Planning and Implementation Guidance Information for

Brush Management, Code 314

A supplement to Florida NRCS Conservation Practice Standard.

U. S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service
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Brush Management Specifications Guide Sheet

Definitions

Native – Species is known to be indigenous to Florida.

Introduced – Species is known to be native to other areas of the world.

Noxious – Species listed as a noxious weed by Florida Department of Agriculture and Consumer Services (***FDACS*)** and/or U.S. Department of Agriculture **(*USDA*).**

Invasive – Species is listed on the Florida Exotic Pest Plant Council's (FLEPPC) Category I invasive, exotic plant. These are species of plants that were introduced into the United States and are expanding on their own in Florida plant communities. These species cause significant damage to native plant communities and their ecological functions.

FLEPPC – Florida Exotic Pest Plant Council. The list is available at http://www.fleppc.org/list/list.htm

Control Priority – Degree of to which immediate treatment is necessary.

High – Control is needed for the benefit of the health of the ecological site, desired plant community, or land use. Presence of woody species is significantly affecting wildlife habitat values and forage production. Invasive or noxious species have become established and are significantly altering the character of the natural plant community and its ecological functions.

Medium – Presence of woody species have become a problem and treatment is recommended to prevent further degradation of the health of the ecological site, desired plant community, or land use. Invasive-exotic species have become established and are beginning to spread. These species are beginning to have significant effects on wildlife habitat values and forage production.

Low – Treatment to control brush is not needed to protect the health of the ecological site, desired plant community, or land use. However, treatment may be necessary to manipulate the cover and structure of woody vegetation in order to create the desired plant community, enhance aesthetic values, and reduce wildfire hazards.

The following table will be used as a guide for determining when brush management is needed.

Native Woody Species	**Origin**	**Noxious and/or Invasive**			**Control Priority**		
		FDACS.	USDA	FLEPPC	High	Medium	Low
					(Percent Canopy)		
Fetterbush *Lyonia spp.*	Native				> 20	10-20	< 10
Gallberry *Ilex glabra*	Native				> 20	10-20	< 10
Oak spp *Quercus spp.*	Native				> 40	15-40	< 15
Persimmon *Diospyros viginiana*	Native				> 20	10-20	< 10
St. Johnswort *Hypericum spp.*	Native				> 30	10-30	< 10
Saw Palmetto *Serenoa repens*	Native				> 30	10-30	< 10
Sea myrtle *Baccharis hamifolia*	Native				> 20	10-20	< 10
Wax myrtle *Myrica cerifera*	Native				> 20	10-20	< 10
Yaupon *Ilex vomitoria*	Native				> 40	15-40	< 15
Other Native Woody Species	Native				>30	15-30	< 15

Noxious and/or Category I Invasive Species

Target Species	Origin	Noxious and/or Invasive			Control Priority		
		FDACS.	USDA	FLEPPC	High	Medium	Low
					(Percent Canopy)		
Australian pine *Casuarina equisetifolia*	Introduced			Cat I	> 10	1-10	< 1
Suckering Australian pine *Casuarina glauca*	Introduced			Cat I	> 10	1-10	< 1
Beach naupaka *Scaevola taccada*	Introduced			Cat I	> 10	1-10	< 1
Brazilian Pepper *Schinus terbinthifolius*	Introduced	Yes	Yes	Cat I	> 10	1-10	< 1
Brazilian jasmine *Jasminum fluminense*	Introduced			Cat I	> 10	1-10	< 1
Camphor tree *Cinnamomum camphora*	Introduced			Cat I	> 10	1-10	< 1
Carrotwood *Cupaniopsis anacardiodes*	Introduced	Yes		Cat I	> 10	1-10	< 1
Catclaw mimosa *Mimosa pigra*	Introduced	Yes	Yes	Cat I	> 10	1-10	< 1
Chinese tallow tree (Popcorn tree) *Sapium sebiferum*	Introduced	Yes	Yes	Cat I	> 10	1-10	< 1
Climbing cassia *Senna pendula*	Introduced			Cat I	> 10	1-10	< 1
Downy rose-myrtle *Rhdomyrtus tmentosa*	Introduced	Yes		Cat I	> 10	1-10	< 1
Earleaf acacia *Accacia auriculiformis*	Introduced			Cat I	> 10	1-10	< 1
Giant sensitive plant *Mimosa invisa*	Introduced		Yes	Cat I	> 10	1-10	< 1
Gold coast jasmine *Jasminum dichotomum*	Introduced			Cat I	> 10	1-10	< 1
Guava *Psidium guajava*	Introduced			Cat I	> 10	1-10	< 1
Java plum *Syzygium cumini*	Introduced			Cat I	> 10	1-10	< 1
Jointed prickly pear *Opuntia aurantiaca*	Introduced			Cat I	> 10	1-10	< 1
Kudzu *Pueraria Montana*	Introduced	Yes	Yes	Cat I	> 10	1-10	< 1
Lantana *Lantana camara*	Introduced			Cat I	> 10	1-10	< 1
Laurel fig *Ficus microcarpa*	Introduced			Cat I	> 10	1-10	< 1
Melaleuca *Melaleuca quinquenervia*	Introduced	Yes	Yes	Cat I	> 10	1-10	< 1
Mimosa (Silk tree) *Albizia julbrissin*	Introduced			Cat I	> 10	1-10	< 1

Target Species	**Origin**	**Noxious and/or Invasive**			**Control Priority**		
		FDACS.	USDA	FLEPPC	High	Medium	Low
					(Percent Canopy)		
Queensland umbrella tree *Schefflera actinophylla*	Introduced			Cat I	> 10	1-10	< 1
Seaside mahoe *Thespesia populnea*	Introduced			Cat I	> 10	1-10	< 1
Sewer vine *Paederia cruddasiana*	Introduced	Yes		Cat I	> 10	1-10	< 1
Skunk vine *Paederia foetdia*	Introduced	Yes		Cat I	> 10	1-10	< 1
Surinam cherry *Eugenia uniflora*	Introduced			Cat I	> 10	1-10	< 1
Womans tongue tree *Albziia lebbeck*	Introduced			Cat I	> 10	1-10	< 1
Category II Invasive-exotic species	Introduced			Cat II	>25	5-25	< 5

Brush Management Methods Guide Sheet

The following table may be used as a guide in the development of site specific treatments.

Major Brush Species	Treatment Periods	Treatment Alternatives	Management Prescription	Treatment Lifespan	Follow-up Practices
Saw palmetto, Gallberry, Wax myrtle	November-June	Roller Chopping-Heavy	A	5-7 years	338, 528
	November-June	Spiral Chopping-Heavy	A	5-7 years	
	November-June	Root Plowing	B	15-20 years	
	November-June	Mowing/Shredding[1]	H	3-5 Years	
Sea myrtle, Wax myrtle	November-June	Roller Chopping-Light	C	5-7 years	338, 528
	March-May	Spiral Chopping-Light	C	5-7 years	
	November-June	Mowing/Shredding[1]	H	3-5 Years	
Fetterbush	November-June	Roller Chopping-Heavy	A	5-7 years	338, 528
	November-June	Spiral Chopping-Heavy	A	5-7 years	
	November-June	Mowing/Shredding[1]	H	3-5 Years	
Persimmon	May-August	Roller Chopping-Heavy	A	5-7 years	338, 528
	May-August	Spiral Chopping-Heavy	A	5-7 years	
	Any time	Dozing (Grubbing)	E	15-20 years	
	Any time	Mowing/Shredding[1]	H	3-5 Years	
Oak spp.	May-August	Roller Chopping-Heavy	A	5-7 years	338, 528
	May-August	Spiral Chopping-Heavy	A	5-7 years	
	Any time	Dozing (Grubbing)	E	15-20 years	
	March-June	Girdle	F	Unknown	
	Any time	Excavator-Slash Scattered	H	15-20 years	
	Any time	Excavator-Slash Piled	I	15-20 years	
	Any time	Tree Shear-Slash Scattered	J	15-20 years	
	Any time	Tree Shear-Slash Piled	K	15-20 years	
St. Johnswort	March-May	Roller Chopping-Light	D	5-7 years	338, 528
	March-May	Spiral Chopping-Light	D	5-7 years	
	March-May	Mowing/Shredding	H	3-5 Years	
Yaupon	May-August	Roller Chopping-Heavy	A	5-7 years	338, 528
	May-August	Spiral Chopping-Heavy	A	5-7 years	
	May-August	Mowing/Shredding[1]	H	3-5 Years	
Melaleuca	Any time	Dozing (Grubbing)[2]	E	20 years	595
Brazilian pepper	Any time	Dozing (Grubbing)[2]	E	20 years	595
	May-August	Roller Chopping-Heavy[2]	A	5-7 years	
	May-August	Spiral Chopping-Heavy[2]	A	5-7 years	

