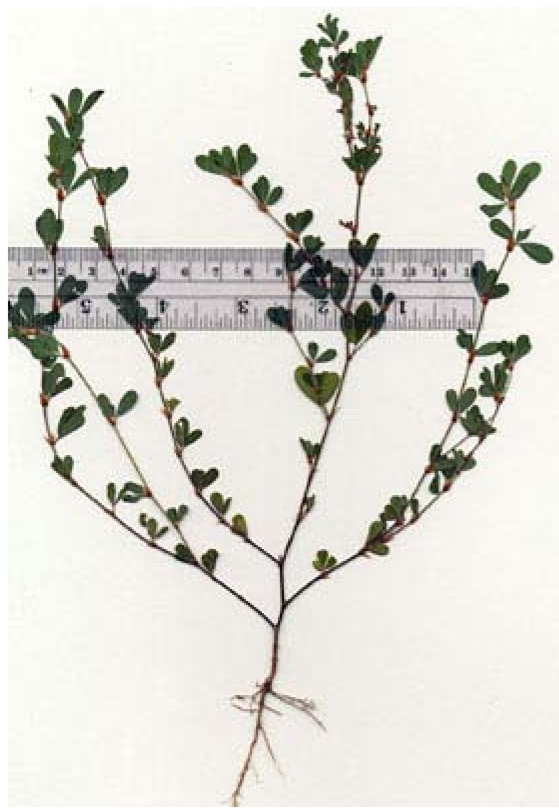
Kummerowia stipulacea, K. striata

INTRODUCTORY



Japanese clover (*Kummerowia striata*)
Photo © University of Tennessee Herbarium

AUTHORSHIP AND CITATION:
Gucker, Corey L. 2010. Kummerowia stipulacea, K. striata. 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, August 4].

FEIS ABBREVIATION:
KUMSTI
KUMSTR

NRCS PLANT CODE [152]:
KUST
KUST2

COMMON NAMES:
For *Kummerowia stipulacea*:
Korean clover
Korean lespedeza

For *Kummerowia striata*:
Japanese clover
common lespedeza
striate lespedeza

TAXONOMY:
The scientific name of Korean clover is *Kummerowia stipulacea* (Maxim.) Makino, and the scientific name of Japanese clover is *Kummerowia striata* (Thunb.) Schindl. (Fabaceae) [38,65,70,164].

Species will be indentified by common name in this review. When citing information common to both species, they are referred to as "clovers". The use of "clovers" in this review refers to only Japanese and Korean clovers and **not** to the large number of other species commonly referred to as clovers (i.e., *Dalea* spp., *Medicago* spp., or *Melilotus* spp.).

SYNONYMS:
For *Kummerowia stipulacea* (Maxim.) Makino:
Lespedeza stipulacea Maxim. [11,49,52,139,140]

For *Kummerowia striata* (Thunb.) Schindl.:
Lespedeza striata (Thunb.) Hook. & Arn. [11,49,52,139,140]

Available literature on these species (as of 2010) suggests that the name change from *Lespedeza* to *Kummerowia* is relatively recent, and usage of the *Kummerowia* genus name was not common until about the 1980s. According to Isely [65], the annual growth habit and various morphological characteristics make *Kummerowia* species distinct from *Lespedeza* species.

LIFE FORM:
Forb

DISTRIBUTION AND OCCURRENCE

SPECIES: Kummerowia stipulacea, K. striata

- GENERAL DISTRIBUTION
- HABITAT TYPES AND PLANT COMMUNITIES

GENERAL DISTRIBUTION:
Japanese and Korean clovers occur as nonnative species in eastern North America. Both species are native to eastern Asia [140]; Korean clover is native to Korea, and Japanese clover is native to Japan and China [38]. In North America, these clovers occur from New York to Florida and west to Texas, Kansas, and Iowa. Although the distributions of these clovers overlap to a great degree, Japanese clover is more common in the southern part of this range and also occurs in New Mexico [65,93,106]. Korean clover is more common in the northern part of this range,

and also occurs in Michigan, Wisconsin, and Nebraska. It is unclear whether Korean clover currently occurs in Florida [109,152]. Records indicate that Korean clover was planted for pasture forage in Hawaii in 1932, but persistence to the current day is doubtful [107,156]. Distributional maps for Korean clover and Japanese clover are available from NatureServe and Plants Database.

Introductions and spread in North America: The introduction of Japanese clover to North America preceded that of Korean clover by about 70 years. Although Japanese clover was likely first introduced accidentally, intentional introductions of both Japanese and Korean clover followed this accidental introduction. Spread of both species was facilitated by human activities, which included construction and use of travel routes and deliberate plantings for erosion control, forage production, and mine rehabilitation. Several cultivars and strains were developed to extend the range in which these species could be utilized in North America [52,64].

Japanese clover was first collected in North America in 1867 from Jasper County, Georgia (Porter 1868 cited in [82]); however, reports indicate that it was observed in the 1840s in the coastal region north of Charleston, Virginia [122]. Japanese clover likely arrived as a seed contaminant [113], possibly in materials shipped from the East Indies. During the Civil War, Japanese clover spread in all directions, especially along railroads and trails traveled by cavalries [122]. Mohr [105] reported that the southern agricultural press promoted the spread of Japanese clover by proclaiming it was a "blessing" capable of transforming barren pine stands and over-cultivated fields into "rich pasture grounds". By the early 1870s, Japanese clover covered "immense" areas east of the Mississippi and was "crowding out almost completely the herbaceous indigenous plants" [105]. In 1884, Japanese clover was described as having taken "possession of immense territory in the South" [96]. During this time of rapid spread, one researcher observed Japanese clover seedlings emerging from cattle excrement and suspected that cattle aided its spread [105]. By the 1890s, Japanese clover also occurred in more western states such as Texas, Kansas [82], and southeastern Missouri [20]. In 1897, there were Japanese clover collections from Columbia, Duval, and Alachua counties in Hitchcock's Florida herbarium [60]. By 1904, populations were reported as far north as New Jersey and Pennsylvania (review by [82]). By 1945, Japanese clover occurred in some counties in western Iowa [42].

Korean clover was first planted by the USDA in an experimental field in Arlington, Virginia, in 1919 [113]. The introduction(s) and early spread of Korean clover are less well documented than those of Japanese clover. Korean clover was not reported in a southeastern flora published by Small in 1933, but it was reported as "becoming abundantly established in many places" in Georgia in 1950 [40]. After its introduction, Korean clover was promoted for soil conservation [139,140] and wildlife forage [75]. Information collected from the University of Missouri's Extension Service showed that the acreage in Korean clover production increased by 33% from 1940 to 1941 [76]. Korean clover was common and abundant throughout Missouri by the late 1940s. Korean clover commonly escaped from hay fields and pastures and was widely seeded for wildlife habitat improvement [78].

Deliberate planting of these clovers for mine site reclamation, forage production, wildlife habitat improvement, soil conservation, and roadside revegetation promoted their spread throughout eastern North America. Seed of Japanese clover was available commercially from Louisiana in 1888 and from New York and Pennsylvania by 1890 [88].

Japanese and Korean clovers were often recommended and commonly used to revegetate coal mined areas in the eastern United States [154]. The proportion of Japanese clover, Korean clover, and sericea lespedeza (*Lespedeza cuneata*) in seed mixes planted on surface mine sites in Kentucky, Illinois, and Indiana, was 34%, 11%, and 9%, respectively [19]. In Rockcastle County, Kentucky, Korean clover persisted for at least 12 years on all 3 surface coal mine sites where it was seeded [148], and on an 18-year-old surface coal mined area in Laurel County, Kentucky, it was considered "adapted to the point of becoming naturalized" [147].

Although the production of Japanese and Korean clover peaked in 1949 at about 50 million acres (20 million ha) (Henson 1957 cited in [93]), it was utilized extensively as hay and pasture from the 1940s to the 1960s. In about 1950, production of these clovers for forage seed exceeded that of all other forage crops [113]. From 1951 to 1960, there were nearly 5 million acres (2 million ha) of the clovers in hay and seed production. American farmers produced more than 6 million tons of clover hay annually from 1943 to 1952 [58]. In the 1960s, Japanese and Korean clovers were the most widely planted pasture and hay legume in the south-central and southeastern United States [143]. McGraw and Hoveland [93] reported that as fertilizer use increased after World War II, use of these clovers as hay and cover crops decreased, making it primarily a pasture species. However, wildlife studies conducted during times of peak Japanese and Korean clover production indicated that Japanese and Korean clover were utilized by a variety of wildlife species [76,77,78]. These findings promoted the use of these clovers to improve wildlife habitats. Easy and inexpensive establishment and permanent forage availability were highlighted in wildlife management studies [75,80].

Japanese and Korean clovers were also planted for erosion control on roadside cuts and to improve soils in cereal crop rotations. Rapid establishment of dense stands can prevent the loss of soil to wind and water, and tilling in these stands can increase soil fertility and organic matter [58]. During surveys of the railroad network around St Louis, Missouri, Korean clover occurred in 7 of 8 sampling sites. Korean clover was seeded on a roadside bank at one site and was still "thriving" at least 10 years later [106].

HABITAT TYPES AND PLANT COMMUNITIES:
In the United States, Japanese and Korean clovers often occur in disturbed areas, pastures, grasslands, old fields, and savannas. Similar habitats are described in the native range for Japanese clover. In Japan, Japanese clover was common in short-grass pasture vegetation dominated by Korean lawngrass (*Zoysia japonica*), especially in cool-temperate climates [111]. Large Japanese clover populations were also described along disturbed floodplains in Japan [108].

Japanese and Korean clovers occur in similar nonnative habitats. Both species are described in fields and open woodlands in the Great Plains [52,140], in sandy soils along Jonca Creek in Ste Genevieve County, Missouri [142], and in old fields and grassy meadows (mowed at intervals of <1 to 5 years) in Athens County, Ohio [131]. Old fields, pastures, other grasslands, and roadsides are common habitats for these clovers in Tennessee [25], Kentucky [146], and Virginia [2]. Grasslands containing these clovers in Kentucky were grazed by bison, elk, and white-tailed deer [146]. Several studies indicate that the clovers may be more abundant and more persistent on grazed than ungrazed sites (see Grazing section). Japanese and Korean clovers are also reported in cedar glade environments in the southeastern United States. Cedar glades are usually dominated by bluestem (*Scoparium* spp.) [13]. See Site Characteristics for information on the edaphic characteristics of cedar glades.

Japanese clover: Various plant communities have been invaded by Japanese clover. Establishment and persistence of Japanese clover often depend on disturbances. In northern Florida, Japanese clover has been reported in shortleaf pine (*Pinus echinata*) stands [46]. In the Ichaway region of Georgia's Coastal Plain, Japanese clover was restricted to disturbed sites that included roads, field margins, wet ditches, fire breaks, and old homesteads in a longleaf pine/pineland threeawn (*P. palustris*/*Aristida stricta*) remnant [39]. In Cameron Parish, Louisiana, Japanese clover occurred infrequently in prairies and on beach ridges along historic Gulf of Mexico shorelines [41]. In southeastern Ohio's Strounds Run State Park, Japanese clover was frequent in old fields snd young deciduous woodlands (30-40 years since canopy closure), and along roadsides and trail edges [55]. Japanese clover occurred on shale barrens in southern Illinois [159] and in seasonally mowed, herbaceous, roadside vegetation bordering a pitch pine-oak (*P. rigida*-*Quercus* spp.) forest in New York [82].

Korean clover: Many early-seral, open habitats support Korean clover populations, but only a few examples are described here. In southern Illinois, Korean clover occurred in lowlands [103], barrens [3], and old-field vegetation. Korean clover was especially common (up to 75% cover) in old fields that had not been disturbed for 25 years and had only occasional shrubs and tree seedlings [103]. In the Devils Kitchen area in Illinois, Korean clover codominated an open area with rock muhly (*Muhlenbergia sobolifera*) [102]. In Calvert County, Maryland, Korean clover occurred, although not abundantly, in a xeric, disturbed barrier dune community [135].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Kummerowia stipulacea, K. striata

- GENERAL BOTANICAL CHARACTERISTICS

Korean clover
Photo © B. Eugene Wofford

Korean clover
Photo © John Beck

University of Tennessee Herbarium

GENERAL BOTANICAL CHARACTERISTICS:

Botanical description: This description covers characteristics that may be relevant to fire ecology and is not meant for identification. Keys for identification are available (e.g., [38,49,52,90,140]).

