not restricted to either seral or climax plant communities. They tolerate both sun [68,101] and shade ([66,68,76,99],reviews by [7,111]). They may be found in habitats created and/or maintained by long-term human disturbance (e.g., roadsides, cemeteries, old fields) [3,18,42,47,48,55,78,94,97,100,103] or in relatively undisturbed areas such as forest understories [4,9,32,37,40,70,71,88,112].

Bigleaf periwinkle often occurs in riparian forest understories [4,70,71,112]. Though restricted to the "shade zone" of a riparian canyon bottom in Arizona (Gebow 2009 personal communication [41]), **bigleaf periwinkle** also establishes in open habitats including woodlands [107], grassland-coastal scrub [75], grasslands [31], and roadsides [55,92]. **Common periwinkle** occurs in forest understories [9,32,37,40,60,67,88,112] including successional [17,28,32,47,67] and mature [88] forests. **Common periwinkle** also grows well in open habitats [68,101] including coastal dunes [24], successional fields [67], former landfill sites [48], grassy meadows [90], and roadsides [3,18,42,47,48,78,94,97,100,115]. See Habitat Types and Plant Communities for specific community associations of **bigleaf** and **common periwinkle**.

Periwinkles may alter successional trajectories in the plant communities in which they occur. The tendency for periwinkles to dominate the forest understory by forming dense mats means that native species are often prevented from establishing or persisting. See Impacts for more information about how periwinkles may alter native plant communities, particularly in riparian and mixed-hardwood dune successional forests. When periwinkles occur in habitats created and/or maintained by long-term human disturbance (e.g., roadsides, cemeteries, old fields), their presence alone may not alter successional trajectories.

FIRE EFFECTS AND MANAGEMENT

SPECIES: Vinca major, V. minor

- FIRE EFFECTS
- FUELS AND FIRE REGIMES
- FIRE MANAGEMENT CONSIDERATIONS

FIRE EFFECTS:
Immediate fire effect on plant: As of this writing (2009), there was no published information on the immediate effects of fire on periwinkles. Stoloniferous species such as periwinkles may be easily damaged or killed by fire. Periwinkle stolons lie on or above the soil surface [72,96], so they are not insulated by mineral soil [95]. It is likely that fire kills stolons and other aboveground portions of periwinkles; however, caudices lying beneath the soil surface are probably only top-killed. As of 2009, no information was available regarding fire effects on or heat tolerance of periwinkle seeds.

Postfire regeneration strategy [95]:
Surface rhizome and/or a chamaephytic root crown in organic soil or on soil surface
Caudex or an herbaceous root crown, growing points in soil

Fire adaptations and plant response to fire:

Fire adaptations: As of this writing (2009), there was no published information pertaining to periwinkle adaptations to fire. Poor seed reproduction (see Regeneration Processes) and vulnerability of stolons to fire and suggest that periwinkles are not well-adapted fire. Since the few periwinkle seeds that are produced are naked and lack a coma [29] or other adaptations for dispersal, it is unlikely that seeds would survive fire or easily disperse into a burned area. If the caudices are not killed, periwinkles may sprout from their caudices after fire. The ability of periwinkles to spread vegetatively suggests that it may be possible for an existing population to spread into a burned area, especially if the fire is patchy and leaves unburned refugia from which unburned plants can spread. However, postfire vegetative spread of periwinkles had not been documented as of 2009.

Plant response to fire: As of this writing (2009), there was very little information available pertaining to periwinkle response to fire. One review states that periwinkles readily sprout after fire [79], though no specific information is given in regard to fire conditions, fire severity, or plant response time. A study from Yosemite National Park, California, documents **bigleaf periwinkle** occurring at very low abundance in a single plot that burned sometime between 1930 and 1999. No specific information was given [62].

FUELS AND FIRE REGIMES:

Fuels: As of this writing (2009), there was no information available regarding the flammability of periwinkles. Some evidence suggests that periwinkles may alter local fuel characteristics by changing community structure, litter dynamics, fuel arrangement, and understory temperatures. In Michigan, understory structure in a mixed-hardwood dune successional forest was changed when mats of **common periwinkle** replaced canopy tree seedlings and herbaceous understory plants [17]. **Common periwinkle** also greatly reduced the overall accumulation of leaf litter in this area (Bultman personal observation cited in [17]). In mature oak-hickory forest in southwestern Illinois, **common periwinkle** in the understory led to an increase in the amount of vegetated surface area [88]. Near Sydney, Australia, areas dominated by **bigleaf periwinkle** had significantly cooler temperatures than sites with little **bigleaf periwinkle** cover ($P<0.01$) [31]. The impact of these altered fuel characteristics likely varies based on departure from historical conditions and the dynamics of local fire regimes.