Major Brush Species	Treatment Periods	Treatment Alternatives	Management Prescription	Treatment Lifespan	Follow-up Practices
Other Small (< 5 feet) Shrub Species	Any time	Dozing (Grubbing	E	20 years	595
	Any time	Mowing/Shredding[1]	G	3-5 Years	
	Any time	Roller Chopping-Heavy	A	5-7 years	
	Any time	Spiral Chopping-Heavy	A	5-7 years	
Other Tall (> 5 feet) Shrub and Single Bole Tree Species	Any time	Excavator-Slash Scattered	H	15-20 years	595
	Any time	Excavator-Slash Piled	I	15-20 years	
	Any time	Tree Shear-Slash Scattered	J	15-20 years	
	Any time	Tree Shear-Slash Piled	K	15-20 years	
Shrubs in pastures or hay fields	March –October	Mowing/Shredding	H	3-5 years	595
	March –October	Roller Chopping-Heavy	A	5-7 years	
	March –October	Spiral Chopping-Heavy	A	5-7 years	
Other Woody Noxious and Invasive Plants	Any time	Excavator-Slash Scattered[2]	H	15-20 years	595
	Any time	Excavator-Slash Piled[2]	I	15-20 years	
	Any time	Tree Shear-Slash Scattered[2]	J	15-20 years	
	Any time	Tree Shear-Slash Piled[2]	K	15-20 years	

[1] Mowing/Shredding is not recommended as a long term control of woody vegetation. However, these treatments may be used in areas where other management tools are prohibited or not available.

[2] Follow-up herbicide treatments are needed to prevent re-infestation.

Prescriptions for Mechanical Brush Management Treatments Guidesheet

A. Roller/Spiral Chopping – Heavy: Stack and burn top growth as needed. Use a drum type roller chopper or aerator arranged in a tandem set, minimum weight of 1,500 lbs./linear foot. (e.g. Marden M-7, empty weighs approximately 10,660 pounds per drum, or 1,522 pounds per linear foot). Pull choppers fast enough to produce a "flipping" action such that brush roots and rhizomes are thrown out of the ground for effective kill. Use a tractor with at least 110 horsepower. For best results, use a 4-wheel drive tractor to minimize tire slip on sandy soils. Two (2) passes are generally needed to achieve maximum control of woody vegetation. The second application should be applied diagonally to the first application. Only one (1) application should be conducted where shrub cover is necessary to attain good wildlife habitat. This practice is most effective when used in conjunction with other practices such as prescribed burning, prescribed grazing, and pest management. Treatment usually needs to be repeated five (5) to seven (7) years after initial treatment.

B. Root Plow/Regrowth Root Plow: Stack and burn top growth as needed. Root plow to a four (4) to six (6) inch depth. Root plow blades should be equipped with kickers (fins) to bring roots to the surface and expose crowns and/or bud zones for greatest effect. Fins should be attached at a 22° (degree) angle, not over 30“ apart, and long enough to project into and through the soil. Use a road grader type, or pull type with plow that can deliver a cutting action 4 to 6 inches below the ground surface. Use a tractor or road grader with at least 110 horsepower. For best results, use a 4-wheel drive tractor or crawler tractor with pull type plow. Treatment may need to be repeated 15 to 20 years after initial treatment.

C. Roller/Spiral Chopping – Light: Stack and burn top growth as needed. This treatment is for wax myrtle, sea myrtle (saltbush) or other undesirable brush on Freshwater marshes and ponds or slough range sites. Use a drum type roller chopper or aerator arranged in a tandem set, minimum weight of 750 lbs./linear foot (e.g. Marden L-7, empty weighs approximately 5,200 pounds per drum, or 754 pounds per linear foot). Use a tractor with at least 80 horsepower. Treatment usually needs to be repeated five (5) to seven (7) years after initial treatment.

D. Roller/Spiral Chopping – Light: Stack and burn top growth as needed. Use a drum type roller chopper or aerator arranged in a side by side set, minimum weight of 500-lbs. /linear foot. (e.g. Marden T5, empty weighs approximately 2,760 pounds per drum, or 552 pounds per linear foot). Use a tractor with at least 40 horsepower. Treatment usually needs to be repeated three (3) to seven (7) years after initial treatment. *Note- prescribed burning (code 338) is a more cost effective treatment to control St. Johnswort (Hypericum) species.*

E. Dozing/Grubbing/Root Raking: Use a crawler tractor equipped with a root rake or dozer blade on front. Sever woody stems below ground surface and push into piles. Burn or remove piles as desired. This treatment is most effective when used in conjunction with Florida NRCS Conservation Practice Standard Pest Management (code 595). This method generally provides only temporary (short-term) control of sprouting species such as Melaleuca and Brazilian Pepper. This treatment is not recommended on extensive areas needing brush control due to the high cost

F. Girdle: Use a handsaw, axe or mechanically powered device to remove a three (3) inch wide strip of bark and outer xylem layer completely around the tree. Works best on larger trees 8 inches in diameter or larger. Cut down smaller trees and chemically treat stumps as needed. This treatment is most effective when used in conjunction with Florida NRCS Conservation Practice Standard Pest Management (code 595). This treatment is not recommended on extensive areas needing brush control due to the high cost.

G. Mowing/Shredding/Mulching: Use a crawler or rubber tired tractor equipped with a rotary or flail mower, shredder or mulcher. These machines use hydraulically operated drums, flails or blades to grind woody material into mulch. The size of the trees and brush that can be mulched is dependant upon the size of the machine. As a general rule, this method works effectively on vegetation that can be pushed over by the tractor. As a general rule this technique provides very short-term control of sprouting vegetation.

H. Hydraulic Excavator – Slash Scattered: Use an excavator equipped with a grapple attachment. This type of machine allows the operator to physically remove the tree or large shrub from the soil. In sandy soils and mucky soils, this method generally removes all above and below ground plant parts. The removal of below ground portions of the plant significantly reduces the potential for trees to resprout. The detached material may be removed from the site or stacked and burned as desired. This method is best used to remove large trees and shrubs. Target brush or tree species will be felled in a manner that places as much of the woody debris in contact with the soil surface as possible. Slash will decompose in a few years if laid on the soil surface. Scatter slash to allow accessibility to livestock and wildlife.

I. Hydraulic Excavator – Slash Piled: Use an excavator equipped with a grapple attachment. This type of machine allows the operator to physically remove the tree or large shrub from the soil. In sandy soils and mucky soils, this method generally removes all above and below ground plant parts. The removal of below ground portions of the plant significantly reduces the potential for trees to resprout. Target brush or tree species will be felled and piled for burning or to provide wildlife habitat... This method is best used to remove large trees and shrubs. Target brush or tree species will be felled and piled for burning later. Make the smallest sized slash piles as practical for the site and size of woody material. Smaller slash piles are easier to burn and minimize adverse effects from excess heat to the soil surface. Leave as much space between piles as practical to allow accessibility to livestock and to prevent areas of soil scarification that may require more intensive critical area treatment

J. Tree Shear – Slash Scattered: Use a tree shear, chain saw, axe or similar implement to physically severe the base of tree or shrub above the soil surface. The detached material may be removed from the site or stacked and burned as desired. This method is best used to remove large trees and shrubs. Burn or remove piles as desired. Cut stumps can be treated with herbicides to kill the roots. Target brush or tree species will be felled in a manner that places as much of the woody debris in contact with the soil surface as possible. Slash will decompose in a few years if laid on the soil surface. Scatter slash to allow accessibility to livestock and wildlife.