Aboveground description: Japanese and Korean clovers are freely branched, short-statured to prostrate annuals [38,52]. Plants are generally more prostrate in sparse stands and more erect in thick stands [113]. The clovers produce fine stems [93] with alternate, compound leaves with 3 leaflets [38,140]. Both chasmogamous and cleistogamous flowers occur either singly or in groups of up to 5 in a spike-like raceme [52,120,139,140]. Legumes are small and 1-seeded [52,139,140].

Several growth characteristics distinguish Japanese from Korean clover. Although both species are generally less than 16 inches (40 cm) tall [38,49,120], Korean clover may be taller, up to 24 inches (60 cm) [49,120]. Korean clover produces coarser foliage and broader leaflets than Japanese clover [161]. Hairs on Japanese clover stems point downward and those on Korean clover point upward [52,104,161]. Japanese clover produces legumes in the leaf axils along the entire stem length, whereas Korean clover produces clusters of legumes in only the leaf axils at the branch tips [93]. Seasonal differences in development may also be useful for differentiating the clovers; see the discussion below. For more distinguishing characteristics, consult the following references: [64,161]. For information on the many Japanese and Korean clover cultivars including morphological characteristics, release date, and preferred site and climate conditions, see these references: [58,93,161].

Belowground description: Japanese and Korean clovers produce shallow taproot systems [93]. At growth stage 0, before true leaves were produced, Japanese clover taproots averaged 0.5 inch (1.4 cm) long. Seedling survival requires available moisture at this shallow depth [108]. Studies in southeastern Iowa revealed that Korean clover roots were confined to the top 6 inches (15 cm) in eroded old-field soils [16].

Raunkiaer [121] life form:
Therophyte

SEASONAL DEVELOPMENT:

Japanese and Korean clovers are warm-season annuals. Korean clover is said to mature earlier than Japanese clover [93,161]; however in field studies in Columbia, Missouri, Japanese clover began flowering 7 to 10 days before Korean clover. Seed yield for Korean clover exceeded that of Japanese clover ($P<0.05$) [14]. These clovers are generally most productive in late summer. In crop production studies in Columbia, Missouri, they produced maximum biomass in July, August, or early September [14,93]. In Missouri, Korean clover is generally 3 to 6 inches (8-15 cm) tall by mid-June [57]. Flowering generally occurs in late summer or early fall. Flowering and seed production are affected by day length. Plants in the South flower and produce seed before those in the North because of short day lengths and high temperatures. Plants remain vegetative longer where days are longer, and low temperatures lengthen the time between flowering and seed maturation [113]. During field experiments in Hawaii, Japanese and Korean clover only grew a few inches tall before setting seed and senescing. In greenhouse studies, plants exposed to days longer than 14 hours produced vegetative growth without flowering, whereas days less than 14 hours long allowed for little vegetative growth before flowering [107]. There is little storage of nonstructural carbohydrates in Japanese and Korean clover roots during the growing season. Total nonstructural carbohydrates ranged from 4 to 45 g/kg in one study [93] and from about 10 to 40 g/kg in another study [36]. Storage levels did not change much with reproduction, cutting, or regrowth [36,93].

Flowering and fruiting dates of Japanese and Korean clovers by state or region		
State/region	Species	Reproductive dates
Carolinas	Both	July-September flowers; August-November fruits [120]
Florida	Japanese clover	Summer-fall [164]
Illinois	Both	August-October [104]
Kansas	Korean clover	August-September [11]; seeds set before winter [1]
West Virginia	Both	July-August [139]
Blue Ridge Province	Both	July-September [163]
Great Plains (southeastern)	Both	July-October [52]

REGENERATION PROCESSES:
Japanese and Korean clovers are annuals and persist through seed production and seedling establishment. Vegetative reproduction does not occur.

Pollination and breeding system: Japanese and Korean clover produce both cleistogamous flowers, which are obligately self fertilized, and chasmogamous flowers, which are capable of cross pollination [52]. Weather can affect the abundance of each flower type. High temperatures at the time of flowering can increase the abundance of chasmogamous flowers, while low temperatures can increase the production of cleistogamous flowers (review by [113]). Although some report that outcrossing in chasmogamous flowers is rare (review by [93]), others report outcrossing rates of up to 70% [45]. Outcrossing rates may differ by species. Korean clover flowers are partially self fertilized and partially cross fertilized (Hanson and Cope 1955 cited in [45]). Japanese clover flowers are primarily self fertilized (Johnson 1951 cited in [45]).

Hybridization between Japanese and Korean clover is unlikely. Experimental crosses between the clovers failed to produce viable seed [54].

Seed production: Although several sources report that Japanese and Korean clovers produce abundant seed, rates of seed production in wildlands were rarely reported in the literature. High levels of seed production by Korean clover occurred on eroded and intact old-field soils near Ashland, Missouri. First-year seed production was "good", and in the next growing season, stands were dense on both soil types [56]. Wheeler [161] reported that "well developed" Korean clover plants produce "hundreds of pods". Increased branching of Japanese clover was associated with increased seed production.

High temperatures, drought conditions, cutting, and grazing can limit seed production by the clovers. In a greenhouse study, nearly all clovers (Japanese clover and 4 Korean clover strains) produced significantly more seeds/plant when exposed to cool night temperatures of 38 to 54 °F (3.5-12 °C) instead of high temperatures of 70 to 84 °F (21-29 °C) [143]. Drought conditions during flowering or fruit ripening can "dramatically" reduce seed production by Japanese and Korean clover ([8], review by [113]). In a crop production study at the Agronomy Research Center in Columbia, Missouri, Japanese and Korean clover crops under optimal moisture conditions produced about 450 to 550 pounds of seed/acre. When stands were harvested for hay after mid-June, seed yields decreased substantially. Stands harvested on 12 July produced less than 250 pounds of seed/acre, and stands harvested on 23 August produced less than 100 pounds of seed/acre [14]. Japanese clover produces seed even under heavy grazing pressure [85]; Meehan [96] suggested that the prostrate growth form protects seeds on low branches. However, when Japanese clover stands were cut for hay in the summer and grazed in the fall, plants produced almost no seed [85].

Seed dispersal: Research indicates that clover seeds are dispersed in cattle and horse feces. The spread of clover along trails and roads suggests seed dispersal by humans as well [42]. Soon after its introduction to North America, researchers suspected that cattle and human movements were important to the spread of Japanese clover. In the mid 1800s, Mohr [105] reported rapid spread of Japanese clover in the Gulf Coast states. He observed Japanese clover seedlings emerging from cattle dung and suspected that both cattle and army movements had aided its spread [105]. During the Civil War, another researcher reported Japanese clover spread along railroads and trails traveled by cavalries [122]. In a more recent study, researchers found that Japanese clover emerged abundantly from horse dung collected from trails within or leading to southern Illinois' Trail of Tears State Forest. In a field experiment, Japanese clover emergence was much greater on plots where horse dung was added (39.2% relative density) than on plots without horse dung added (9% relative density) [23].

Seed banking: A large proportion (40-60%) of Japanese or Korean clover seeds are hard just after maturity, but this proportion decreases over time and is much lower (≤10%) by late winter or early spring (reviews by [93,113]). The length of time that this small remnant of dormant seeds remains viable in the soil is unknown. The available seed bank studies suggest a short-lived seed bank, but experiments involving burial and recovery over time are rare. When Korean clover seed collected from plants in Kentucky and/or Tennessee was sown in moist soil and monitored for many years in a greenhouse with open windows and no temperature control, some seed germinated as late as year 2. No seed germinated in the later years of the 8-year experiment [12]. A seed burial study conducted outdoors at the USDA Seed Testing Laboratory in Indiana found 48% of lespedeza (*Lespedeza* spp.) seeds were viable after 20 years of burial [30]. The study failed to identify seeds to the species level, and although Japanese and Korean clovers were still classified in the genus *Lespedeza* at the time of this study, it is unclear whether they were among the seeds tested.

The following seed bank studies suggest a short-lived or transient seed bank for Japanese and Korean clover. Generally the aboveground and seed bank abundance of the clovers decreased with time since disturbance. In the Duke Forest area within the North Carolina Piedmont, Japanese clover germinated from soil samples collected in old fields but not from samples collected in more successionally advanced shortleaf pine stands. Japanese clover emergence was greatest from soil from 5-year-old fields when 1-, 2-, and 5-year-old field soil samples were compared [115]. Likely the differences in seed bank abundance are a reflection of increases in aboveground Japanese clover abundance with increasing field age, which were reported for 1- to 3-year old fields in another old-field study in the Piedmont [114]. When researchers compared seed rain and seed banks in a transition area between a native prairie and an old field in

Jefferson County, Kansas, Korean clover germinated from soil collected from the old field but was not collected in seed traps [127]. Researchers did not report whether Korean clover occurred in the aboveground vegetation in the old field. The relative frequency of Korean clover seed in soil collected from a 12-year-old reclaimed surface coal mine was 0.01. Korean clover was present in the aboveground vegetation [26].

Germination: The few studies on germination of Japanese and Korean clovers indicate that dry conditions and submergence will delay or inhibit germination. One report indicated that scarification improves germination [140], while another indicated that scarification is unnecessary [161]. In controlled experiments, 70% of Japanese clover seed collected from plants in Japan germinated. Seeds stored outside for a year germinated faster than seeds stored outside for only 4 months, but final germination percentages were not different [108].

Moisture: Too little moisture as well as submerged conditions can limit germination of the clovers. In a field study, Japanese clover seeds on the gravelly Ohta River floodplain in Hiroshima Prefecture, Japan, germinated poorly, but when ungerminated seeds were collected and monitored in the laboratory, 6 of 7 seeds germinated within 3 days. The researcher suspected that germination was limited by low-moisture conditions in the gravel [108]. Korean clover emerged from wetland soil samples collected from a 12-year-old reclaimed surface coal mine when soil samples were kept moist, but when soil samples were submerged (under 2 cm of water), no Korean clover emerged [26].

Hard seed: A large proportion of Japanese and Korean clover seeds are hard soon after maturity. Dormancy decreases from fall to winter and early spring. Germination of mature Korean clover seed in the laboratory averaged 46.7% in November, 83.3% in December, and 84.9% in March [98]. Seed size and hard seed abundance are related. A higher percentage of small Korean clover seeds were hard. Of the small seeds, 48% to 72% were hard, whereas just 1% to 3% of large seeds were hard [99].

Seedling establishment and plant growth: Detailed studies on seedling establishment and population ecology of Japanese and Korean clover are lacking, but years of cultivation records and crop production observations indicate that few site or environmental conditions adversely affect establishment ([8], review by [93]). In a crop production article, Japanese and Korean clovers were reported as the easiest of all major forage legumes to establish. The article reported that the clovers germinated quickly and grew rapidly as seedlings. Clover seedlings succeeded when all other species failed even in infertile soils or drought conditions. The clovers were recommended as "insurance" in forage seed mixtures [8]. However, when Korean clover was seeded in a mowed field near Lawrence, Kansas, fewer than 5% of seedlings survived to maturity in some plots [100]. When establishment and growth are compared between crop production studies and more natural field studies, it seems that the abundance and vigorous growth found in crop production studies do not generally occur in old field or wildland settings.

Site or environmental conditions: Open sites are likely best for establishment of Japanese or Korean clover. Seedlings can survive in infertile, eroded soils [8,56], are somewhat drought tolerant [8,108], and may grow well in warm to high soil temperatures [92]. In western Iowa, Japanese clover was spreading "rapidly in clearings and along thoroughfares" [42]. On an old-field site near Ashland, Missouri, Korean clover established on eroded as well as intact soils. Once mature, plants produced abundant seed, and dense stands established in the next growing season on both soil types [56]. In a crop production article, Japanese and Korean clovers were reported to establish in infertile soils even if drought conditions occurred soon after establishment [8]. However, conditions were likely too dry for successful seedling establishment on a gravelly floodplain along the Ohta River floodplain in Hiroshima Prefecture, Japan. On the gravel site, only about 5% of Japanese clover seeds developed into seedlings. The researcher suspected dry conditions caused seedling mortality. When growth was monitored, seedling taproots averaged only 0.5 inch (1.4 cm) long at growth stage 0, before true leaves were formed. Seedling survival requires that moisture be available at shallow depths soon after germination [108]. In experiments designed to test the effects of soil temperature on Korean clover radicle growth, radicle extension was 20 mm to about 35 mm at temperatures from 72 to 99 °F (22-37 °C), less than 10 mm at 54 to 63 °F (12-17 °C), and failed at 120 °F (47 °C) [92]. These findings, however, involved only 1 study and only initial development under controlled conditions; similar results may not occur in field conditions.