Fire regimes: It is not known what type of fire regime periwinkles are best adapted to. In North America, periwinkles are found in plant communities that historically experienced long (e.g., northern hardwood, southern floodplain forests) and short (e.g., Appalachian oak-hickory-pine forests) fire-return intervals (see the Fire Regime Table). In many areas where periwinkles occur, historical fire regimes have been dramatically altered due to fire exclusion and massive disturbances associated with human settlement.

It is unclear how the presence of periwinkles may affect fire regimes in invaded communities. In ecosystems where periwinkles replace plants with similar fuel characteristics, they may alter fire intensity or slightly modify an existing fire regime. If periwinkle spread introduces novel fuel properties to the invaded ecosystem, fire behavior, and potentially fire regime, may be altered (see these citations: [14,26]). This topic warrants additional study.

See the Fire Regime Table for further information on fire regimes of vegetation communities in which periwinkles may occur.

FIRE MANAGEMENT CONSIDERATIONS:

Preventing postfire establishment and spread: Preventing invasive plants from establishing in weed-free burned areas is the most effective and least costly management method. This can be accomplished through early detection and eradication, careful monitoring and follow-up, and limiting dispersal or spread of invasive plants. General recommendations for preventing postfire establishment and spread of invasive plants include:

- Incorporate cost of weed prevention and management into fire rehabilitation plans

- Acquire restoration funding
- Include weed prevention education in fire training
- Minimize soil disturbance and vegetation removal during fire suppression and rehabilitation activities
- Minimize the use of retardants containing nitrogen and phosphorus
- Avoid areas dominated by high priority invasive plants when locating firelines, monitoring camps, staging areas, and helibases
- Clean equipment and vehicles prior to entering burned areas
- Regulate or prevent human and livestock entry into burned areas until desirable site vegetation has recovered sufficiently to resist invasion by undesirable vegetation
- Monitor burned areas and areas of significant disturbance or traffic from management activity
- Detect weeds early and eradicate before vegetative spread and/or seed dispersal
- Eradicate small patches and contain or control large infestations within or adjacent to the burned area
- Reestablish vegetation on bare ground as soon as possible
- Avoid use of fertilizers in postfire rehabilitation and restoration
- Use only certified weed-free seed mixes when revegetation is necessary

For more detailed information on these topics see the following publications: [5,13,43,105].

Use of prescribed fire as a control agent: As of this writing (2009), no studies used prescribed fire to control periwinkles. Repeated application of flame with a blowtorch in the rainy season was used to control **bigleaf periwinkle** at the Elkhorn Slough National Estuarine Research Reserve in California. Though **bigleaf periwinkle** cover was reduced significantly on treated plots compared to control plots (P=<0.001), eradication was not accomplished. The 40% reduction in **bigleaf periwinkle** cover was not high enough for the authors to recommend this control method [11].

Altered fuel characteristics: Periwinkles may alter local fuels characteristics by changing community structure, litter dynamics, fuel arrangement, and understory temperatures. See Fuels for more information.

MANAGEMENT CONSIDERATIONS

SPECIES: Vinca major, V. minor

- IMPORTANCE TO WILDLIFE AND LIVESTOCK
- OTHER USES
- IMPACTS AND CONTROL

IMPORTANCE TO WILDLIFE AND LIVESTOCK:

Palatability and/or nutritional value: Periwinkles are generally unpalatable and have little nutritional value. **Bigleaf periwinkle** is listed as poisonous in South Africa [16]. **Common periwinkle** was an infrequent food item of the volcano rabbit in Mexico [20] and white-tailed deer in Indiana [91]. Caged Canada geese would not feed on **common periwinkle**, even when it was the only forage available [23].

Cover value: No information is available on this topic.

OTHER USES:

Periwinkles are popular ornamental groundcovers [10,37,68]. Their establishment in North America is largely due to their escape from cultivation [29,42,50,51,55,92,97,100,103,107]. **Common periwinkle** is easily propagated by cuttings [66]. **Common periwinkle** was planted for erosion control near Washington, DC [37]. Periwinkles are valued medicinal herbs (reviews by [7,81]), and **common periwinkle** is considered an aphrodisiac (review by [81]).