K. Tree Shear – Slash Piled: Use a tree shear, chain saw, axe or similar implement to physically severe the base of tree or shrub above the soil surface. The detached material may be removed from the site or stacked and burned as desired. This method is best used to remove large trees and shrubs. Cut stumps can be treated with herbicides to kill the roots. Target brush or tree species will be felled and piled for burning or to provide wildlife habitat. Make the smallest sized slash piles as practical for the site and size of woody material. Smaller slash piles are easier to burn and minimize adverse effects from excess heat to the soil surface. Leave as much space between piles as practical to allow accessibility to livestock and to prevent areas of soil scarification that may require more intensive critical area treatment. Burn or remove piles as desired.

Follow-up treatments are usually required within three (3) to five (5) years after initial treatment for all methods with the exception of roller chopping, aeration, root plowing and mechanical excavation. Best results mechanical treatments should be used in conjunction with other treatments such as prescribed burning, pest management or biological brush management. If herbicides are used they must applied in accordance with FL. Conservation Practice Pest Management (code 595) and all label instructions. Due to the high cost these treatments are not recommended on extensive areas needing brush control.

Equipment Description

The following descriptions of equipment and applications were originally published in the "Revegetation Equipment Catalog". This publication was developed by Dr. Harold Wiedemann at Texas A&M University, in cooperation with the Rangeland Technology & Equipment Council, USDA Forest Service and USDI Bureau of Land Management. The "Revegetation Equipment Catalog" can be obtained from the following web site: http://reveg-catalog.tamu.edu/ . *Any references to trade names are used for illustration purposes only and do not constitute an endorsement of the product.*

Rootplows

Description
A rootplow is a heavy-duty, V-shaped, horizontal blade, 10- to 16-feet wide pulled by a large crawler tractor at a depth of 12 to 14 inches to sever tree roots. Tractor horsepower required to pull the integral mounted plows varies from 170 to 400. Fins are attached to the top of the blade to dislodge roots and stumps and move them near the soil surface. Commercial rootplowing averages about 2 acres/hour.

Application
The rootplow severs roots to prevent sprouting of most brush species, although it is not effective on those with shallow root systems. Plant mortality is usually 85 to 99%, but care must be taken to determine where and how it should be used. Chaining or raking following rootplowing helps to smooth the soil surface and remove sprouting species or stumps. Rootplows have been used since the 1940s to clear dense stands of mesquite and other hard-to-kill brush species in preparation for seeding to grass or crops. Sculpting dense brush infested areas by selective plowing and seeding with plants favorable for wildlife habitat, grazing animals, and watershed management could enhance the multiple-use value of depleted rangeland with fertile soils. Rocky soils prevent plowing and gravelly soils cause excessive blade wear.

Regrowth Rootplows

Description
In the middle 1990s a Texas company started manufacturing regrowth rootplows and rakes to control regrowth brush in pastures previously cleared by conventional rootplows and rakes. These 10-foot wide plows have been structurally downsized so they can be pulled by 140- to 170-horsepower crawler tractors. Additionally, regrowth root rakes, 14-feet wide, have been developed to operate in concert with the plows. The rakes remove roots from the soil and pile them with the above-ground brush debris. They use the same quick hitch as the regrowth plow. Regrowth plows are more energy efficient and cost effective than conventional rootplows when used in previously cleared areas or in the early stages of brush establishment.

Application
Regrowth plows are especially useful in pastures that have compacted soils and moderate to dense stands of brush with trunk diameters less than 4 inches. In pasture situations where herbicides and burning are restricted or ineffective, these plows may be the only option to control the brush. Regrowth plows can also be pulled by rubber-track tractors and large wheeled farm tractors to fracture compacted soils when brush and debris are not present. Pastures or rangeland must be free of underground stumps or rocks to prevent undue damage to the plow.

Roller Choppers

Description
Roller choppers are large drums with a series of longitudinally mounted blades. As the drums rotate they chop and crush brush debris, small trees, and slash. They also form small trenches or pits in the soil to capture rainfall, increase infiltration, and provide a seedbed. The drums are hollow and are usually filled with water to increase their weight and chopping action. Drum diameters vary from 24 to 60 inches.

Choppers can be pulled in single, duplex, triplex, or tandem configurations. Width can vary between 5 to 16 feet, and required horsepower for pulling varies from 60 to 350.

Application
Roller choppers are effective in forest site preparation. They are also popular for treating brush species that produce regrowth valuable for goats and wildlife. Choppers can cut brush up to 5 inches in diameter. They should not be used in rocky soils. The faster choppers are pulled the more they bounce, increasing chopping effectiveness, but the vibration is detrimental to the equipment. Hitches often use springs to absorb the vibration. Models called “land imprinters” use wedges rather than blades to form depressions in different directions to decrease runoff and increase infiltration. They are used more for seedbed preparation. A popular variation in blade pattern is a spiral-blade chopper, often called an aerator or renovator (see section on spiral blade choppers).

Spiral-blade Choppers (Aerators)

Description
Spiral-blade choppers, often called aerators or renovators, differ from conventional roller choppers in that they use small blades welded to the heavy drums in a staggered, spiral pattern around the drum rather than the long, longitudinally mounted blades. These choppers normally use two drums mounted on a frame similar to an offset disk, and they are equipped with rubber tires for transporting. Spiral-blade choppers are pulled by a crawler tractor or a four-wheel drive tractor with special tires. Drum diameters vary from 18 to 42 inches and they can be filled with water for extra weight. Width is 12 foot but options are available. Tractor horsepower requirements vary between 120 and 350 and depend on chopper size, weight, tree/shrub size, and type of terrain.

Application
Spiral-blade choppers have gained popularity in the 1990s, especially in brush-dominated landscapes, because of minimal vibration, effective top growth removal, soil fracturing, and the small basins formed in the soil to hold rainfall. The basins also provide a good seedbed. Because of the rubber tires, the units are easily transported from site to site. Blade wear can be a problem, and new blades are welded in place. These choppers should not be used on rocky ground. Gravelly and some sandy soils can cause excessive blade wear.

Offset Disks

Description
Disks used in brush control are the heavy-duty, offset type. They chop and turn under surface debris and uproot shallow-rooted, sprouting brush species. Offset disks consist of two gangs of disks set at angles to each other. Each gang has a separate frame and axle assembly. On some models gang angles can be adjusted for varying soil conditions or desired disking action. Blade may be notched or straight-edged and vary from 24 to 36 inches in diameter. Disks range from 8 to 15 feet in width and require tractors with 70 to 350 drawbar horsepower. These disks usually have rubber tires that are raised and lowered hydraulically for transport or depth control. Disks without wheels are hinged and they must be transported on trailers.

Application
Disks with 36-inch blades are used for brush control on undisturbed soil while units with blade diameters less than 30 inches are used for seedbed preparation following rootplowing. In both situations, disks bury much of the surface brush debris and form a desirable seedbed. Most disks used on rangeland employ notched disk blades to chop and bury debris. Disks can be used on a wide range of soil conditions and moderately rocky soil, but they cannot be used if there is excessive timber or rocks. Farm-type disks are not suited for the rigors of debris-littered rangeland.

Brush Rakes

Description
Brush rakes are mounted on the front of crawler tractors or front-end loaders to pile or stack trees and shrubs prior to revegetation. Evenly spaced teeth across the front of the rake trap debris and prepare relatively soil-free piles. Multi-application (MA) rakes can penetrate into the soil to remove roots and stumps. These rakes are about 12-feet wide. Stacker rakes slide on the soil surface for fast shearing and stacking. A shearing plate is often welded to the teeth to improve performance. Widths of stacker rakes vary from 14 to 19 feet. Root rakes are towed behind the tractor and are designed to remove roots and stumps following rootplowing. These rakes vary in width from 18 to 24 feet. Horsepower recommended for both stacker and root rakes varies from 140 and 350.

Application
Rakes are used in land clearing for debris removal to allow follow-up brush control, traversing of the landscape, and primary tillage. Piles of debris may be burned or saved for wildlife habitat depending on goals of the project. A skillful operator can build piles relatively free of soil. In some situations, soil disturbance is sufficient for seeding. Root rakes are used to clear land for farming operations.

Grubbers

Description
Grubbers are sharp, U-shaped blades mounted on the front of crawler tractors, wheel loaders, excavators, or farm tractors to uproot individual trees. Smaller tractors (65 horsepower) often use hydraulically assisted blades that enhance the output by tearing roots loose as the blade is rotated. Width of the cutting blade is usually 3 or 4 feet. Tractor size and type depend on the size of trees to be grubbed and the type of terrain. Tractor horsepower varies from 65 to 170. Units are available commercially, but many are fabricated in welding shops.