Seedling density: Field experiments found that plant size generally increased as the seeding density of Korean clover increased, but plant survival decreased as seeding density increased. During studies in an old field in Missouri, seedling mortality was high in areas where seeding densities were highest and low in areas with low seeding densities. Actual seeding densities were not reported. Seedling mortality was greatest in the early part of the growing season [56]. In another study of an early-seral old field in northeastern Kansas, researchers found that Korean clover survival was greatest but plant growth and seed production were lowest in pots seeded at low densities. Plant growth and seed production were both high in pots seeded at moderate and high densities. Seedling survival, however, was very low in high-density pots [1]. Statistical analyses were not done on the growth and survival parameters within this old-field soil type.

Growth and survival of Korean clover plants based on the density of seeding in open-bottom pots sunk in an old field in northeastern Kansas [1]

Seeding density	Proportion of planted seeds alive on 5 September	Average plant size on 5 September
Low (0.215 seeds/cm²)	0.26	Smallest
Moderate (1.72 seeds/cm²)	0.17	Largest
High (6.89 seeds/cm²)	0.08	Nearly as large as those in moderate density pots

Vegetative regeneration: Neither Japanese nor Korean clover reproduce vegetatively. Vegetative regrowth is common after cutting if the clovers are not cut too low to the ground or late in the growing season [14,113].

SITE CHARACTERISTICS:
The clovers are most common in old fields, pastures, open woodlands, and along roads and stream banks [38,44,49,52,65,139]. Disturbed sites are often habitat for the clovers in recreation areas, wildlife refuges, and state parks. Disturbed sites typically include visitor-use areas, mowed lawns, rights-of-way, fire breaks, boat ramps, and/or parking areas [59,61,62,69].

Japanese and Korean clovers tolerate a wide range of environmental conditions. During a phytosociological study of weedy old fields in Scotland County in North Carolina's Upper Coastal Plain, Japanese clover "did not exhibit an exact affinity to specific edaphic conditions" [128]. Both clovers have been reported in cedar glade communities in the southeastern United States. Cedar glades occur in open areas on calcareous soils and are characterized by high sunlight levels, high summer soil temperatures, and extreme soil moisture levels that range from saturated or flooded to below the permanent wilting point [13].

Climate: The US distribution of Japanese and Korean clovers is limited by climatic tolerances. The northern boundary represents the area at which plants fail to reproduce before the first killing frost, and the western boundary represents areas that receive too little moisture to support the clovers (review by [93]).

Soils: While growth of Japanese and Korean clovers may be best on fertile, well-drained soils [49,93,140], plants survive in a variety of soil textures and in infertile, acidic, or limestone soil types. Both clovers have been reported on dry soils in West Virginia [139], sands in eastern Texas [38] and Missouri [142], sandy loams on the Coastal Plain, and clays in the Piedmont [58]. In the southeastern United States, the clovers grew best on fertile bottomlands, and although described as fairly drought tolerant, plants were most productive in areas with "adequate" moisture [58]. In 2- to 3-year-old fields in South Carolina, production of Japanese clover was greatest (13.5 g/m²) in fields with poorly drained soils (44% silt+clay in subsoil). Productivity was much lower (0.5-2.7 g/m²) on soils with moderate to excellent drainage (9-20% silt+clay in subsoil) [112]. While soil may have been important to Japanese clover abundance, past land use and proximity to a clover seed source were also likely important. Growth of the clovers can also be good on eroded, acidic soils with low levels of phosphorus (review by [93]). A review reports that Korean clover is less tolerant of acidic soils and more tolerant of alkaline soils than Japanese clover (review by [113]).

Two studies monitored the growth of Korean clover in old-field soils with differing textures and moisture and pH levels. Productivity varied on the different soil types studied but not consistently with soil moisture, fertility, or pH. In the greenhouse, germination of Korean clover was nearly 100% on both eroded and intact field soils collected near Ashland, Missouri. At the end of the growing season, however, the average biomass of Korean clover was greater on eroded (108.2 g/m²) than intact (89.2 g/m²) soils. Eroded soils lacked an A horizon and had a clay content that was nearly twice that of intact soils. Eroded soils had lower average growing-season moisture content (10.6%) than intact soils (12.2%). Based on these findings and results from a weeding experiment, researchers concluded that Korean clover was most "competitive" on poor, eroded soils [56]. In southeastern Iowa, Korean clover growth was compared on 3 eroded old-field sites: 2 upland and 1 lowland site (see table below for soil descriptions of these sites). Korean clover established and grew well on all sites, but establishment and growth were best on lowland sites. Available soil moisture during July, the driest growing-season month, was greatest for upland Weller soils. Soil moisture was evaluated in the top 6 inches (15 cm) of soil, where Korean clover roots were confined [16].

Soil characteristics of upland and lowland sites in southeastern Iowa that supported Korean clover [16]

Soil type (site)	Surface texture	Average topsoil depth (inches)	Acidity	Fertility
Bottomland (lowland)	fine sandy loam	6-8	moderately acidic	fair-medium
Lindley (upland)	loam	2-4	moderately acidic	medium-low
Weller (upland)	silt loam	4-6	highly acidic	medium-low

Flooding: The following studies indicate that both clovers tolerate some flooding but that Japanese clover may be more tolerant than Korean clover. Large Japanese clover populations are common along floodplains in Japan. Along the Ohta River floodplain in Hiroshima Prefecture, Japan, Japanese clover occurred in an area that flooded 3 to 7 times/year but rarely experienced flooding of more than 10 days. Japanese clover's distribution was more closely correlated to soil texture than flooding regime or flooding period. Japanese clover occurred on fine-textured soils and was rare or absent on coarse-textured soils. Japanese clover cover was positively correlated with the percent weight of fine soil particles (r =0.78, P<0.001) [108]. Around Cave Run Lake in northeastern Kentucky, Korean clover occurred on mud flats but not on frequently or infrequently flooded sites, and Japanese clover occurred on mud flats and frequently flooded sites [87]. Growing-season flood frequency or duration during the study period was not reported.

SUCCESSIONAL STATUS:
Japanese and Korean clovers are typically early-seral species common to ruderal or disturbed sites. Abundance of these clovers generally decreases as time since last disturbance increases; however, decreases in abundance and/or persistence may occur much more quickly on sites where woody vegetation encroaches soon after disturbance.

Shade relationships: Both clovers grow best in full-sun conditions, but Japanese clover may tolerate shading better than Korean clover. At the University of Missouri Horticulture and Agroforestry Research Center, the aboveground weight of Korean clover was significantly reduced by 50% shading when compared to full-sun conditions and by 80% shading when compared to 50% shading (P<0.05). For Japanese clover aboveground weights were not significantly different between full sun and 50% shade, but weights at 80% shade were significantly reduced (P<0.05) [86]. On old fields in Tennessee, cover of Japanese clover was consistently higher beyond the influence of sassafras (*Sassafras albidum*) canopies. However, this finding may not entirely relate to shading, because follow-up experiments suggested that sassafras may have an allelopathic affect on associated vegetation [47]. When Korean clover was seeded to improve cattle and wildlife forage availability on a preserve in Taney County, Missouri, it established well in old fields but not in woodlands [34].

Disturbance relationships: Japanese and Korean clovers are common on disturbed sites [59,62,135], and long-term persistence is generally limited to sites with recurring disturbance. At the Fort Riley Military Reservation in northeastern Kansas, high-use areas were associated with an increased abundance of Korean clover [43]. Both clovers were common in mowed old fields and meadows at the Waterloo Wildlife Research Station in southeastern Ohio. Sites were mowed at intervals ranging from less than 1 year to 5 years [131]. During studies at a ski resort in central Japan, Japanese clover occurred on ski slopes, the edges of ski slopes, and open water fronts, but not in forests. Frequency of Japanese clover was greatest (60-79%) on ski slopes, which were mowed 3 to 4 times/year and had 41.3% canopy closure. In the forests, canopy closure was 77.9% [81].

Larger disturbance patch sizes and/or recurring disturbance events are typical in areas where clovers are persistent. At a prairie-forest ecotone in northeastern Kansas, Korean clover persisted with greater abundance on large than small patches ($P<0.05$, in 1 of 3 sampling years), even though succession progressed faster on large than small patches [27]. On abandoned agricultural land near Norman, Oklahoma, Korean clover abundance decreased as time since disturbance increased. The old field was seeded to Korean clover in 1941 and grazed until 1949, when a portion of the old field was plowed. After 1949, the plowed and unplowed portions were left fallow. By 1954, Korean clover was no longer found in the old field [118]. In southern Illinois, Japanese clover occurred on a shale barren site with little woody vegetation that was burned every other year for 10 years. Japanese clover did not occur in unmanaged shale barrens with only small forest canopy openings [159].

Grazing: Both clovers tolerate grazing, and persistence can be prolonged with grazing. Sources also report that Japanese clover typically tolerates heavy grazing without large losses in seed production [85,140]. Removal of livestock led to the loss of Korean clover from pastureland in McClain County, Oklahoma. Korean clover was seeded in the pasture in 1941 and until 1949 there was long-term, moderate grazing pressure. In 1949, a portion of the pasture was protected from grazing. In the first year of protection, Korean clover cover averaged 25.5%. In the 10th year of protection, Korean clover was absent. In the grazed pasture, cover of Korean clover was about 3% in the 10th year [117]. On the Konza tallgrass prairie in eastern Kansas, researchers compared 200-m^2 plots in unburned, annually burned, ungrazed, and grazed areas of the prairie. Korean clover did not occur on unburned, burned, or ungrazed plots but had 15% frequency on grazed plots. Researchers noted that Korean clover made up a minor component of the prairie vegetation [132], suggesting that abundance may have been affected as much by sampling site selection as by management. However, dispersal of Japanese and Korean clover seeds by cattle and horses is common and may have contributed to the persistence of Korean clover on grazed sites. For more information, see the discussion on Seed dispersal.

Old-field succession: Old fields are common habitat for Japanese and Korean clover. Generally, the clovers decrease in abundance as time since abandonment increases; however, old-field persistence is typically related to the rate at which woody shrubs and trees establish and grow in the old fields.

While Japanese and Korean clovers are common soon after the abandonment of agriculture, abundance is typically low in 1-year-old fields. Although there are trends in old-field succession, it is important to note that abundance of the clovers could be affected by past land use (e.g., grazing or use of Japanese or Korean clover as a cover crop) or proximity to a seed source (see Seed dispersal discussion) as much as by shading or other successional changes. In Aiken, South Carolina, frequency and density of Japanese clover were greater on 12-year-old than 1-year-old fields. Both fields were dominated by herbaceous species and had little to no recruitment of woody vegetation [50]. In the Piedmont of North Carolina, Japanese clover frequency increased with time on recently abandoned fields (up to 3 years old) but was absent from fields when loblolly pine had established (fields 11 years and older). Frequency averaged 8% on 1-year-old fields, 12.9% on 2-year-old fields, and 20% on 3-year-old fields. Loblolly pine (*Pinus taeda*) established early in old field succession. When old fields with loblolly pine stands aged 11 to 75 years old were surveyed, Japanese clover occurred only in a 42-year-old stand, in which tree density resembled that of the 11-year-old stand [114]. Findings were similar when old fields in the Duke Forest of North Carolina's Piedmont were studied. Japanese clover was most common in a 5-year-old field, and although it also occurred in a 13-year-old shortleaf pine stand, it did not occur in 21- to 110-year-old stands [15].