IMPACTS AND CONTROL:

Impacts: The ability of periwinkles to establish and spread is inconsistent throughout their nonnative ranges. Consequently, impacts may vary depending on location. Regular monitoring of existing periwinkle populations is recommended to minimize potential impacts. As of 2008, periwinkles covered an estimated 29,254 acres (11,839 ha) across 12 southern states, with the majority of cover in Virginia (14, 419 acres (5835 ha)) [73].

Bigleaf periwinkle infestation.
Photo by Nancy Loewenstein, Auburn University, Bugwood.org

The tendency of periwinkles to form dense mats under forest canopies (review by [72]) may lead to the exclusion of native species [74]. In Ohio, a dense stand of **bigleaf periwinkle** covered a 148- × 197-foot (45 × 60 m) terrace above the Ohio River floodplain [4]. **Bigleaf periwinkle** has replaced native vegetation throughout its nonnative range ([2,27,29,31], reviews by [7,10,111]), and is particularly problematic to managers in riparian and wetland areas of the south and central coasts of California [33]. It may suppress the recruitment of shrub and tree seedlings (reviews by [80,111]). In the northern Diablo Range of California, **bigleaf periwinkle** was one of a number of nonnative species blocking light to the federally threatened pallid manzanita, resulting in "unhealthy", diseased, and dying pallid manzanita plants in some areas [107]. In riparian areas of California, **bigleaf periwinkle** is an important year-round host to the bacteria causing Pierce's disease, a threat to California's vineyards [6].

Bigleaf periwinkle's replacement of native vegetation may have cascading effects on other organisms. In a cemetery near Sydney, Australia, 40% of the groundcover once suitable as habitat for the garden skink was covered with a 6-inch (15 cm) high mat of **bigleaf periwinkle**. Grasses were the alternative groundcover in this area. Garden skinks were placed in enclosures with sparse, intermediate, and dense levels of **bigleaf periwinkle** cover, and their behavior was monitored. Temperatures under sparse **bigleaf periwinkle** cover were significantly warmer than temperatures under dense **bigleaf periwinkle** cover ($P<0.01$), where the preferred temperature for garden skink activity was never reached. The garden skinks in enclosures with dense **bigleaf periwinkle** cover were forced to climb into the **bigleaf periwinkle** canopy to achieve optimal basking temperatures, requiring them to expend energy and potentially expose themselves to predation. Garden skinks in enclosures with dense **bigleaf periwinkle** cover had slower growth rates, longer limbs, faster sprinting speeds, and lower clutch masses than those in enclosures with sparse or intermediate levels of **bigleaf periwinkle**, which the authors attributed to the changes in basking and hiding behaviors they observed [31].

A population of **bigleaf periwinkle** in a riparian area at the Ramsey Canyon Preserve allegedly suppressed natural erosion, which in turn altered local hydrology and vegetation (review by [10]). However, staff at the Ramsey Canyon Preserve believed these impacts were unsubstantiated (Gebow 2009 personal communication [41]).

Common periwinkle may replace native species ([28,32], review by [25]). In mixed-hardwood dune successional forests in Michigan, sites with **common periwinkle** had significantly fewer native tree seedlings than paired sites without **common periwinkle** (P=0.0045). However, dense mats of **common periwinkle** formed at only one site despite its establishment in several locations [17]. In field tests where **common periwinkle** cover was removed, there was increased survival of native tree seedlings. Laboratory tests suggested that **common periwinkle** allelopathy limited native woody tree seedling growth but not seed germination. However, light competition from **common periwinkle** was thought to be more important than allelopathy in suppressing native woody tree seedlings [28]. In

Michigan, the presence of **common periwinkle** was associated with reduced abundance of native spiders, as well as changes in spider guilds [17].

Common periwinkle may not be problematic at all locations. In mature oak-hickory forest in Illinois, there was no difference in the diversity, evenness, or richness of native plants between areas with established **common periwinkle** and reference areas without **common periwinkle**, leading to the conclusion that "Our limited case study provides little evidence that vinca invasion poses a threat to plant species diversity" [88]. In Canada, **common periwinkle** was rated as "a limited invasive of a local nature that is stable" [115].

Common periwinkle infestation.
Photo by Chris Evans, River to River CWMA, Bugwood.org

Rate of spread: **Bigleaf periwinkle** may spread with "great rapidity" (review by [7]).