Application
Grubbing is an excellent method to selectively thin brush-infested land. This technique is called “sculpting” and it is very effective in protecting wildlife habitat while providing cleared areas for grazing. Wheel or track loaders or excavators give the operator excellent vision during plant uprooting. “Low-energy” grubbing is the use of small tractors on small trees, and it is cost efficient and effective. These units often use hydraulically assisted blades. Farm tractors with small, three-point-hitch grubbers are popular for use on limited acreages of previously cleared areas. Grubbing techniques can vary depending on sprouting characteristics of the targeted plant’s roots. Grubbing is not practical in rocky soil or when tree densities are more than 250 per acre over extensive acreages.

The following descriptions of equipment and applications were developed from product manufacturer’s web sites and other online sources. *Any references to trade names are used for illustration purposes only and do not constitute an endorsement of the product.*

Hydraulic Shearing Blades

Description
Hydraulic shears are use to sever tree trunks near the ground. Two horizontally mounted blades are forced through the tree trunk by hydraulic cylinders attached to the blades. The shearing units can be front-mounted on skid-steer loaders, wheel loaders, or excavators. Skid-steer loaders equipped with 14-inch shears are commonly used for clearing non-sprouting brush species. A 20-inch unit is also available. Attachments include brush guards, push bars, and spray nozzles to treat sprouting species as they are sheared. Skid-steer loaders are also available with tracks.

Application
Skid steers with shears are highly maneuverable and move quickly between trees. They are valuable in sculpting brush infested rangeland to provide cleared area while protecting wildlife habitat. Shearing is popular in species like junipers whose top-growth is valuable for fence posts or cedar oil. Tires need

protection from puncture by thorns. Steep slopes, rocks, and large debris should be avoided. Skid-steers are well suited to level and undulating landscapes. Tree saws such as the Hydro-ax or the Marshall Tree Saw are constructed of hydraulically operated cutting device used to severe trees. Tree saws have ability to cut trees a different heights and positions than tree shears. In fact, some tree saws will allow the operator to cut the tree below the soil surface. Some tree saws are mounted on the boom of tracked vehicles, while others are mounted on the front of a wheeled vehicle.

Shredders (mulchers)

Description

Brush shredders are similar to pasture or crop shredders but are much heavier duty. Shredders use rotating, horizontal blades attached to a vertical shaft that can be driven by the tractor's power-take-off (PTO) or hydraulic system. The blades are enclosed in a metal frame and shroud for safety and to increase the mulching effect. Width can be 5 to 20 feet. The wide models, 15 feet or more, use three sections that flex to conform to the terrain. Some manufacturers classify their shredders according to the diameter of trees or shrubs they can cut: up to 1 inch, light duty (pasture); 2 inches, medium duty; 3 inches, heavy duty; and 4 to 6 inches, extra-heavy duty. A few models that can cut from 6- to 12-inch diameter trees are built for excavators or loaders. Flail shredders use blades attached to a long, rotating horizontal shaft. Flail shredders used for tree masticating are called rotobeaters. Blades can be flails, swing stirrup cutters, or hammers. Tree size capabilities are similar to those for horizontal-blade shredders. All of these shredder-types can be pulled by a tractor drawbar or three-point hitch, mounted on the side or front of the tractor, or be mounted on a boom that can reach up to trim trees or down into ditches. Tractor horsepower required to power the shredders varies from 35 to 150 or more. Self-propelled units are available with either the horizontal-blade-type or the rotobeater-type shredders and tree size can be 6 or more inches in diameter (check manufacturers' ratings).

Application

Brush shredders are effective in removing weeds and small trees of non-sprouting species in pastures, rangeland, and utility or road rights-of-way. Shredding results in a manicured appearance with vegetation a few inches above the ground. Repeated mowing is necessary to remove top growth of sprouting species and re-occurring weeds. Brush shredding is prone to mechanical failures (cutting too large a tree or too many trees to fast) and should not be used in rocky ground. Protection of the operator, tractor, and tires are usually required. Self-propelled units can shred dense stands of brush and trees and can traverse rough terrain. Care must be taken to match the shredder to tractor size and size of the trees/brush to be cut as some manufacturers have over a hundred models.

Excavators

Description

Excavator is a general term that is usually used to describe a piece of earth moving equipment. For the purposes of this document the term will be used to describe a tracked vehicle equipped with an articulating arm. Another term for this type of equipment is a "track hoe". A typical excavator used in brush management consists of a vertically mounted rotating head or saw blade. The head is typically attached to an articulated arm along with a grappling implement. The grappling implement allows the operator to lift and move vegetation.

Application

Typically excavators are used to selectively thin woody vegetation in areas where use other methods are not desirable. Excavators can be used to physically remove the tree from the soil, or the vertically mounted rotating head or saw blade is used to shatter and chop standing fuels into small pieces. Articulating arms allow excavators to process material that is higher off the ground than horizontal-shaft machines. These machines literally grind standing trees down to stumps. The arm also allows thinning of selected vegetation and trees without damaging adjacent desirable vegetation.

Biological Brush Control Using Small Ruminants Guidesheet

This guidance document is intended to be used in planning and implementing brush management treatments through the use of small ruminant animals. This document is not intended to be used as a guide to manage small ruminants systems for production of food or fiber.

Small ruminant animals such as sheep and/or goats can be used effectively to control woody vegetation. Under normal conditions it is not uncommon for woody shrubs and trees to decline in areas where small ruminants are allowed to forage. However, it is difficult to eradicate or fully suppress woody vegetation and maintain high animal production levels. The general goal of this treatment is to overgraze selected (target) plants and allow non-target plants to increase. As a general rule, small ruminants are most effective when used as a follow-up treatment after mechanical, prescribed burning, chemical treatments, or for initial treatment of low growing woody vegetation. If herbicides are used it is important to ensure that they are not toxic to animals that may use the area.

Caution must be used when planning to use small ruminants as a means of brush control. This land treatment poses significant risks associated which may lead to less than desirable results or death of the animals. In many cases, the animals will be thrust into a situation where:

- The animals preferred foodstuffs are absent or occur in limited quantities,
- Diet quality is not adequate to ensure sustained animal health,
- Physical dangers, such as junk, loose wire, nails and chemical containers are present on-site,
- Poisonous or toxic plants and parasites occur on site.

To prevent disease, animal mortality and/or poor performance it is essential that the livestock owner or manager inspect the site prior to introduction of animals to ensure the site is free of substances and situations which may harm the animals. If dangerous conditions are present the owner or manager should take the necessary actions needed to eliminate or minimize the potential harm to the animals. Where dangerous conditions cannot be eliminated the owner/manager should employ other means to control woody vegetation.

To ensure that animal welfare is not jeopardized regular (daily) inspections are needed. Inspections must ensure that animals have access to sufficient amounts of feed and/or water available. Poisoning in animals occurs primarily when hungry animals are turned into a toxic weed-infested area where better forage is absent. The site should be inspected prior to the introduction of animals to ensure that toxic or poisonous plants are not present. Physical removal of any toxic plants is encouraged.

There are two (2) common methods used to manage woody vegetation using small ruminants. Both Short Duration-High Density Stocking and Multi-Species Stocking can be used effectively to suppress or eradicate woody vegetation. However, Multi-Species Stocking is best used to suppress woody vegetation. Short Duration-High Density Stocking is best used to significantly reduce woody plant cover or to eradicate the target species. Regardless of the treatment method, the manager must ensure that the nutritional needs of the animals are met to prevent animal mortality and reduced animal production. This will include body condition scoring, parasite control, and strategic supplementation.

Multi-species Stocking entails grazing an area with a mixture of animal species with complimentary diet preferences. Usually this entails grazing sheep or goats at low stock densities (< 1.5 animals/acre) with cattle or horses. It usually takes several years (> 3) to see measurable effects from this treatment. This method is traditionally used in situations where the woody vegetation comprises a small portion of the plant community. Attention must be given to ensure the stocking rate is maintained. It is probable that reductions in the stocking rate of small ruminant animals will need to be reduced as woody vegetation

declines. With proper supplementation and management this method can be used with breeding animals. However, without proper nutritional management poor reproductive performance will occur.