Available studies suggest that the clovers may be more persistent in the succession of old fields in the Midwest than those in the Southeast or Atlantic Coastal areas, although more studies are necessary to determine the strength of this trend. In upland Piedmont sites near Camp Hill, Alabama, Japanese clover decreased as old-field succession progressed. Japanese clover cover averaged 14.5% in 3- to 5-year-old fields, 6.3% in 11- to 12-year-old fields, 1% in 15-year-old fields, and 0.5% in 17-to 18-year-old fields. Slash pine (*P. elliottii*) dominated 17- to 18-year-old fields [134]. In middle Tennessee, both clovers were common in fields abandoned for 1 to 20 years but absent from a 25-year-old field. The 15- to 20-year-old fields were very open, young woodlands, while the 25-year-old field was a woodland with few canopy openings [119]. In Cumberland County, Virginia, Korean clover was abundant in agricultural fields abandoned 1 to 4 years earlier. Abundance decreased in 5- to 9-year-old fields as shrub and tree abundance increased. Korean clover did not occur in fields abandoned for 10 years or more [22]. Reports from Illinois show greater persistence of the clovers. In southern Illinois' Ferne Clyffe State Park, Korean clover occurs in both lowland and old-field vegetation types. Lowlands were typically dominated by American elm (*Ulmus americana*), sugar maple (*Acer saccharum*), and/or oak (*Quercus* spp.). Korean clover was especially common in old fields with only occasional shrubs and tree seedlings. Korean clover cover was 75% or greater in a pasture abandoned and undisturbed for 25 years [103]. In southwestern Illinois, Japanese clover was common on agricultural fields abandoned 42 years earlier. In the previous 32 years, the only disturbance in the field was occasional cutting of fence posts. Japanese clover was common on plots with nearly 40% tree cover [6].

FIRE EFFECTS AND MANAGEMENT

SPECIES: Kummerowia stipulacea, K. striata

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

FIRE EFFECTS:

Immediate fire effect on plant: As of this writing (2010), no studies have clearly documented the immediate fire effects on Japanese or Korean clover. The clovers have often established or occurred on burned sites [4,158], and a controlled study suggests that seeds can survive high temperatures [91]. However without more information, it is not possible to establish whether fire stimulates seed germination or if seed germination and seedling establishment are encouraged by the postfire environment.

Postfire regeneration strategy [136]:
Initial off-site colonizer (off site, initial community)
Secondary colonizer (on- or off-site seed sources)

Fire adaptations and plant response to fire: Specific fire adaptations for Japanese and Korean clover were not presented in the available literature (2010), although a controlled study found that Japanese clover seed tolerated some heating, and several studies reported postfire establishment of the clovers. About 80% of Japanese clover seed germinated after 4 minutes in a 180 °F (80 °C) oven. After 4 minutes at 185 °F (85 °C), about 45% of seeds germinated; at 190 °F (90 °C), about 15% of seeds germinated; and at 210 °F (100 °C), about 5% of seeds germinated. The authors reported that the germination of untreated *Lespedeza* spp. seed was only 5%. This untreated sample likely included Japanese clover seed [91]. In loblolly pine stands in South Carolina's Piedmont, Japanese clover did not occur before prescribed fires but occurred on 3% of spring-burned and 4% of summer-burned plots after fire [31]. Prescribed fires were of moderate severity and consumed 50% or less of surface fuels [33]. When the clovers were intentionally seeded on burned sites, successful establishment and abundant growth were reported [5,32]. Japanese clover established "well" after winter prescribed fires in rights-of-way in Alabama and Mississippi [5]. Korean clover was abundant and produced 3.5 lbs of seed/acre after being seeded in a logged, then burned beetle-infested pine stand. The stand burned in an "intense" spring prescribed fire that consumed most of the slash piles [32].

Several studies reported Japanese and Korean clover on burned sites; however, no fire studies focused directly on the effects of fire on the clovers or on their means of postfire establishment. Most fire studies lacked prefire or unburned comparisons. In a report about prairie chicken habitat maintenance in Illinois, Westemeier [160] indicated that 3 years without fire could lead to Korean clover's disappearance from grassland communities in which it was seeded. Winter fires may increase clover abundance, while spring fires may decrease it. In one report, fire was considered necessary for Korean clover persistence.

In some cases, spring fires may reduce abundance of the clovers. Based on experience gained while burning quail habitats in the southeastern United States, Stoddard [138] reported that spring fires "severely check" Japanese clover populations. Spring fires killed young Japanese clovers [137]. In south-central Iowa pastures, however, the abundance of Korean clover was not significantly (P<0.1) affected by spring (March or April) prescribed fire even when followed by herbicide treatments [123]. In warm-season grasslands in Kentucky, Korean clover occurred on unburned as well as burned and herbicide treated plots. The prescribed fire occurred on 23 March when winds were 5 to 10 mph (8-16 km/h), relative humidity was 27%, and air temperature averaged 55 °F (13° C). A post-emergent herbicide application followed the fire [158].

In some cases, winter fires may increase abundance of the clovers. While winter fires may scarify seeds or provide openings for establishment, without additional studies it is not possible to determine which fire effect is most important to clover establishment. Korean clover abundance increased substantially and Japanese clover established following a December prescribed fire in a southern Illinois prairie. The fire was described as "clean and hot" and consumed nearly all litter. Researchers speculated that the fire created openings that allowed the establishment of annual species, including the clovers [4].

Frequency and density of the clovers before fire and in the 1st growing season following a winter fire in Illinois prairie [4]

		Frequency (%)		Density (stems/ha)	
Species	Plot	Prefire	Postfire	Prefire	Postfire
Korean clover	Burned	3.3	24.9	5,965	26,948
	Unburned	8.8	9.6	3,001	5,632
Japanese clover	Burned	0	10.8	0	14,610
	Unburned	0	0	0	0

Japanese clover occurred in annually burned pasture areas within longleaf pine forests and savannas at the Mississippi Agricultural Experiment Station. Fires burned each winter for 11 years [157]. However, Korean clover did not occur on annually burned plots in upland flatwoods in Butler County, Missouri. Korean clover was also absent from unburned plots, but its frequency was 6% on a plot burned once in 1949 and again in 1954. Frequency was assessed 1 year after the 2nd fire, and the researcher reported severe drought conditions from 1952 to 1956 [116]. Without prefire data, it is impossible to determine whether annual fires eliminated the reproductive potential of established Korean clover populations or only limited new population recruitment.

FUELS AND FIRE REGIMES:

Fuels: Based on 2 studies that evaluated the flammability of Japanese clover, it seems unlikely that Japanese clover would limit fire spread during the dry season unless it was severely grazed. When Japanese clover was tested as a firebreak in pond pine (*Pinus serotina*) vegetation in the North Carolina Piedmont, it was rated as moderately flammable. It rated from a 5 to a 6.5 on a flammability scale, where 1 was nonflammable and 10 was highly flammable. When grazed, Japanese clover was dry enough during the fire season to burn with a pressure torch [130]. In Texas, Lay [85] reported that when grazed short, Japanese clover functioned as a firebreak in the absence of extreme fire weather conditions. Japanese clover stopped "normal" fires but only slowed "hazardous" fires burning in high winds. For best firebreak functioning, plowed strips were needed around the grazed Japanese clover [85].

Fire regimes: As of 2010, there was no information available on the typical fire regimes in Japanese or Korean clover habitats or on the effects of large Japanese or Korean clover populations on the fire frequency or fire severity in US habitats. See the Fire Regime Table for further information on fire regimes of vegetation communities in which Japanese and/or Korean clover may occur.

FIRE MANAGEMENT CONSIDERATIONS:

Potential for postfire establishment and spread: Several studies report that Japanese and Korean clovers have established on burned sites [4,31]. Whether fire stimulates germination from soil-stored seed or provides an optimal seed bed for germination and establishment by seed from nearby sources is unclear. Nonetheless, burned sites are likely establishment areas for the clovers.

Preventing postfire establishment and spread: Preventing Japanese and Korean clover from establishing in weed-free burned areas is the most effective and least costly management method. This may be accomplished through early detection and eradication, careful monitoring and follow-up, and limiting dispersal of the clover seeds into burned areas. 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 that may alter soil nutrient availability, such as those 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: [7,17,51,151].

Use of prescribed fire as a control agent: In the available literature (2010), use of fire to control Japanese and Korean clover was not discussed. Fires that burn the clovers at a young growth stage may decrease their abundance [137,138], but dormant-season fires are unlikely to do so [4]. Fire may also be useful in depleting the seed bank [4,31], although additional studies are needed to determine the effectiveness and appropriate timing and frequency for this type of treatment.

Altered fuel characteristics: As of 2010, effects of large Japanese or Korean clover populations on fuel characteristics in invaded US habitats were not described.

MANAGEMENT CONSIDERATIONS

SPECIES: Kummerowia stipulacea, K. striata

- FEDERAL LEGAL STATUS
- OTHER STATUS
- IMPORTANCE TO WILDLIFE AND LIVESTOCK
- OTHER USES
- IMPACTS AND CONTROL

FEDERAL LEGAL STATUS:
None

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

IMPORTANCE TO WILDLIFE AND LIVESTOCK:
Japanese and Korean clovers are utilized by both wildlife and livestock. The clovers provide palatable, high-quality forage for livestock and deer. Foliage and seeds are often seasonally important in the diets of a variety of small mammals and birds [140]. A review reports that the clovers are among the most important winter quail foods in the South, consumed extensively by doves in the spring when other foods are scarce, preferred by wild turkeys in Missouri, and important summer deer food in Ohio. They are also eaten by cotton rats, rabbits, mallards, starlings, juncos, cardinals, towhees, and English sparrows, although they are rarely a predominant diet component [37].

Deer and elk: Studies from Indiana, Missouri, and Louisiana indicate that both clovers can be important in the summer diets of white-tailed deer. In southern Indiana, Korean clover was frequent (52%) in, although it did not comprise a high volume (2%) of white-tailed deer summer diets [133]. In the Missouri Ozarks, white-tailed deer consumed little Korean clover in the spring, but the volume of Korean clover in diets in July was 7.9%, in August 12.6%, and in September 5.9%. A significantly greater quantity of Korean clover was consumed by male than female deer ($P<0.05$) [80]. Findings were similar in an earlier study of white-tailed deer diets throughout Missouri. Korean clover made up 15% of white-tailed deer summer diets. When preferred foods were unavailable, the entire plant was eaten [78]. In the openings in loblolly pine-shortleaf pine-hardwood forests in central Louisiana, Japanese clover was important in summer and fall white-tailed deer diets [145]. Japanese clover contributed a maximum of 2.4% to the relative density of plant fragments in summer-collected fecal samples from elk reintroduced to southeastern Kentucky [126].

Cattle: Japanese and Korean clover may cause hemorrhaging in cattle (similar to that caused by sweetclovers) when hay is moldy [38,140], but some studies report high levels of clover use by cattle. Henson and Cope [58] report that livestock "readily" eat dried Korean clover leaves and seeds. In openings within loblolly pine-shortleaf pine-hardwood forests in central Louisiana, Japanese clover made up 9.4% of summer cattle diets [145].

Small mammals: Rabbits, mice, and rats feed on Japanese and Korean clover. In the Fountain Grove Wildlife Area in north-central Missouri, Korean clover was heavily utilized by cottontail rabbits from June to November. Summer and fall diets averaged 11.5% and 7.8% Korean clover, respectively [79]. *Lespedeza* and *Kummerowia* seeds or seed shells were found at oldfield mouse nests during 5 years of observations made in South Carolina, Georgia, and Florida [48]. Feeding trials showed that Japanese clover's highest preference ranking was 11th in more than 50 species presented to rodents in southern Florida. The hispid cotton rat was the most common rodent in the study area [97].

Birds: Many song and game birds feed on Japanese and Korean clover seeds or utilize the clovers as habitat or in nest construction. Of the birds that utilize the clovers, northern bobwhites have been studied most extensively.

Eastern meadowlark: Japanese and/or Korean clovers were used as eastern meadowlark nest material and nesting habitat near Carbondale, Illinois. Researchers found that the clovers were used in the construction of 11.3% of nests, and nests were found in Korean clover patches in lightly grazed pastures [124].

Greater prairie-chicken: Korean clover was predominant in greater prairie-chicken diets in Missouri and Oklahoma. Between the late 1950s and the early 1960s, about 5,000 greater prairie-chicken droppings were collected from western Missouri. Korean clover was the 4th most abundant food by volume (10.4%). Korean clover was used most heavily in July, August, and September. Foliage was the most commonly consumed part; seeds were rarely eaten [77]. Korean clover was a maximum of 16.2% of the volume of greater prairie-chicken diets from October to March, 28.3% from April to June, and 68% from July to September in cultivated pastures in Beaver County, Oklahoma [68].

Ruffed grouse: Korean clover was important in August and September, as indicated by droppings collected from central and southern Missouri. Only foliage was consumed [75].