In its native range, **common periwinkle** is considered a "slow colonizer". Researchers in Belgium looked at the spread of **common periwinkle** from forest relicts into establishing forests ranging from approximately 20 to 120 years old. The maximum distance from a relict forest in which **common periwinkle** was found was 164 feet (50 m); it averaged 43 feet (13 m). The maximum rate at which **common periwinkle** spread was 98 feet (30 m) in a century; it averaged 52 feet (16 m) in a century [54]. In The Netherlands, **common periwinkle** had low spread rates into approximately 10- to 90-year-old second-growth forest planted on former heathland. The authors attributed this pattern to **common periwinkle's** lack of an active dispersal mechanism [44].

In its nonnative range, **common periwinkle** may persist for decades, with single clones spreading vegetatively and covering "large areas" of the forest understory (review by [81]). A planting guide for the Northeast suggests that plants spaced 12 inches (30 cm) apart produce complete cover in 1 to 2 years [68].

Control: Control of biotic invasions is most effective when it employs a long-term, ecosystem-wide strategy rather than a tactical approach focused on battling individual invaders [69]. In all cases where invasive species are targeted for control, no matter what method is employed, the potential for other invasive species to fill their void must be considered [15]. Managers in the Huachuca Mountains were concerned that the native soil seed bank could be disrupted during attempts to remove **bigleaf periwinkle**, though the lack of **bigleaf periwinkle** in the soil seed bank was encouraging [83]. Staff at the Ramsey Canyon Preserve found that native grasses and shrubs were able to establish in areas where **bigleaf periwinkle** was removed (Gebow 2009 personal communication [41]).

Control of periwinkles may be complicated by the ability of stems to root easily when nodes touch the ground (review by [81]). Starch stored in **bigleaf periwinkle** roots may facilitate growth after herbicide treatments or manual removal of aboveground biomass [11].

Fire: For information on the use of prescribed fire to control this species, see Fire Management Considerations.

Prevention: It is commonly argued that the most cost-efficient and effective method of managing invasive species is to prevent their establishment and spread by maintaining "healthy" natural communities [69,89] (e.g., avoid road building in wildlands [104]) and by monitoring several times each year [59]. Managing to maintain the integrity of the native plant community and mitigate the factors enhancing ecosystem invasibility is likely to be more effective than managing solely to control the invader [52]. Weed prevention and control can be incorporated into many types of management plans, including those for logging and site preparation, grazing allotments, recreation management, research projects, road building and maintenance, and fire management [105]. See the Guide to noxious weed prevention practices [105] for more information.

Because most periwinkle reproduction occurs through vegetative spread, the simplest way to prevent future periwinkle establishment is to avoid planting it, particularly in areas where periwinkles are known to establish outside of cultivation. Periwinkles are commonly sold as shade-tolerant groundcovers for landscaping [10,37,68]. The use of native plant species instead of periwinkles should be encouraged.

Cultural control: No information is available on this topic.

Physical or mechanical control: A number of sources suggest that periwinkles may be controlled by raising stolons with a rake and mowing (reviews by [7,81]). Staff at the Ramsey Canyon Preserve found this method was the most effective means of controlling **bigleaf periwinkle**, though repeated treatment was necessary (Gebow 2009 personal communication [41]). Periwinkle seedlings and small infestations may be easy to pull or dig out. Solarization by plastic sheeting for 4 to 6 months may kill small infestations (review by [111]).

Biological control: Biological control of invasive species has a long history that indicates many factors must be considered before using biological controls. Refer to these sources: [109,116] and the Weed control methods handbook [102] for background information and important considerations for developing and implementing biological control programs. While no specific biological control programs existed for periwinkles as of 2009, **common periwinkle** is susceptible to fungal foliar diseases that cause leaf and steam lesions and stem death [63].

Chemical control: Herbicides are effective in gaining initial control of a new invasion or a severe infestation, but they are rarely a complete or long-term solution to weed management [19]. See the Weed control methods handbook [102] for considerations on the use of herbicides in natural areas and detailed information on specific chemicals.

Both **bigleaf** ([39,114], review by [7]) and **common** [98] **periwinkle** are damaged by some herbicides. The waxy leaf cuticle of **bigleaf periwinkle** makes herbicide penetration difficult (review by [7]). Spot treatment with herbicides may be effective on isolated periwinkle plants (review by [81]).

Integrated management: Cutting during the growing season followed by herbicide application has been used to control both **bigleaf** (reviews by [81,111]) and **common** (reviews by [25,81]) **periwinkle**, though follow-up may be needed to control seedlings and vegetative growth (review by [111]). In Illinois, **common periwinkle** was cut at the base and glyphosate was applied. One and 2 years later, **common periwinkle** populations were reduced by about 50%. Retreatment of the area was difficult, because **common periwinkle** cover was sparser and it was more difficult to find it spreading vegetatively in the leaf litter. However, the treatments resulted in higher summer native plant species diversity and richness compared to untreated control and invaded areas [88].