Short Duration-High Density Stocking is commonly used to control woody vegetation. Under this method small ruminants are stocked in an area at high to very stock densities. High stock densities are generally more than 10 goats or sheep per acre. Good results have been obtained in Florida at stocking rates of 300 animals per acre or higher. The objective of this treatment is to obtain rapid defoliation of the target species and allow the non-target vegetation the opportunity to recover from the treatment. This method is most commonly used in situations where woody plant comprise more than 50% of the annual plant production on the site. It is not recommended to use multi-species grazing due to the increased impact on non-target vegetation. This method may result in accelerated soil erosion and impacts to surface water quality. Nutritional deficiencies, poor animal performance and occasional animal mortality may occur due to animals consuming low quality or toxic plants. This method is not recommended for breeding and/or growing animals unless proper supplementation can be provided.

Plant mortality is usually caused by repeated defoliation of the plants. However, some woody plants may be killed by damage to the bark or roots (Mitchell, Peischel). Stock density is the key factor determining the impact on the vegetation. As the number of animals increases per acre the competition for food increases. Usually this results in animals consuming a larger amount of non-preferred foods or repeated defoliation of the plants. The potential for animals to consume toxic plants also grows as stock density increases.

The proper stocking density is dependant upon several factors including:

- goals and objectives of the landowner,
- amount of vegetation on-site,
- availability of the vegetation to the animals,
- potential for injury to no-target plant species,
- potential for accelerated soil erosion.

General Rules-

Low stocking density can used if the goal is to maintain the current level of woody vegetation and maintain high animal reproductive efficiency.

High stocking density can be used to achieve a rapid reduction in woody vegetation, however, animal performance will be reduced.

Small ruminants should not be used the primary brush management treatment unless the brush is accessible for control by the animals. The amount of woody vegetation that is accessible to small ruminants is dependant upon the type and size of the animals used. Goats may use vegetation up to 7 feet tall while sheep are generally limited to vegetation shorter than 42 inches.

Best results will be obtained when the following conditions are met.

1. The target plant species are known to be consumed by the animals.
2. Animals are not forced to consume toxic plants.
3. The target plant species are accessible to the animals.
4. The preferred non-target plants are not available to animals in quantities that will significantly reduce consumption of the target plants..
5. The area is stacked with sufficient animals to ensure that animal demand for food exceeds the target plants regrowth rate.
6. The animals are allowed sufficient time to completely defoliate the target plants.

Timing of defoliation will have significant affect on the success of this treatment. For best results, the target species should be completely defoliated immediately following full leaf development of the target species. For most brush species in Florida leaf out generally occurs between March 1st and June 1st. Follow-up treatment soon after the initial treatment is necessary to prevent the plant from replacing energy reserves. As a general rule, the follow-up should occur with 45 days of the initial treatment. The amount of plant regrowth should be used as a guide to schedule follow-up treatments. A reduction in stocking density may be required to prevent overuse of non-target species.

The number, kind and class of animals available will impact the rate and level of defoliation, hence the size of the effective treatment area. If the area is too large, the plants will not receive sufficient stress for plant mortality to occur. The size of the area must be small enough to concentrate the goats for optimum success. Temporary fencing may be required to reduce the size of the treatment area and concentrate the animals. Class of animal is an important consideration. Lactating and growing animals cannot be utilized for brush control as effectively as mature, non reproductive animals (e.g., wethers or cull ewes) because some level of animal performance may need to be sacrificed to achieve desired brush control.

It may be necessary to allow animals to become familiar with plants that are unfamiliar to them in order to obtain the desired results. This can be accomplished by feeding penned animals small amounts of the new foodstuff. The need to familiarize the animals with the target plants will depend upon the animal type and history. Animals that are brought into Florida from other states may not be familiar with the plants grown here. By ensuring that the animal will consume the target species we will achieve better control of target species and reduce animal mortality due to toxic plants.

Plant defoliation will depend on diet preferences exhibited by the animals that are allowed to feed upon them. Diet preferences vary greatly among animal species and can vary within a species. Diet preferences can also be influenced by the type of supplement fed to animals, the combination of plants available to the animals, and the order in which the plant material was consumed. Therefore, it is extremely difficult to accurately describe the dietary preferences of small ruminants. However, there are some generalities which can be used in conservation planning. The following table shows the general diet preferences of several species of animals.

Animal Species	**Type of Diet**		
	Grasses	**Broadleaf weeds and legumes**	**Woody vegetation**
Cattle	65-75	20-30	5-10
Horses	70-80	15-25	0-5
Sheep	45-55	30-40	10-20
Goats	20-30	10-30	40-60
White tailed-deer	10-30	30-50	30-50
Elk, red and fallow deer	30-60	40-50	10-30

Source: D. Forbes and G.W. Evers, Texas A&M Univ.; D.I. Bransby, Auburn Univ.; M.A. McCann, Virginia Tech Univ.; and W.R. Getz, Fort Valley State Univ. In Southern Forages 3rd Edition.

Procedure for implementing biological control of woody vegetation using the Short Duration-High Density Stocking method.

1. Identify the target species needing control.
2. Select the animal best suited for control of the target plant.
    a. Familiarize animal with target species, if needed.
3. Identify the area needing treatment.
4. Inspect the area and treat or remove all toxic plants and hazardous substances.
5. Install equipment and facilities needed for adequate animal control, protection, and health. This may include fencing, animal watering facilities, and supplemental feeders.
6. Stock the treatment area with sufficient animals to achieve a 90% defoliation of the target species within 30 days following introduction of animals.
7. Following the initial defoliation, defer biological brush management for 30 to 60 days to allow non-target vegetation an opportunity to recover from treatment.
    a. Utilize deferment period to conduct spot treatment needed to ensure adequate results (e.g. use hand tools to severe woody vines such as Kudzu).
    b. Inspect the area and treat soil erosion and other resource problems.
    c. Remove or treat toxic plants.
8. Re-introduce animals to treatment area.
    a. Reduce number of animals or days animals are in the treatment area, or provide supplemental feed to if forage/browse is not sufficient to meet animal demand.
9. Repeat process as needed.

Diet preferences and toxicity of selected plants for sheep and goats.

Target Species	Diet Preference		Toxic Plant	Notes
	Goats	Sheep		
American beautyberry (*Callicarpa americana*)	High	High	No	High for both animals based on personal observations (Williams) USDA PLANTS database.
Arabian jasmine *(Jasminum sambac)*	Unknown	Unknown	No	
Australian almond *(Terminalia muelleri)*	Unknown	Unknown	No	
Australian pine *(Casuarina equisetifolia)*	Unknown	Unknown	Possible	Vegetation contains tannins which may be toxic at high concentrations.
Suckering Australian pine *(Casuarina glauca)*	Unknown	Unknown	Possible	Vegetation contains tannins which may be toxic at high concentrations.
Australian pine (*Casuarina cunninghamiana)*	Consumed	Consumed	No	USDA PLANTS database indicate plant has a low palatability for browsing animals and is nontoxic. The foliage is palatable to sheep and cattle, but is considered useful only as emergency drought fodder (Bulloch 1986, Turnbull et al. 1986).
Baccharis (*Baccharis glomeruliflora*)	Medium	Low	No	USDA PLANTS database. Medium diet preference for goats Personal observation (Peischel)
Bamboo palm *(Chamaedorea seifrizii)*	Unknown	Unknown	No	
Bay (*Persea palustris*)	Medium	Low	No	USDA PLANTS database. Medium diet preference for goats Personal observation (Peischel)
Beach naupaka *(Scaevola taccada)*	Low	Low	No	USDA PLANTS database indicate plant has a low palatability for browsing animals and is nontoxic.
Blackberry (*Rubus spp.*)	High	High	No	In bahiagrass pastures, this is a preferred species by both sheep and goats. (Williams). USDA PLANTS database High diet preference by goats Personal observation (Peischel)
Bowstring hemp *(Sansevieria hyacinthoides)*	Consumed	Consumed	No	Anecdotal evidence suggests that livestock readily consume this species.
Brazilian Pepper *(Schinus terbinthifolius)*	Non-consumed	Non-consumed	Yes	"Ingestion of the leaves and fruits can be fatal to grazing animals such as cattle and horses (Morton 1978)".
Brazilian jasmine *(Jasminum fluminense)*	Unknown	Unknown	No	