Mourning dove: Japanese and Korean clovers were regarded as "fair" mourning dove foods during feeding trial observations made in the wild in Georgia and Mississippi. "Fair" foods were seldom or never eaten if a "choice" food was available. "Choice" foods were eaten "eagerly" every time they were presented [35].

Quail: Japanese and Korean clovers are among the most important foods for northern bobwhites from Missouri to Florida. Korean clover ranked among the 5 most important items consumed by northern bobwhites in Missouri's lowland, prairie, and Ozark regions. Japanese clover was much less common in northern bobwhite diets, but this finding may reflect availability rather than preference. Based on information collected by the University of Missouri's Extension Service, the number of acres in Korean clover production had increased by 33% around the time of this study [76]. In northern bobwhite crop contents collected from hunters in Virginia, the relative volume of Japanese clover seeds was 1.2% in November, 8.3% in December, and 19.7% in January [9]. Northern bobwhite stomachs collected during the fall and winter in Kentucky contained 16.6% Japanese clover by volume in Calloway County, and 32.6% and 27.5% Korean clover from Warren and Pulaski counties, respectively [10]. In the Georgia Piedmont, Japanese clover seed was a major northern bobwhite food in January (32.1%). Less was consumed in February, but that may have reflected food source depletion rather than seasonal preference [95]. Although the previously described studies suggest that Japanese and Korean clover are preferred northern bobwhite foods, feeding trials of northern bobwhites live-trapped from southern Florida showed that Japanese clover seed was not highly preferred. It ranked 25th among 53 seed species presented [97]. In another study, caged northern bobwhites fed only Korean clover lost weight. Birds survived an average of 31 days when fed only Korean clover. Males survived better than females [110]. When scaled quail adults trapped from southwestern Kansas were fed only Korean clover seeds, birds acquired less than 60% of their daily energy requirements. In at least one case, more than 10% of a bird's body weight was lost within 2 days. Researchers suggested that Korean clover seeds may be more valuable when paired with seeds of another species, a phenomenon shown for some seed species in the study but not Korean clover [125].

In southern Illinois, Japanese and Korean clover were common at northern bobwhite nest sites. The clovers were recorded at 47.2% of nest sites but were used as nest material in only 4% of nests [74].

Palatability and/or nutritional value: The clovers are considered high quality summer livestock forage. High summer production levels are important because little other forage is available at that time (review by [93]). In pine savannas in Louisiana, Japanese clover is considered "very good" forage with nutritive values sufficient for producing good weight gains by all classes of healthy cattle [24]. A review reports that cattle can gain up to 1 kg/head/day on clover pasture in the summer [113].

When seeds were collected from hedgerows and fence lines where tree sparrows were feeding near Champaign, Illinois, researchers found that Korean clover seed averaged 4,965 calories/gram [72]. Foliage and seeds of the clovers had protein levels of 12.9% to 41%, fiber levels of 9% to 26.2%, carbohydrate levels of 27.7% to 44%, and fat levels of 3.1% to 6.7%. For more details, see the following references: [28,43,79,110].

OTHER USES:
Japanese and Korean clover were planted extensively throughout the eastern half of the United States for revegetating erodible sites, reclaiming mine areas, and producing wildlife and livestock forage. These uses and their effects on the establishment and spread of the clovers are discussed in the Distribution and Occurrence section.

IMPACTS AND CONTROL:
Impacts: Few sources reported that Japanese and Korean clovers have negative impacts on natural vegetation. Although some aggressive growth by the clovers has been reported in prairies [101], other herbaceous communities [105], and reclaimed mine sites [19], the clovers are not usually weed management priorities. Their persistence and spread typically require recurring disturbance [73,101,144].

In some herbaceous vegetation types, the clovers have impacted associated vegetation. Soon after its introduction to the Gulf Coast states, one researcher noted prolific spread and growth of Japanese clover. Populations covered "immense" areas east of the Mississippi and were "crowding out almost completely the herbaceous indigenous plants". The researcher noted that Japanese clover established in "thickly matted stolons" of the nonnative Bermuda grass (*Cynodon dactylon*) [105]. In Kentucky, Illinois, and Indiana, the clovers were often used to seed surface-mine sites.

Use of the clovers in mine reclamation "contributed to the creation of stable yet very floristically simple nonnative communities" [19]. In New York, Japanese clover occurred in seasonally mowed herbaceous vegetation bordering a pitch pine (*Pinus rigida*)-oak forest. Near Japanese clover populations were 5 forbs considered threatened or endangered in New York: lesser snakeroot (*Ageratina aromatica* var. *aromatic*), white colicroot (*Aletris farinosa*), New England blazing star (*Liatris scariosa* var. *novae-angliae*), sandplain flax (*Linum intercursum*), and narrowleaf whitetop aster (*Sericocarpus linifolius*) [82,152]. Potential or current impacts of Japanese clover on these species were not discussed in the study.

In crop-production reports, Japanese and Korean clovers are not considered especially aggressive, and established stands are easily invaded by other vegetation. Reports indicate that weeds encroach rapidly in pure stands of Japanese and Korean clover, and due to their short growing season, the clovers do not "compete well" with other "weedy" plants [8,113]. Growth of the clovers does not appear to be inhibited by nonsod-forming grasses, but the clovers can be eliminated by the second growing season when grown with sod-forming grasses such as Bermuda grass or carpetgrass (*Axonopus* spp.) [58].

Allelopathy: Laboratory experiments showed that root exudates from Japanese clover inhibited the growth of lettuce radicles [29]. How these findings may apply to other vegetation and field conditions is unknown.

Climate change: Controlled experiments suggest that Korean clover productivity could increase with increasing carbon dioxide levels associated with global climate change. Total Korean clover biomass was significantly ($P \leq 0.05$) greater in elevated than in ambient carbon dioxide conditions. Korean clover test plants were grown in low-phosphorus soil collected from a citrus orchard in China [141].

Control: Few studies reported on the best methods to control Japanese or Korean clover populations. General weed control theory suggests that 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 [89]. In all cases where the clovers are targeted for control, the potential for other invasive species to fill their void must be considered [18].

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

Prevention: Initial steps to prevent the establishment and growth of the clovers in uninfested areas should include limiting or prohibiting their seeding in nearby areas.

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 [89,129] (e.g., avoid road building in wildlands [150]) and by monitoring several times each year [67]. 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 [63].

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 [151]. See the Guide to noxious weed prevention practices [151] for specific guidelines in preventing the spread of weed seeds and propagules under different management conditions.

Cultural control: No information is available on this topic.

Physical or mechanical control: Cutting or mowing the clovers after the flowering stage may provide some control. In a crop production article, the authors reported that the clovers were still capable of setting seed after being cut at about the time of 1st bloom [58]. In a review of cultivation materials, cutting clovers after flowering, cutting plants close to the ground, and cutting plants during drought conditions could lead to decreased abundance of the clover stands [113].

Cultivation is not likely tolerated by the clovers. When annual plowing was compared at various times of the year in

Tallahassee, Florida, Japanese clover did not occur in plots plowed in December, February, April, June, or August, although plants did occur on plots plowed annually in October [71].

Biological control: Insect pests and diseases known to attack the clovers in the United States are identified and discussed in the following references: [8,58,93].

Biological control of invasive species has a long history that indicates many factors must be considered before using biological controls. Refer to these sources: [153,162] and the Weed control methods handbook [149] for background information and important considerations for developing and implementing biological control programs.

Chemical control: Very few studies (as of 2010) described in detail the effects of herbicides on clover populations. In Georgia, several herbicides and application timings were tested. In one trial, a single growing-season herbicide application provided good control (up to 99%) of Japanese clover within 2 years of its application in centipede grass (*Eremochloa ophiuroides*). Herbicides tested in March, before emergence of Japanese clover, provided little to no control [66].

While herbicides can be effective in gaining initial control of a new invasion or a severe infestation, rarely are they a complete or long-term solution to weed management [21]. See the Weed control methods handbook [149] for considerations on the use of herbicides in natural areas and detailed information on specific chemicals.

Integrated management: No information is available on this topic.

APPENDIX: FIRE REGIME TABLE

SPECIES: Kummerowia stipulacea, K. striata

The following table provides fire regime information that may be relevant to Japanese or Korean clover habitats. Follow the links in the table to documents that provide more detailed information on these fire regimes.

Fire regime information on vegetation communities in which Japanese or Korean clover may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [84], 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.

Northern Great Plains	Great Lakes	Northeast
South-central US	Southern Appalachians	Southeast

Northern Great Plains

- Northern Plains Grassland
- Northern Plains Woodland

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)

Northern Plains Grassland					
Southern mixed-grass prairie	Replacement	100%	9	1	10
Central tallgrass prairie	Replacement	75%	5	3	5
	Mixed	11%	34	1	100
	Surface or low	13%	28	1	50
Southern tallgrass prairie (East)	Replacement	96%	4	1	10
	Mixed	1%	277		
	Surface or low	3%	135		
Oak savanna	Replacement	7%	44		
	Mixed	17%	18		
	Surface or low	76%	4		
Northern Plains Woodland					
Oak woodland	Replacement	2%	450		
	Surface or low	98%	7.5		
Great Plains floodplain	Replacement	100%	500		

Great Lakes

- Great Lakes Grassland
- Great Lakes Woodland
- Great Lakes Forested

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 Grassland					
Mosaic of bluestem prairie and oak-hickory	Replacement	79%	5	1	8
	Mixed	2%	260		
	Surface or low	20%	2		33
Great Lakes Woodland					
Great Lakes pine barrens	Replacement	8%	41	10	80
	Mixed	9%	36	10	80
	Surface or				

	low	83%	4	1	20
Jack pine-open lands (frequent fire-return interval)	Replacement	83%	26	10	100
	Mixed	17%	125	10	
Northern oak savanna	Replacement	4%	110	50	500
	Mixed	9%	50	15	150
	Surface or low	87%	5	1	20
Great Lakes Forested					
Great Lakes floodplain forest	Mixed	7%	833		
	Surface or low	93%	61		
Great Lakes spruce-fir	Replacement	100%	85	50	200
Great Lakes pine forest, jack pine	Replacement	67%	50		
	Mixed	23%	143		
	Surface or low	10%	333		
Oak-hickory	Replacement	13%	66	1	
	Mixed	11%	77	5	
	Surface or low	76%	11	2	25
Red pine-eastern white pine (frequent fire)	Replacement	38%	56		
	Mixed	36%	60		
	Surface or low	26%	84		

Northeast

- Northeast Woodland
- Northeast Forested

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northeast Woodland					
Eastern woodland mosaic	Replacement	2%	200	100	300
	Mixed	9%	40	20	60
	Surface or low	89%	4	1	7
	Replacement	16%	128		

Rocky outcrop pine (Northeast)	Mixed	32%	65		
	Surface or low	52%	40		
Pine barrens	Replacement	10%	78		
	Mixed	25%	32		
	Surface or low	65%	12		
Oak-pine (eastern dry-xeric)	Replacement	4%	185		
	Mixed	7%	110		
	Surface or low	90%	8		
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

South-central US

- South-central US Grassland
- South-central US Woodland
- South-central US Forested

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
South-central US Grassland					
Bluestem-sacahuista	Replacement	70%	3.6	1	
	Mixed	30%	7.7	2	
Blackland prairie	Replacement	96%	4		
	Surface or low	4%	100		
Southern tallgrass prairie	Replacement	91%	5		
	Mixed	9%	50		
Oak savanna	Replacement	3%	100	5	110
	Mixed	5%	60	5	250
	Surface or low	93%	3	1	4
South-central US Woodland					
	Replacement	1%	227		

Oak-hickory savanna	Surface or low	99%	3.2		
Interior Highlands dry oak/bluestem woodland and glade	Replacement	16%	25	10	100
	Mixed	4%	100	10	
	Surface or low	80%	5	2	7
Interior Highlands oak-hickory-pine	Replacement	3%	150	100	300
	Surface or low	97%	4	2	10
Pine bluestem	Replacement	4%	100		
	Surface or low	96%	4		
South-central US Forested					
Interior Highlands dry-mesic forest and woodland	Replacement	7%	250	50	300
	Mixed	18%	90	20	150
	Surface or low	75%	22	5	35
Gulf Coastal Plain pine flatwoods	Replacement	2%	190		
	Mixed	3%	170		
	Surface or low	95%	5		
West Gulf Coastal plain pine (uplands and flatwoods)	Replacement	4%	100	50	200
	Mixed	4%	100	50	
	Surface or low	93%	4	4	10
West Gulf Coastal Plain pine-hardwood woodland or forest upland	Replacement	3%	100	20	200
	Mixed	3%	100	25	
	Surface or low	94%	3	3	5
Southern floodplain	Replacement	42%	140		
	Surface or low	58%	100		
Southern floodplain (rare fire)	Replacement	42%	≥1,000		
	Surface or low	58%	714		