APPENDIX: FIRE REGIME TABLE

SPECIES: Vinca major, V. minor

These Fire Regime Tables summarize characteristics of fire regimes for vegetation communities in which **bigleaf periwinkle** or **common periwinkle** may occur based on descriptions in available literature. Follow the links in the tables to documents that provide more detailed information on these fire regimes. These tables do not include plant communities across the entire distributional range of either periwinkle. For information on other plant communities in which periwinkles may occur, see the Expanded Fire Regime Table.

Bigleaf periwinkle
Common periwinkle

Fire regime information on vegetation communities in which **bigleaf periwinkle** may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [65], which were developed by local experts using available literature, local data, and/or expert opinion. This table summarizes fire regime characteristics for each plant community listed. The PDF file linked from each plant community name describes the model and synthesizes the knowledge available on vegetation composition, structure, and dynamics in that community. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.

California Southwest Southern Appalachians Northeast

California

- California Grassland
- California Shrubland
- California Woodland
- California Forested

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
California Grassland					
California grassland	Replacement	100%	2	1	3
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
California Shrubland					
Coastal sage scrub	Replacement	100%	50	20	150
Coastal sage scrub-coastal prairie	Replacement	8%	40	8	900
	Mixed	31%	10	1	900
	Surface or low	62%	5	1	6
California Woodland					
California oak woodlands	Replacement	8%	120		
	Mixed	2%	500		
	Surface or low	91%	10		

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
California Forested					
Coast redwood	Replacement	2%	=1,000		
	Surface or low	98%	20		
Southwest					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southwest Forested					
Riparian deciduous woodland	Replacement	50%	110	15	200
	Mixed	20%	275	25	
	Surface or low	30%	180	10	
Ponderosa pine-Gambel oak (southern Rockies and Southwest)	Replacement	8%	300		
	Surface or low	92%	25	10	30
Southern Appalachians • Southern Appalachians Forested					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southern Appalachians Forested					
Bottomland hardwood forest	Replacement	25%	435	200	≥1,000
	Mixed	24%	455	150	500
	Surface or low	51%	210	50	250
Northeast					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northeast Forested					
Appalachian oak forest (dry-mesic)	Replacement	2%	625	500	≥1,000
	Mixed	6%	250	200	500
	Surface or low	92%	15	7	26

*Fire Severities—
Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [46,64].

Fire regime information on vegetation communities in which **common periwinkle** may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [65], which were developed by local experts using available literature, local data, and/or expert opinion. This table summarizes fire regime characteristics for each plant community listed. The PDF file linked from each plant community name describes the model and synthesizes the knowledge available on vegetation composition, structure, and dynamics in that community. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.

Great Lakes | Northeast | Southern Appalachians | Southeast

Great Lakes

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Great Lakes Forested					
Northern hardwood maple-beech-eastern hemlock	Replacement	60%	>1,000		
	Mixed	40%	>1,000		
Oak-hickory	Replacement	13%	66	1	
	Mixed	11%	77	5	
	Surface or low	76%	11	2	25

Northeast

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northeast Forested					
Northern hardwoods (Northeast)	Replacement	39%	≥1,000		
	Mixed	61%	650		
Northern hardwoods-eastern hemlock	Replacement	50%	≥1,000		
	Surface or low	50%	≥1,000		
Appalachian oak forest (dry-mesic)	Replacement	2%	625	500	≥1,000
	Mixed	6%	250	200	500

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
	Surface or low	92%	15	7	26
Southern Appalachians					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southern Appalachians Forested					
Appalachian oak-hickory-pine	Replacement	3%	180	30	500
	Mixed	8%	65	15	150
	Surface or low	89%	6	3	10
Oak (eastern dry-xeric)	Replacement	6%	128	50	100
	Mixed	16%	50	20	30
	Surface or low	78%	10	1	10
Appalachian oak forest (dry-mesic)	Replacement	6%	220		
	Mixed	15%	90		
	Surface or low	79%	17		
Southeast					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southeast Forested					
Sand pine scrub	Replacement	90%	45	10	100
	Mixed	10%	400	60	
Coastal Plain pine-oak-hickory	Replacement	4%	200		
	Mixed	7%	100		
	Surface or low	89%	8		
Maritime forest	Replacement	18%	40		500
	Mixed	2%	310	100	500
	Surface or low	80%	9	3	50

*Fire Severities—
Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [46,64].

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