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Bumelia spp.	Medium	Low	Yes	USDA PLANTS database.
Buttonbush (*Cephalanthus occidentalis*)	Low	Low	No	USDA PLANTS database.
Cabbage palm (*Sabal palmetto*)	Preferred	Preferred	No	Juvenal palms should be as readily consumed as the saw palmettos. (Williams) USDA PLANTS database.
Camphor tree *(Cinnamomum camphor)*	Unknown	Unknown	Yes	Anecdotal evidence from Australia indicates that horses have been poisoned by chewing bark (http://camphorlaurel.com).
Carrotwood *(Cupaniopsis anacardiodes)*	Unknown	Unknown	No	
Castor bean *(Ricinus communis)*	Consumed	Consumed	Yes	All parts of the plants are toxic, but most dangerous are the seeds. The most susceptible animal species include cattle, horses, sheep, pigs, fowl, rabbits and other small animals. Seeds ingested at 0.2% of body weight have caused toxicosis in cattle and 0.01% of body weight was toxic to horses (http://www.library.uiuc.edu/vex/toxic/castor/castor2.htm). Plant parts of castor beans and rosary peas, other than the seeds, are rarely reported as a cause for poisoning in animals. Although the leaves of the castor bean plant are rarely eaten, they are reported to be toxic. Cattle fed castor bean leaves develop signs distinct from those associated with ricin. Affected animals develop neuromuscular impairment characterized by muscle weakness, tremors, salivation, and excessive eructation. Recovery may occur after a short period or the animal dies, presumably as a result of the quantity of leaves consumed. Tokarnia CH, Dobereiner J, Canella CFC. Experimental poisoning by the leaves of *Ricinus communis* in cattle. Pesq Agropec Bras Ser Vet, 1975; 10:1-7. Goats consume the leaves Personal observation (Peischel)
Catclaw mimosa *(Mimosa pigra)*	Medium	Consumed	Possible	Mimosa contains mimosine, which could restrict its use for animals. "Mimosa is commonly used by native animals in Nigeria, forming a favoured and stable part of the food supply for the larger herbivores in Yankari Game Reserve (Geerling 1973)". Medium diet preference for goats Personal observation (Peischel)

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Cathedral bells (Life plant) *(Kalanchoe pinnata)*	Consumed	Consumed	Yes	*Kalanchoe* species contain cardiac glycosides and are toxic to animals. In South Africa and Australia, where these plants are found in the wild, cattle and sheep poisonings are common. McKenzie, R.A.; Dunster, P.J.: Hearts and flowers: *Bryophyllum* poisoning of cattle. *Aust. Vet. J. 63* (7):222-227; 1986.
Chinaberry *(Melia azedarach)*	Preferred	Preferred	Yes	The smooth, yellowish fruit ripens in September and October and is eaten by birds, but is toxic to goats and pigs. The leaves are also toxic to these animals (http://uvalde.tamu.edu/herbarium/meaz.htm). Based on personal observation, this plant is preferred. It is toxic, but the animals can eat a limited amount with no harm. When small tree was cut back, sheep eventually killed it by eating the resprouts. (Williams)
Chinese fan palm *(Livistona chinensis)*	Unknown	Unknown	No	
Chinese tallow tree (Popcorn tree) *(Sapium sebiferum)*	Consumed w/ caution	Consumed	Yes	Sheep and goats will eat the leaves of *S. sebiferum*, but toxicity to cattle limits their effectiveness as a control agent. Cattle will eat seedlings less than 6 cm tall (Bruce et al.1997). Not toxic for Goats and Sheep Toxic for cattle Personal observation (Peischel)
Cypress (*Taxodium spp.*)	Low	Low	No	USDA PLANTS database.
Day Jessamine *(Cestrum diurnum)*	Consumed	Consumed	Yes	The plant has the drawback of being poisonous to livestock. The leaves contain a calcinogenic glycoside called 1,25- dihydroxycholecalciferol that leads to a vitamin D toxicity that results in elevated serum calcium and deposition of calcium in soft tissues. Fifteen to 30 percent of day jasmine leaves in an animal's diet are sufficient to cause symptoms (Animal Science at Cornell University 2001).
Devil-tree *(Alstonia macrophylla)*	Unknown	Unknown	No	
Dogwood (*Cornus florida*)	Low	Low	No	USDA PLANTS database.
Downy rose-myrtle *(Rhodomyrtus tomentosa)*	Unknown	Unknown	Unknown	
Dwarf Huckleberry (*Gaylussacia dumosa*)	Medium	Low	No	USDA PLANTS database.

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Earleaf acacia *(Acacia auriculiformis)*	Unknown	Unknown	Unknown	Forage preferences or use values for Earleaf acacia are unknown. However, native species of Acacia are known to be used by livestock. Whitethorn acacia is not considered a preferred browse species for cattle. Some suggest that whitethorn acacia legumes are grazed by cattle when no better food source is available (Vines, Robert A. 1960).
False banyan (Council tree) *(Ficus altissima)*	Consumed	Consumed	No	An online literature search indicated that this species has been used for livestock feed in Asia (Khampha Chanthirath)
Fetterbush *(Lyonia spp.)*	Medium	Medium	No	USDA PLANTS database indicate species has a medium palatability for browsing animals and is nontoxic.
Flamegold tree *(Koelreuteria elegans)*	Unknown	Unknown	No	
Gallberry *(Ilex glabra)*	Consumed	Consumed	No	Goat preference assumed based on evidence suggesting gallberry is moderately preferred by white tailed deer (Conover & Kania, 1988).
Giant sensitive plant *(Mimosa invisa)*	Consumed	Consumed	Possible	Mimosa contains mimosine, which could restrict its use for animals. "Mimosa is commonly used by native animals in Nigeria, forming a favoured and stable part of the food supply for the larger herbivores in Yankari Game Reserve (Geerling 1973)".
Gold coast jasmine *(Jasminum dichotomum)*	Unknown	Unknown	No	
Golden Bamboo *(Phyllostachys aurea)*	Consumed	Consumed	No	
Governor's plum *(Flacourtia indica)*	Preferred	Preferred	No	Reported to be a preferred species in Ethiopia (Eckman and Hines).
Guava *(Psidium guajava)*	High	Unknown	No	Forage preferences or use values for this species are unknown. However, anecdotal evidence suggests livestock may consume the fruit and shoots of Guava plants. "Removal of feral cattle from anthropogenic grasslands in the highlands of San Cristobal about 50 years ago allowed previously cropped guava shoots to quickly develop into mature trees that dominate the dense tangled and dwarf forests prevalent today" (Elkhart 1972). High diet preference by goats Personal observation (Peischel)
Indian rosewood *(Dalbergia sissoo)*	Consumed	Consumed	No	Leaves used a fodder for livestock in India (Singh, Et Al.).

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Java plum *(Syzygium cumin)*	Medium	Consumed	No	USDA PLANTS database indicate plant has a low palatability for browsing animals and is nontoxic. Medium diet preference for goats Personal observation (Peischel)
Jointed prickly pear *(Opuntia aurantiaca)*	Consumed	Not Consumed	No	Plant is not toxic to grazing or browsing animals. Injury may occur to animals when alternative feedstuffs are limited. "Jointed prickly pear-selected on occasion especially in dry areas & drought, the spines drop off, the goats are bipedal & break off large pieces. They begin eating from the broken & succulent edge" Personal observation (Peischel).
Kudzu *(Pueraria Montana)*	Preferred	Preferred	No	Infestations of Kudzu have been successfully controlled with prescribed grazing by sheep and goats.
Lantana *(Lantana camara)*	Consumed	Not preferred	Yes	Lantana leaves contain poisonous triterpines and lantadenes A and B that cause death of horses, cattle, sheep, goats, and rabbits by failure of the liver and other organs (Morton 1994). Animals in pastures with sufficient forage will often avoid lantana, perhaps because of its pungent aroma and taste, but animals unfamiliar to the plant may ingest enough to affect them (http://www.library.uiuc.edu/vex/toxic/lantana/lantana2.htm). "Selected on occasion & roots chewed Personal observation (Peischel)"
Laurel fig *(Ficus microcarpa)*	Unknown	Unknown	No	An on-line literature review indicates that pigs and small mammals consume fruit and may aid in the spread of the species. Information is very limited regarding livestock consumption of this species.
Lead tree *(Leucaena leucocephala)*	Preferred	Preferred	Yes	Literature indicates this species is used for feed for livestock (Brewbaker). Leucaena species evaluated in Florida contain mimosine. Sub clinical symptoms of toxicity include cessation of hair growth (e.g., wool break in sheep or loss of switch hair in cattle). "Preferred when the animals are accustomed to it (Williams)"
Magnolia (*Magnolia grandiflora*)	Low	Low	No	USDA PLANTS database.
Maple spp. (*Acer spp.)*	Low	Low	No	USDA PLANTS database.
Melaleuca *(Melaleuca quinquenervia)*	Low	Low	No	Relatively low moisture (56%) and high crude fiber contents indicate melaleuca has a low digestibility coefficient and is probably not a desirable deer food (Schortemeyer, et al, 1981].