Southern Appalachians

- Southern Appalachians Grassland
- Southern Appalachians Woodland
- Southern Appalachians Forested

Vegetation Community (Potential Natural	Fire	Fire regime characteristics			
			Mean	Minimum	Maximum

Vegetation Group)	severity*	Percent of fires	interval (years)	interval (years)	interval (years)
Southern Appalachians Grassland					
Bluestem-oak barrens	Replacement	46%	15		
	Mixed	10%	69		
	Surface or low	44%	16		
Eastern prairie-woodland mosaic	Replacement	50%	10		
	Mixed	1%	900		
	Surface or low	50%	10		
Southern Appalachians Woodland					
Appalachian shortleaf pine	Replacement	4%	125		
	Mixed	4%	155		
	Surface or low	92%	6		
Southern Appalachians Forested					
Bottomland hardwood forest	Replacement	25%	435	200	≥1,000
	Mixed	24%	455	150	500
	Surface or low	51%	210	50	250
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

- Southeast Grassland
- Southeast Shrubland
- Southeast Woodland
- Southeast Forested

		Fire regime characteristics			

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southeast Grassland					
Southeast Gulf Coastal Plain Blackland prairie and woodland	Replacement	22%	7		
	Mixed	78%	2.2		
Gulf Coast wet pine savanna	Replacement	2%	165	10	500
	Mixed	1%	500		
	Surface or low	98%	3	1	10
Southeast Shrubland					
Pocosin	Replacement	1%	>1,000	30	>1,000
	Mixed	99%	12	3	20
Southeast Woodland					
Longleaf pine/bluestem	Replacement	3%	130		
	Surface or low	97%	4	1	5
Longleaf pine (mesic uplands)	Replacement	3%	110	40	200
	Surface or low	97%	3	1	5
Longleaf pine-Sandhills prairie	Replacement	3%	130	25	500
	Surface or low	97%	4	1	10
Pond pine	Replacement	64%	7	5	500
	Mixed	25%	18	8	150
	Surface or low	10%	43	2	50
South Florida slash pine flatwoods	Replacement	6%	50	50	90
	Surface or low	94%	3	1	6
Southeast Forested					
Coastal Plain pine-oak-hickory	Replacement	4%	200		
	Mixed	7%	100		
	Surface or low	89%	8		
Mesic-dry flatwoods	Replacement	3%	65	5	150
	Surface or low	97%	2	1	8
	Replacement	7%	900		

Southern floodplain	Surface or low	93%	63		

*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 [53,83].

Kummerowia stipulacea, K. striata: REFERENCES

1. Alexander, Helen M.; Mihail, Jeanne D. 2000. Seedling disease in an annual legume: consequences for seedling mortality, plant size, and population seed production. Oecologia. 122(3): 346-353. [77059]

2. Allard, H. A.; Leonard, E. C. 1943. The vegetation and floristics of Bull Run Mountain, Virginia. Castanea. 8(1/3): 1-64. [72123]

3. Anderson, Roger C.; Schwegman, John E.; Anderson, M. Rebecca. 2000. Micro-scale restoration: a 25-year history of a southern Illinois barrens. Restoration Ecology. 8(3): 296-306. [36810]

4. Anderson, Roger C.; Van Valkenburg, Charles. 1977. Response of a southern Illinois grassland community to burning. Transactions, Illinois State Academy of Science. 69(4): 399-414. [19481]

5. Arner, Dale H. 1981. Prescribed burning in utility rights-of-way management. In: Wood, Gene W., ed. Prescribed fire and wildlife in southern forests: Proceedings of a symposium; 1981 April 6-8; Myrtle Beach, SC. Georgetown, SC: Clemson University, Belle W. Baruch Forest Science Institute: 163-166. [14823]

6. Ashby, William C.; Weaver, George T. 1970. Forest regeneration on two old fields in southwestern Illinois. The American Midland Naturalist. 84(1): 90-104. [77168]

7. Asher, Jerry; Dewey, Steven; Olivarez, Jim; Johnson, Curt. 1998. Minimizing weed spread following wildland fires. Proceedings, Western Society of Weed Science. 51: 49. Abstract. [40409]

8. Baldridge, Joe D. 1957. The lespedezas: II. Culture and utilization. Advances in Agronomy. 9: 122-141. [79760]

9. Baldwin, W. P., Jr.; Handley, C. O. 1946. Winter food of bobwhite quail in Virginia. Journal of Wildlife Management. 10(2): 142-149. [77116]

10. Barbour, Roger W. 1951. Observations on the fall and winter food of bob-white quail in Kentucky. Journal of Wildlife Management. 15(1): 108. [77103]

11. Bare, Janet E. 1979. Wildflowers and weeds of Kansas. Lawrence, KS: The Regents Press of Kansas. 509 p. [3801]

12. Baskin, Carol C.; Baskin, Jerry M. 1988. Germination ecophysiology of herbaceous plant species in a temperate region. American Journal of Botany. 75(2): 286-305. [60185]

13. Baskin, Jerry M.; Baskin, Carol C. 2003. The vascular flora of cedar glades of the southeastern United States and its phytogeographical relationships. Journal of the Torrey Botanical Society. 130(2): 101-118. [47404]

14. Beuselinck, P. R.; McGraw, R. L. 1994. Management of annual lespedeza for seed or herbage. Journal of Production Agriculture. 7(2): 230-232. [77061]

15. Billings, W. D. 1938. The structure and development of old field shortleaf pine stands and certain associated physical properties of the soil. Ecological Monographs. 8(3): 437-499. [10701]

16. Brewer, Howard E. 1947. Response of certain legumes to variations in soil and microclimate on eroded areas in southeastern Iowa. Ecological Monographs. 17(4): 471-500. [76227]

17. Brooks, Matthew L. 2008. Effects of fire suppression and postfire management activities on plant invasions. In: Zouhar, Kristin; Smith, Jane Kapler; Sutherland, Steve; Brooks, Matthew L., eds. Wildland fire in ecosystems: Fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 269-280. [70909]

18. Brooks, Matthew L.; Pyke, David A. 2001. Invasive plants and fire in the deserts of North America. In: Galley, Krista E. M.; Wilson, Tyrone P., eds. Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species; Fire conference 2000: 1st national congress on fire ecology, prevention, and management; 2000 November 27 - December 1; San Diego, CA. Misc. Publ. No. 11. Tallahassee, FL: Tall Timbers Research Station: 1-14. [40491]

19. Brothers, Timothy S. 1990. Surface-mine grasslands. Geographical Review. 80(3): 209-225. [77132]

20. Bush, B. F. 1894. Notes on a list of plants collected in southeastern Missouri in 1893. Botanical Garden Annual Report. 1894: 139-153. [77145]

21. Bussan, Alvin J.; Dyer, William E. 1999. Herbicides and rangeland. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 116-132. [35716]

22. Byrd, M. A. 1956. Relation of ecological succession to farm game in Cumberland County in the Virginia Piedmont. The Journal of Wildlife Management. 20(2): 188-195. [77191]

23. Campbell, Jonathan E.; Gibson, David J. 2001. The effects of seeds of exotic species transported via horse dung on vegetation along trail corridors. Plant Ecology. 157(1): 23-35. [77062]

24. Campbell, Robert S.; Cassady, John T. 1951. Grazing values for cattle on pine forest ranges in Louisiana. Louisiana Bulletin No. 452. Baton Rouge, LA: Louisiana State University, Agricultural Experiment Station. 31 p. [30915]

25. Carpenter, Jackie S.; Chester, Edward W. 1987. Vascular flora of the Bear Creek Natural Area, Stewart County, Tennessee. Castanea. 52(2): 112-128. [75372]

26. Cole, C. Andrew. 1991. The seedbank of a young surface mine wetland. Wetlands Ecology and Management. 1(3): 173-184. [19468]

27. Collins, Cathy D.; Holt, Robert D.; Foster, Bryan L. 2009. Patch size effects on plant species decline in an experimentally fragmented landscape. Ecology. 90(9): 2577-2588. [78055]

28. Conley, James B.; Blem, C. R. 1978. Seed selection by Japanese quail, Coturnix coturnix japonica. The American Midland Naturalist. 100(1): 135-140. [77184]

29. Creek, Robert; Wade, Gary L. 1985. Excretion of phenolic compounds from the roots of Festuca arundinacea, Eragrostis curvula, and Lespedeza striata. Transactions, Kentucky Academy of Science. 46(1-2): 51-55. [24996]

30. Crocker, William. 1938. Life-span of seeds. Botanical Review. 4(5): 235-274. [77196]

31. Cushwa, Charles T.; Hopkins, Melvin; McGinnes, Burd S. 1970. Response of legumes to prescribed burns in loblolly pine stands of the South Carolina Piedmont. Res. Note SE-140. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 6 p. [11587]

32. Cushwa, Charles T.; Redd, John B. 1966. One prescribed burn and its effects on habitat of the Powhatan Game Management Area. Res. Note SE-61. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 2 p. [11505]

33. Cushwa, Charles Terry. 1967. The effects of prescribed fire on plant succession in pine stands of the Piedmont--with particular emphasis on response of game food plants. Blacksburg, VA: Virginia Polytechnic Institute. 126 p. Dissertation. [35684]

34. Dalke, Paul D.; Spencer, David L. 1944. Development and land use on a private game preserve in southern Taney County, Missouri. The Journal of Wildlife Management. 8(1): 1-6. [77161]

35. Davidson, Verne E.; Sullivan, Edward G. 1963. Mourning doves' selection of foods. The Journal of Wildlife Management. 27(3): 373-383. [77127]

36. Davis, David K.; McGraw, Robert L.; Beuselinck, Paul R.; Roberts, Craig A. 1995. Total nonstructural carbohydrate accumulation in roots of annual lespedeza. Agronomy Journal. 87: 89-92. [77082]

37. Davison, Verne E. 1945. Wildlife values of the lespedezas. The Journal of Wildlife Management. 9(1): 1-9. [45572]

38. Diggs, George M., Jr.; Lipscomb, Barney L.; O'Kennon, Robert J. 1999. Illustrated flora of north-central Texas. Sida Botanical Miscellany, No. 16. Fort Worth, TX: Botanical Research Institute of Texas. 1626 p. [35698]

39. Drew, Mark B.; Kirkman, L. Katherine; Gholson, Angus K., Jr. 1998. The vascular flora of Ichauway, Baker County, Georgia: a remnant longleaf pine/wiregrass ecosystem. Castanea. 63(1): 1-24. [71943]

40. Duncan, Wilbur H. 1950. Preliminary reports on the flora of Georgia--4. Notes on the distribution of flowering plants including species new to the state. Castanea. 15(4): 145-159. [77206]

41. Dutton, Bryan E.; Thomas, R. Dale. 1991. The vascular flora of Cameron Parish, Louisiana. Castanea. 56(1): 1-37. [73744]

42. Fox, William B. 1945. The Leguminosae in Iowa. The American Midland Naturalist. 34(1): 207-230. [77167]

43. Fraps, G. S.; Frdge, J. F. 1940. The chemical composition of forage grasses of the East Texas timber country. Bulletin No. 582. College Station, TX: Texas Agricultural Experiment Station. 35 p. [34715]

44. Freeman, Craig C.; Hulbert, Lloyd C. 1985. An annotated list of the vascular flora of Konza Prairie Research Natural Area, Kansas. Transactions of the Kansas Academy of Science. 88(3/4): 84-115. [75342]

45. Fryxell, Paul A. 1957. Mode of reproduction of higher plants. Botanical Review. 23: 135-233. [67749]

46. Gano, Laura. 1917. A study in physiographic ecology in northern Florida. Botanical Gazette. 63: 337-372. [21989]

47. Gant, Robert E.; Clebsch, E. C. 1975. The allelopathic influences of Sassafras albidum in old-field succession in Tennessee. Ecology. 56: 604-615. [21919]