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Mimosa (Silk tree) *(Albizia julbrissin)*	Medium	Low	No	Mimosa was considered a low preference tree by goats in this trial (score of 3–4). Goats would only taste the leaves and then move on to one of the other species. Nevertheless it is possible goats would readily consume Mimosa and perform satisfactorily when it is the only option for browsing. (Addelstone, et al, 1999). "Medium diet preference" Personal observation (Peischel)
Mockernut hickory (*Carya alba*)	Low	Low	No	USDA PLANTS database.
Nettle-leaf porterweed *(Stachytarpheta urticifolia)*	Consumed	Consumed	Possible	Anecdotal evidence suggests this species may be consumed by livestock. However, seed and plant material may be toxic. This species is in the same family as Lantana.
Oak spp. *(Quercus spp.)*	Preferred	Consumed	Possible	Depending on growth form, oaks, winged elm and yaupons were generally selected in proportion to their availability (Lopes & Stuth, 1984). Some literature indicates that toxicosis may occur when oak or other high tannin vegetation comprises a major portion of the animal's diet. Preferred by goats, Personal observation (Peischel)
Paper mulberry *(Broussonetia papyifera)*	Consumed	Consumed	No	"Mulberry leaves are sometimes eaten as a vegetable and are useful as a cattle fodder. Being nutritious and palatable, they are said to improve milk yield of dairy animals" (Duke).
Persimmon *(Diospyros viginiana)*	Preferred	Consumed	Possible	Persimmon fruits contain water soluble tannins, which precipitate in the acidity of the stomach to form a sticky coagulum of fruit skin, pulp, seeds, and gastric protein that becomes a solid mass or phytobezoar. Once formed, the phytobezoar is abrasive and can lead to ulcers and even rupture of the stomach of horses that have eaten large quantities of ripe persimmon fruits. Severe colic results when impaction of the stomach occurs. Preferred by goats Personal observation (Peischel)
Pine Spp. (*Pinus* spp.*)*	Medium	Low	No	USDA PLANTS database. Medium diet preference for goats Personal observation (Peischel))
Pond Cypress (*Taxodium ascendens*)	Low	Low	No	USDA PLANTS database.
Pothos (Centipede tongavine) *(Epipremnum pinnatum)*	Unknown	Unknown	No	

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Queensland umbrella tree *(Schefflera actinophylla)*	Unknown	Unknown	Unknown	No information available
Queen palm *(Arecastrum romanzoffianum)*	Unknown	Unknown	No	
Rattlebox *(Sesbania punicea)*	Consumed	Consumed	Yes	"Saponins are believed to be the principal toxins present in all parts of the plants and especially the seeds. The green seeds are most poisonous, and the seeds remain toxic for years. The leaves appear to be least toxic. Birds, with the exception of ducks, are especially susceptible to poisoning. Sheep, cattle, and goats are also susceptible to poisoning, sheep being fatally poisoned after eating less than 2 oz of seeds per hundred weight [29].(Knight).
Red sandalwood *(Adenanthera pavonina)*	Consumed	Consumed	No	It is described as a minor food for livestock in Pacific Island Agroforestry systems (Wilkinson, Et. Al.).
Rose-apple *(Syzygium jambos)*	Consumed	Consumed	Yes	The seeds are said to be poisonous. An unknown amount of hydrocyanic acid has been reported in the roots, stems and leaves. An alkaloid, jambosine, has been found in the bark of the tree and of the roots, and the roots are considered poisonous. Leaves of other Syzygium species have been fed to livestock (Morton). Therefore, it is possible that goats and other browsing animals may be able to use this species.
Sand Holly (*Ilex ambigua*)	Medium	Medium	Yes	Slight toxicity based on USDA PLANTS database.
Saw Greenbriar (*Smilax bona-nox*)	High	Low	No	USDA PLANTS database
Saw Palmetto *(Serenoa repens)*	Preferred	Preferred	No	USDA PLANTS database. Preferred by sheep & goats (Williams)
Sea Hibiscus *(Hibiscus tiliaceus)*	Consumed	Consumed	No	The leaves are fed to cattle in Southeast Asia (http://ntbg.org/). "Fed as browse species to zoological animals (Williams).
Sea myrtle *(Baccharis hamifolia)*	Consumed	Consumed	Yes	Sea myrtle is a "desirable" browse species for white-tailed deer, although it probably has little or no value for other wildlife species and may be toxic to some (Grelen, 1975).
Seaside mahoe *(Thespesia populnea)*	Consumed	Consumed	No	USDA PLANTS database indicate plant has a low palatability for browsing animals and is nontoxic.
Senegal date palm *(Phoenix reclinata)*	Unknown	Unknown	Unknown	

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Sewer vine *(Paederia cruddasiana)*	Consumed	Consumed	No	Anecdotal evidence indicates cattle graze closely related species.
Shrub morning-glory *(Ipomoea carnea)*	Not preferred	Not Preferred	Toxic	This species has been associated with a lysomal disease in goats. Apparently, goats deprived of adequate feed consumed Ipomoea carnea (De Balogh, Et. Al.)
Simple-leaf chaste tree *(Vitex trifolia)*	Unknown	Unknown	Unknown	
Skunk vine *(Paederia foetdia)*	Consumed	Consumed	No	Skunk vine also invades pasturelands, where cattle have been observed grazing on the weed. Effects on growth and reproduction of livestock, however, are unknown (Gann and Gordon, 1998).
Solitary palm *(Ptychosperma elegans)*	Unknown	Unknown	Unknown	
St. Johnswort (*Hypericum spp.)*	Not preferred	Not preferred	Yes	St. Johnswort presents difficult problems for grazing livestock. It depresses the central nervous system and increases the animal's sensitivity to temperature change and handling. St. Johnswort also affects the liver, causing temporary sensitivity to sunlight. Livestock usually avoid it unless food is scarce.(http://www.wildflowers-and-weeds.com/weedsinfo/Hypericum_perforatum.htm)
Summer grape (*Vitis aestivalis*)	High	Low	No	USDA PLANTS database
Surinam cherry *(Eugenia uniflora)*	Unknown	Unknown	Unknown	No information available
Sweetbay (*Magnolia virginiana*)	Medium	Low	No	Sweetbay is important forage for deer and cattle (Priester). Winter use by cattle can account for as much as 25 percent of their diet (Lay). White-tailed deer browse the leaves and twigs year-round (Little). . Medium diet preference for goats Personal observation (Peischel)
Taiwanese cheesewood *(Pittosporum pentandrum)*	Unknown	Unknown	Unknown	
Thorny elaeagnus *(Elaeagnus pungens)*	Consumed	Consumed	No	Other species in the genus Elaeagnus are known to be readily consumed by livestock and wildlife. Therefore it is assumed that they will consume this specie.
Tropical almond *(Terminalia catappa)*	Consumed	Consumed	No	Literature indicates this specie is an important animal feed source (Wilkinson, Et. Al.).

Target Species	**Diet Preference**		**Toxic Plant**	**Notes**
	Goats	**Sheep**		
Trumpet tree *(Cecropia palmate)*	Not Selected	Unknown	Yes	The species is assumed to have toxic properties given that the plant contains white, milky sap and t is known to contain glycosides, lipids, alkaloids, flavonoids, tannins, cardenolids, triterpenes, polyphenols, steroids, and resins (Tropical Plant Database). Not selected by goats Personal observation (Peischel)
Tung oil tree *(Aleurites fordii)*	Unknown	Unknown	Yes	Plants contain sap with toxic properties (Tropical Plant Database).
Washington fan palm *(Washingtonia robusta)*	Unknown	Unknown	Unknown	
Wax myrtle *(Myrica cerifera)*	Preferred	Consumed	No	Anecdotal evidence suggests goats prefer Wax myrtle over other plants (Sweet Grass Dairy). Texas Plant Information Database lists Wax myrtle as food for large mammals.
Willow (*Salix floridana*)	High	Medium	No	Readily consumed by zoo animals, would suggest that goats and sheep might also utilize the species (Williams) USDA PLANTS database. Personal observation (Peischel)
Winged sumac (*Rhus copallinum*)	Medium	Low	Possible	Plants contain tannins Medium diet preference for goats Personal observation (Peischel)
Womans tongue tree *(Albizia lebbeck)*	Consumed	Consumed	Unknown	The Agro forestry Guides for Pacific Islands (www.agrofrestry.net) indicates that this species has potential as a forage/fodder crop for livestock.
Wood-rose *(Merremia tuberosa)*	Unknown	Unknown	Unknown	
Yaupon *(Ilex vomitoria)*	Preferred	Consumed	No	"Goats persistently used these species, regardless of treatment or season. Depending on growth form, oaks, winged elm and yaupons were generally selected in proportion to their availability" (Lopes & Stuth, 1984).

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Guidesheet for Use of Beneficial Insects to Control Woody Vegetation

Use of beneficial insects as a brush management treatment can provide long-term control benefits. However, the treatment will require more intensive planning and management than other methods.

Biological control is the use of a living organism (predator) to cause harm to a target organism. In effect, one is manipulating nature to achieve the desired result. For best results biological controls should be incorporated into an Integrated Pest Management (IPM) program.

The principle advantages of using beneficial insects to control woody plants include:

- Reduction in the use of herbicides,
- Reduction in the amount of machinery and fuel,
- Reduction in the amount of time devoted to brush management,
- Reduction in environmental issues associated with traditional treatments,
- Reduction in health hazards associated with traditional control methods and,
- Reduction in the legal issues associated with traditional brush management treatments.

In addition, the use of beneficial insects may actually prevent economic damages associated with uncontrolled brush infestations. This treatment may provide control on a landscape level when conditions are right for populations of beneficial insects to increase.

Disadvantages associated with this treatment include:

- High cost to obtain and apply beneficial insects,
- Requires more intensive planning and management,
- Application of insect may require specialize procedures and equipment,
- Stringent federal, state or local record keeping requirements may be associated with treatment,
- Treatment requires long time frame (>3 years) before results are achieved.

Only biological agents that have been properly screened and approved should be used. The USDA Animal and Plant Health Inspection Service (APHIS) and the Florida Department of Agriculture and Consumer Services (FDACS) are responsible for approving biological agents. A partial list of biological agents that have been approved for use on invasive plants in Florida may be obtained from the USDA Invasive Plants Research Laboratory (IPRL). The IPRL is an element of the USDA Agricultural Research Service. A partial list of approved biological agents can be obtained from the IPRL website at: http://www.ars.usda.gov/Services/Services.htm?modecode=66-29-00-00 .

The following insects have been approved for use to control woody vegetation in Florida

Melaleuca (*Melaleuca quinquenervia)*

Melaleuca leaf weevil (*Oxyops vitiosa)* - Weevils consume foliage and reduce the trees ability to maintain photosynthesis. For additional information refer to the Tame Florida website at: http://tame.ifas.ufl.edu/media/docs/Enemies.pdf .

Melaleuca Psyllid (*Boreioglycaspis melaleucae)* - Sap sucking insects damage buds and prevent branch development. This limits the trees ability to produce seed. For additional information refer to the Tame Florida website at: http://tame.ifas.ufl.edu/media/docs/Enemies.pdf .

Melaleuca bud gall fly (*Fergusonina turneri*) - The fly (Fergusonina) and a symbiotically compatible nematode reduce reproduction by creating galls on leaf and flower buds. This reduces flower and seed production.

Old World Climbing Fern (*Lygodium micrphyllum)*

Australian pyralis moth (*Cataclysta camptozonale*) - Leaf feeding larvae have been observed consuming all the foliage, and scarifying the stems, which kills the plants.

Leaf roll galling mite (*Floracarus perrepae)* – Mites feed on foliage and reduce plants ability to maintain photosynthesis.

Procedure for implementing biological control of woody vegetation using beneficial insects.

1. Identify the target species needing control.
2. Determine extent of woody plant infestation. Estimates of the extent of infestation will be completed using approved methods described in the NRCS National Range and Pasture Handbook (NRPH).
3. Establish goals for reduction of target species.
    a. Goals may include actual desired mortality of target species.
    b. Goals may include reduction in reproductive potential of target species. For example, some insects feed on flower buds. This reduces the plants ability to produce viable seed.
    c. Goals should include adequate time for effects to appear.
4. Select the initial treatment area.
    a. Treatment area must be large enough to sustain a viable population of beneficial insects.
    b. Treatment area must be free of chemicals, animals, pesticides, and/or other materials and objects which will reduce the efficacy of the treatment.
    c. Consider the effects of chemicals used on adjacent lands.
5. Consider current and long-term effects associated with the treatment when identifying treatment areas.
    a. Effects should be evaluated on economic and environmental perspective
    b. Biological control may not be an appropriate treatment if immediate control of species is of paramount importance.
6. Select the beneficial insect or combination insects best suited for control of the target plant.
    a. Use only biological agents that have been screened and approved in accordance with policies and procedures developed by the USDA Animal and Plant Health Inspection Service (APHIS) and the Florida Department of Agriculture and Consumer Services (FDACS).
    b. Use biological agents which are compatible with the environmental conditions in the treatment area.
    c. Do not use biological agents which are susceptible to land management activities commonly used onsite and on adjacent properties.
    d. Do not select biological agents if specialized environmental conditions, handling requirements and or equipment cannot be provided.
7. If specialized equipment and facilities are needed for adequate control and protection of beneficial insects they must be obtained prior to release of the agent.
8. Conduct all site preparation activities prior to release of the agent. This may include exclusion of livestock or humans, pre-treatment of release site, etc.
9. Release beneficial insects in accordance with specific handling instructions.

10. Implement follow-up management activities needed for successful establishment of beneficial insects.
11. Implement other management activities needed to control vegetation. For example, mechanical treatments such as mowing maybe needed in the first few years until the population has become well established.
    a. Mechanical treatments such as mowing or roller chopping may be needed to keep woody plant populations from spreading until biological agent is well established.
    b. Establishment desirable vegetation may be needed to protect the site following treatment.
12. Conduct monitoring activities as needed to determine the efficacy of the treatment.

Guidesheet for Use of Chemical Application to Control Woody Vegetation

Follow the Recommendations found in Herbicide Application Techniques for Woody Plant Control, Publication SS-AGR-260 http://edis.ifas.ufl.edu/AG245 or Weed Management in Fence Rows-2009, Publication SS-AGR-110 http://edis.ifas.ufl.edu/wg210 .

NRCS does not originate specific instructions, specifications, formulations, or recommendations regarding pesticides. If such information is required, it is to be derived from official publications from University of Florida IFAS Extension or of USDA or its cooperating agencies. NRCS employees can only recommend pesticides that are listed in these publications or are noted in approved supplements to the brush management stand and specification.

NRCS employees must advise the Cooperator on:

1. Safe handling and disposal of herbicides to avoid injury to humans, domestic animals, desirable plants and fish, other wildlife, and any contamination of nearby crops.
2. Federal, state and county laws and regulations governing the use of herbicides and labeling. The uses for which a herbicide has been registered are included in the information provided on the label of the commercial product. Determine the proper uses for which the product is intended by reading the label. Refer to the label on the commercial product for detailed information concerning dosage application and precautions. Certain precautions may be noted in the publications that are not included on the label but are applicable to local conditions in Florida.
3. It is legal to use registered mixtures of herbicides; however, only a few mixtures of herbicides are registered.
4. Proper certification to apply the herbicide.
5. Note that label data on herbicides are maximal values and also represents manufactures guaranteed product efficacy rates. Lower marginal rates must be approved by the ASTC/Technical Services.
6. Environmental Risk Analysis (WIN-PST) and interpretation of analysis and identification of appropriate mitigation techniques must be integrated into the conservation plan and discussed with the operator.