48. Gentry, John B.; Smith, Michael H. 1968. Food habits and burrow associates of Peromyscus polionotus. Journal of Mammalogy. 49(3): 562-565. [77152]

49. Gleason, Henry A.; Cronquist, Arthur. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. New York: New York Botanical Garden. 910 p. [20329]

50. Golley, Frank B.; Gentry, John B. 1965. A comparison of variety and standing crop of vegetation on a one-year and a twelve-year abandoned field. Oikos. 15(2): 185-199. [77148]

51. Goodwin, Kim; Sheley, Roger; Clark, Janet. 2002. Integrated noxious weed management after wildfires. EB-160. Bozeman, MT: Montana State University, Extension Service. 46 p. Available online: http://www.montana.edu/wwwpb/pubs/eb160.html [2003, October 1]. [45303]

52. Great Plains Flora Association. 1986. Flora of the Great Plains. Lawrence, KS: University Press of Kansas. 1392 p. [1603]

53. Hann, Wendel; Havlina, Doug; Shlisky, Ayn; [and others]. 2008. Interagency fire regime condition class guidebook. Version 1.3, [Online]. In: Interagency fire regime condition class website. U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior; The Nature Conservancy; Systems for Environmental Management (Producer). 119 p. Available: http://frames.nbii.gov/frcc/documents/FRCC_Guidebook_2008.07.10.pdf [2010, 3 May]. [70966]

54. Hanson, Clarence H.; Cope, Will A. 1955. Interspecific hybridization in lespedeza. The Journal of Heredity. 46: 233-238. [45574]

55. Harrelson, Sarah M.; Cantino, Philip D. 2006. The terrestrial vascular flora of Strounds Run State Park, Athens County, Ohio. Rhodora. 108(934): 142-183. [72485]

56. Harris, Howard L.; Drew, William B. 1943. On the establishment and growth of certain legumes on eroded and uneroded sites. Ecology. 24(2): 135-148. [77102]

57. Helm, C. A.; Etheridge, W. C. 1933. Lespedeza sericea: The newest legume for Missouri. Agricultural Experiment Station Bulletin 331. Columbia, MO: University of Missouri, College of Agriculture. 15 p. [45575]

58. Henson, P. R.; Cope, W. A. 1969. Annual lespedezas: Culture and use. Farmer's Bulletin No. 2113. Washington, DC: U.S. Department of Agriculture. 16 p. [79643]

59. Herring, Brenda J.; Judd, Walter S. 1995. A floristic study of Ichetucknee Springs State Park, Suwannee and Columbia counties, Florida. Castanea. 60(4): 318-369. [71988]

60. Hitchcock, A. S. 1897-1898. List of plants in my Florida herbarium. Transactions of the Kansas Academy of Science. 16: 108-157. [77183]

61. Hoagland, Bruce W.; Buthod, Amy K. 2004. Vascular flora of Hugo Lake Wildlife Management Area, Choctaw County, Oklahoma. Southeastern Naturalist. 3(4): 701-714. [76671]

62. Hoagland, Bruce W.; Johnson, Forrest L. 2001. Vascular flora of the Chickasaw National Recreation Area, Murray County, Oklahoma. Castanea. 66(4): 383-400. [71992]

63. Hobbs, Richard J.; Humphries, Stella E. 1995. An integrated approach to the ecology and management

of plant invasions. Conservation Biology. 9(4): 761-770. [44463]

64. Isely, Duane. 1948. Lespedeza striata and L. stipulacea. Rhodora. 50: 21-27. [79763]

65. Isely, Duane. 1998. Native and naturalized Leguminosae (Fabaceae) of the United States (exclusive of Alaska and Hawaii). Provo, UT: Brigham Young University, Monte L. Bean Life Science Museum. 1007 p. [77050]

66. Johnson, B. J. 1979. Bahiagrass (Paspalum notatum) and common lespedeza (Lespedeza striata) control with herbicides in centipedegrass (Eremochloa ophiuroides). Weed Science. 27(3): 346-348. [77094]

67. Johnson, Douglas E. 1999. Surveying, mapping, and monitoring noxious weeds on rangelands. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 19-36. [35707]

68. Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. Journal of Wildlife Management. 27: 757-778. [5522]

69. Joyner, James J.; Chester, Edward W. 1994. The vascular flora of Cross Creeks National Wildlife Refuge, Stewart County, Tennessee. Castanea. 59(2): 117-145. [75373]

70. Kartesz, John T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. 1st ed. In: Kartesz, John T.; Meacham, Christopher A. Synthesis of the North American flora (Windows Version 1.0), [CD-ROM]. Chapel Hill, NC: North Carolina Botanical Garden (Producer). In cooperation with: The Nature Conservancy; U.S. Department of Agriculture, Natural Resources Conservation Service; U.S. Department of the Interior, Fish and Wildlife Service. [36715]

71. Kay, Carol A. Rolph; Clewell, Andre F.; Ashler, Elizabeth Winstead. 1978. Vegetative cover in a fallow field: responses to season of soil disturbance. Bulletin of the Torrey Botanical Club. 105(2): 143-147. [77173]

72. Kendeigh, S. Charles; West, George C. 1965. Caloric values of plant seeds eaten by birds. Ecology. 46(4): 553-555. [48440]

73. Kentucky Exotic Pest Plant Council. 2008. Invasive exotic plant list, [Online]. Southeast Exotic Pest Plant Council (Producer). Available: http://www.se-eppc.org/ky/list.htm [2009, January 5]. [72785]

74. Klimstra, W. D.; Roseberry, John L. 1975. Nesting ecology of the bobwhite in southern Illinois. Wildlife Monographs No. 41. Washington, DC: The Wildlife Society. 37 p. [77153]

75. Korschgen, L. J. 1966. Foods and nutrition of ruffed grouse in Missouri. The Journal of Wildlife Management. 30(1): 86-100. [77120]

76. Korschgen, Leroy J. 1948. Late-fall and early-winter food habits of bobwhite quail in Missouri. The Journal of Wildlife Management. 12(1): 46-57. [77118]

77. Korschgen, Leroy J. 1962. Food habits of greater prairie chickens in Missouri. The American Midland Naturalist. 68(2): 307-318. [77200]

78. Korschgen, Leroy J. 1962. Foods of Missouri deer, with some management implications. The Journal of Wildlife Management. 26(2): 164-172. [77190]

79. Korschgen, Leroy J. 1980. Food and nutrition of cottontail rabbits in Missouri. Terrestrial Series #6.

Jefferson City, MO: Missouri Department of Conservation. 16 p. [25171]

80. Korschgen, Leroy J.; Porath, Wayne R.; Torgerson, Oliver. 1980. Spring and summer foods of deer in the Missouri Ozarks. The Journal of Wildlife Management. 44(1): 89-97. [77111]

81. Kubota, Hitomi; Shimano, Koji. 2010. Effects of ski resort management on vegetation. Landscape and Ecological Engineering. 6(1): 61-74. Published online--DOI: 10.1007/s11355-009-0085-4. [77084]

82. Lamont, Eric E. 1994. Lespedeza striata (Fabaceae), an addition to the flora of New York, with notes on its introduction and spread in the eastern United States. Bulletin of the Torrey Botanical Club. 121(4): 377-378. [77068]

83. LANDFIRE Rapid Assessment. 2005. Reference condition modeling manual (Version 2.1), [Online]. In: LANDFIRE. Cooperative Agreement 04-CA-11132543-189. Boulder, CO: The Nature Conservancy; U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior (Producers). 72 p. Available: http://www.landfire.gov/downloadfile.php?file=RA_Modeling_Manual_v2_1.pdf [2007, May 24]. [66741]

84. LANDFIRE Rapid Assessment. 2007. Rapid assessment reference condition models, [Online]. In: LANDFIRE. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Lab; U.S. Geological Survey; The Nature Conservancy (Producers). Available: http://www.landfire.gov/models_EW.php [2008, April 18] [66533]

85. Lay, Daniel W. 1952. Bobwhite quail in relation to land management in pine woodland type. Final report: Federal Aid Project 20-R; July 1, 1946 to March 31, 1951. Austin, TX: Texas Game and Fish, Division of Wildlife Restoration. 54 p. [77056]

86. Lin, C. H.; McGraw, R. L.; George, M. F.; Garrett, H. E. 2004. Shade effects on forage crops with potential in temperate agroforestry practices. Agroforestry Systems. 44(2-3): 109-119. [77086]

87. Luken, James O.; Thieret, John W. 2001. Floristic relationships of mud flats and shorelines at Cave Run Lake, Kentucky. Castanea. 66(4): 336-351. [76230]

88. Mack, Richard N. 1991. The commercial seed trade: an early disperser of weeds in the United States. Economic Botany. 45(2): 257-273. [55368]

89. Mack, Richard N.; Simberloff, Daniel; Lonsdale, W. Mark; Evans, Harry; Clout, Michael; Bazzaz, Fakhri A. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications. 10(3): 689-710. [48324]

90. Magee, Dennis W.; Ahles, Harry E. 2007. Flora of the Northeast: A manual of the vascular flora of New England and adjacent New York. 2nd ed. Amherst, MA: University of Massachusetts Press. 1214 p. [74293]

91. Martin, Robert E.; Cushwa, Charles T. 1966. Effects of heat and moisture on leguminous seed. In: Proceedings, 5th annual Tall Timbers fire ecology conference; 1966 March 24-25; Tallahassee, FL. Tallahassee, FL: Tall Timbers Research Station: 159-175. [18925]

92. Masiunas, J. B.; Carpenter, P. L. 1984. Effects of temperature on radicle growth of Lolium multiflorum, Bouteloua curtipendula, and Lespedeza stipulacea. Hortscience. 19(2): 300-301. [77069]

93. McGraw, Robert L.; Hoveland, Carl S. 1995. Lespedezas. In: Barnes, Robert F.; Miller, Darrell A.; Nelson, C. Jerry, eds. Forages. Volume 1: An introduction to grassland agriculture. 5th ed. Ames, IA: Iowa State University Press: 261-271. [45323]

94. McGregor, R. L.; Volle, L. D. 1950. First year invasion of plants on the exposed bed of Lake Fegan, Woodson County, Kansas. Transactions of the Kansas Academy of Science. 53(3): 372-377. [77158]

95. McRae, W. Alan. 1980. Unusual bobwhite foods on abandoned piedmont farmlands. Georgia Journal of Science. 38: 49-54. [41041]

96. Meehan, Thomas. 1884. Survival of the fittest. Bulletin of the Torrey Botanical Club. 11(5): 53-55. [77142]

97. Michael, Victor C.; Beckwith, Stephen L. 1955. Quail preference for seed of farm crops. The Journal of Wildlife Management. 19(2): 281-296. [77143]

98. Middleton, Gordon K. 1933. Hard seed in Korean lespedeza. Journal of the American Society of Agronomy. 25: 119-122. [79767]

99. Middleton, Gordon K. 1933. Size of Korean lespedeza seed in relation to germination and hard seed. Journal of the American Society of Agronomy. 25(3): 173-177. [79764]

100. Mihail, J. D.; Alexander, H. M.; Taylor, S. J. 1998. Interactions between root-infecting fungi and plant density in an annual legume, Kummerowia stipulacea. Journal of Ecology. 86(5): 739-748. [77070]

101. Missouri Botanical Garden. 2002. Missouri exotic pest plants: A list of non-native plants that threaten Missouri's native biodiversity, [Online]. In: MO projects--North America. St. Louis, MO: Missouri Botanical Garden (Producer). Available: http://www.mobot.org/mobot/research/mepp/alphalist.shtml [2009, April 6]. [73559]

102. Mohlenbrock, Robert H. 1962. A floristic study of the Devils Kitchen area, Williamson and Union counties, Illinois. Castanea. 27(3): 101-131. [77121]

103. Mohlenbrock, Robert H. 1966. A floristics study of Ferne Clyffe State Park, Illinois. Castanea. 31(3): 198-235. [75335]

104. Mohlenbrock, Robert H. 1986. [Revised edition]. Guide to the vascular flora of Illinois. Carbondale, IL: Southern Illinois University Press. 507 p. [17383]

105. Mohr, Charles. 1878. Foreign plants introduced into the Gulf States. Botanical Gazette. 3(5): 42-46. [77151]

106. Muhlenbach, Victor. 1979. Contributions to the synanthropic (adventive) flora of the railroads in St. Louis, Missouri, USA. Annals of the Missouri Botanical Garden. 66(1): 1-108. [71736]

107. Nakata, Shigeru. 1952. Photoperiodic response of lespedeza. Plant Physiology. 27(3): 644-647. [77087]

108. Nakatsubo, Takayuki. 1995. Factors limiting the distribution of the annual legume Kummerowia striata in a river floodplain. Ecological Research. 10(2): 179-187. [77072]

109. NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life, [Online]. Version 7.1. Arlington, VA: NatureServe (Producer). Available http://www.natureserve.org/explorer. [69873]

110. Newlon, Charles F.; Baskett, Thomas S.; Breitenbach, Robert P.; Stanford, Jack A. 1964. Sustaining values of emergency foods for bobwhites. The Journal of Wildlife Management. 28(3): 532-542. [77099]

111. Numata, Makoto. 1969. Progressive and retrogressive gradient of grassland vegetation measured by degree of succession--ecological judgment of grassland condition and trend IV. Vegtatio. 19(1/6): 96-127. [77129]

112. Odum, Eugene P. 1960. Organic production and turnover in old field succession. Ecology. 41(1): 34-49. [77181]

113. Offutt, Marion L.; Baldridge, Joe D. 1973. The Lespedezas. In: Heath, Maurice E.; Metcalfe, Darrel S.; Barnes, Robert F., eds. Forages: The science of grassland agriculture. 3rd ed. Ames, IA: The Iowa State University Press: 189-198. [21655]

114. Oosting, Henry J. 1942. An ecological analysis of the plant communities of the Piedmont, North Carolina. The American Midland Naturalist. 28: 1-126. [50588]

115. Oosting, Henry J.; Humphreys, Mary E. 1940. Buried viable seeds in a successional series of old field and forest soils. Bulletin of the Torrey Botanical Club. 67(4): 253-273. [5933]

116. Paulsell, Lee K. 1957. Effects of burning on Ozark hardwood timberlands. Res. Bull. 640. Columbia, MO: University of Missouri, College of Agriculture, Agricultural Experiment Station. 24 p. [11885]

117. Penfound, William T. 1964. The relation of grazing to plant succession in the tall grass prairie. Journal of Range Management. 17: 256-260. [29706]

118. Penfound, William T.; Rice, Elroy L. 1957. Effects of fencing and plowing on plant succession in a revegetating field. Journal of Range Management. 10(1): 21-22. [77178]

119. Quarterman, Elsie. 1957. Early plant succession on abandoned cropland in the central basin of Tennessee. Ecology. 38(2): 300-309. [77156]

120. Radford, Albert E.; Ahles, Harry E.; Bell, C. Ritchie. 1968. Manual of the vascular flora of the Carolinas. Chapel Hill, NC: The University of North Carolina Press. 1183 p. [7606]

121. Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]

122. Ravenel, H. W. 1882. The migration of weeds. Bulletin of the Torrey Botanical Club. 9(9): 112-114. [77133]

123. Rosburg, Thomas R.; Glenn-Lewin, David C. 1992. Effects of fire and atrazine on pasture and remnant prairie plant species in southern Iowa. In: Smith, Daryl D.; Jacobs, Carol A., eds. Recapturing a vanishing heritage: Proceedings, 12th North American prairie conference; 1990 August 5-9; Cedar Falls, IA. Cedar Falls, IA: University of Northern Iowa: 107-112. [24724]

124. Roseberry, John L.; Klimstra, W. D. 1970. The nesting ecology and reproductive performance of the eastern meadowlark. The Wilson Bulletin. 82(3): 243-267. [77130]

125. Saunders, David K.; Parrish, John W. 1987. Assimilated energy of seeds consumed by scaled quail in Kansas. The Journal of Wildlife Management. 51(4): 787-790. [77100]

126. Schneider, Jennifer; Maehr, David S.; Alexy, Karen J.; Cox, John J.; Larkin, Jeffery L.; Reeder, Brian C. 2006. Food habits of reintroduced elk in southeastern Kentucky. Southeastern Naturalist. 5(3): 535-546. [75259]

127. Schott, Gary W.; Hamburg, Steven P. 1997. The seed rain and seed bank of an adjacent native tallgrass prairie and old field. Canadian Journal of Botany. 75(1): 1-7. [27399]

128. Sharp, D. 1976. A phytosociological study of weed communities on the southwestern Coastal Plain of North Carolina. Vegtatio. 31(2): 103-119. [77123]

129. Sheley, Roger; Manoukian, Mark; Marks, Gerald. 1999. Preventing noxious weed invasion. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 69-72. [35711]

130. Shepherd, W. O.; Hughes, R. H.; Dillard, E. U.; Rea, J. L. 1956. Pasture firebreaks: Construction and species trials on pond pine sites in North Carolina. Bulletin No. 398. Raleigh, NC: North Carolina State College, Agricultural Experiment Station. 34 p. In cooperation with: U.S. Department of Agriculture. [63069]

131. Small, Christine J.; McCarthy, Brian C. 2001. Vascular flora of the Waterloo Wildlife Research Station, Athens County, Ohio. Castanea. 66(4): 363-382. [71703]

132. Smith, Melinda D.; Knapp, Alan K. 1999. Exotic plant species in a C4-dominated grassland: invasibility, disturbance, and community structure. Oecologia. 120(4): 605-612. [30903]

133. Sotala, Dennis J.; Kirkpatrick, Charles M. 1973. Foods of white-tailed deer, Odocoileus virginianus, in Martin County, Indiana. The American Midland Naturalist. 89(2): 281-286. [15056]

134. Speake, Dan W. 1967. Effects of controlled burning on bobwhite quail populations and habitat of an experimental area in the Alabama Piedmont. Proceedings, Annual Conference of the Southeastern Association of Game and Fish Commission. 20: 19-32. [14649]

135. Steury, Brent W. 1999. Annotated list of vascular plants from a nontidal barrier wetland along the Chesapeake Bay in Calvert County, Maryland. Castanea. 64(2): 187-200. [71990]

136. Stickney, Peter F. 1989. Seral origin of species comprising secondary plant succession in Northern Rocky Mountain forests. FEIS workshop: Postfire regeneration. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT. 10 p. [20090]

137. Stoddard, Herbert L. 1931. The use and abuse of fire on southern quail reserves. In: The bobwhite quail: Its habits, preservation and increase. New York, NY: Charles Scribner's Sons: 401-414. [50463]

138. Stoddard, Herbert L. 1961. Management leaflets and news letters: Memorandum on the spring 1932 burning of quail lands. In: Stoddard, Herbert L.; Beadel, Henry L.; Komarek, E. V., eds. The Cooperative Quail Study Association: May 1, 1931--May 1, 1943. Misc. Publ. No. 1. Tallahassee, FL: Tall Timbers Research Station: 274-280. [15071]

139. Strausbaugh, P. D.; Core, Earl L. 1977. Flora of West Virginia. 2nd ed. Morgantown, WV: Seneca Books, Inc. 1079 p. [23213]

140. Stubbendiek, James; Conard, Elverne C. 1989. Common legumes of the Great Plains: an illustrated guide. Lincoln, NE: University of Nebraska Press. 330 p. [11049]

141. Tang, Jianjun; Chen, Jing; Chen, Xin. 2006. Response of 12 weedy species to elevated CO2 in low-phosphorus-availability soil. Ecological Research. 21(5): 664-670. [77076]

142. Taylor, W. Carl. 1976. Vascular flora of Jonca Creek, Ste. Genevieve County, Missouri. Castanea. 41(2): 93-118. [73984]

143. Templeton, W. C., Jr.; Franks, K. N.; Taylor, T. H. 1969. Relative performance of lespedeza varieties under different managements. Agronomy Journal. 61(4): 581-584. [77090]

144. Tennessee Exotic Pest Plant Council. 2001. Tennessee invasive exotic plant list, [Online]. In: Invasive exotic plants in Tennessee. Fairview, TN: Tennessee Exotic Pest Plant Council (Producer) Available:

http://www.tneppc.org/Invasive_Exotic_Plant_List/The_List.htm [2009, June 12]. [74677]

145. Thill, Ronald E. 1984. Deer and cattle diets on Louisiana pine-hardwood sites. The Journal of Wildlife Management. 48(3): 788-798. [77155]

146. Thompson, Ralph L.; Poindexter, Derick B. 2006. Vascular flora of the Elk and Bison Prairie, Land Between the Lakes National Recreation Area, Trigg County, Kentucky. Castanea. 71(2): 105-123. [71986]

147. Thompson, Ralph L.; Vogel, Willis G.; Taylor, David D. 1984. Vegetation and flora of a coal surface-mined area in Laurel County, Kentucky. Castanea. 49(3): 111-126. [75263]

148. Thompson, Ralph L.; Wade, Gary L. 1991. Flora and vegetation of a 12-year-old coal surface-mined area in Rockcastle County, Kentucky. Castanea. 56(2): 99-116. [77098]

149. Tu, Mandy; Hurd, Callie; Randall, John M., eds. 2001. Weed control methods handbook: tools and techniques for use in natural areas. Davis, CA: The Nature Conservancy. 194 p. [37787]

150. Tyser, Robin W.; Worley, Christopher A. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). Conservation Biology. 6(2): 253-262. [19435]

151. U.S. Department of Agriculture, Forest Service. 2001. Guide to noxious weed prevention practices. Washington, DC: U.S. Department of Agriculture, Forest Service. 25 p. Available online: http://www.fs.fed.us/invasivespecies/documents/FS_WeedBMP_2001.pdf [2009, November 19]. [37889]

152. U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. PLANTS Database, [Online]. Available: http://plants.usda.gov/. [34262]

153. Van Driesche, Roy; Lyon, Suzanne; Blossey, Bernd; Hoddle, Mark; Reardon, Richard, tech. coords. 2002. Biological control of invasive plants in the eastern United States. Publication FHTET-2002-04. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team. 413 p. Available online: http://www.invasive.org/eastern/biocontrol/index.html [2009, November 19]. [54194]

154. Vogel, Willis G. 1981. A guide for revegetating coal mine soils in the eastern United States. Gen. Tech. Rep. NE-68. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 190 p. [15576]

155. Voss, Edward G. 1985. Michigan flora. Part II. Dicots (Saururaceae--Cornaceae). Bulletin 59. Bloomfield Hills, MI: Cranbrook Institute of Science; Ann Arbor, MI: University of Michigan Herbarium. 724 p. [11472]

156. Wagner, Warren L.; Herbst, Derral R.; Sohmer, S. H., eds. 1999. Manual of the flowering plants of Hawai'i. Revised edition: Volume 1. Bishop Museum Special Publication 97. Honolulu, HI: University of Hawai'i Press; Bishop Museum Press. 988 p. [70167]

157. Wahlenberg, W. G.; Greene, S. W.; Reed, H. R. 1939. Effects of fire and cattle grazing on longleaf pine lands, as studied at McNeill, Mississippi. Tech. Bull. No. 683. Washington, DC: U.S. Department of Agriculture. 52 p. [13795]

158. Washburn, Brian E.; Barnes, Thomas G.; Rhoades, Charles C.; Remington, Rick. 2002. Using imazapic and prescribed fire to enhance native warm-season grasslands in Kentucky, USA. Natural Areas Journal. 22(1): 20-27. [42553]

159. West, Natalie M.; Gibson, David J.; Minchin, Peter R. 2008. Characterizing the microhabitats of exotic species in Illinois shale barrens. Plant Ecology. 200(2): 255-265. [77092]

160. Westemeier, Ronald L. 1973. Prescribed burning in grassland management for prairie chickens in Illinois. In: Proceedings, annual Tall Timbers fire ecology conference; 1972 June 8-9; Lubbock, TX. Number 12. Tallahassee, FL: Tall Timbers Research Station: 317-341. [8473]

161. Wheeler, W. A.; Hill, D. D. 1957. Grassland seeds. Princeton, NJ: D. Van Nostrand Company. 628 p. [18902]

162. Wilson, Linda M.; McCaffrey, Joseph P. 1999. Biological control of noxious rangeland weeds. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 97-115. [35715]

163. Wofford, B. Eugene. 1989. Guide to the vascular plants of the Blue Ridge. Athens, GA: The University of Georgia Press. 384 p. [12908]

164. Wunderlin, Richard P.; Hansen, Bruce F. 2003. Guide to the vascular plants of Florida. 2nd edition. Gainesville, FL: The University of Florida Press. 787 p. [69433]

FEIS Home Page