

Invasive Species Management Plan

Eradication of the false puncture vine *Tribulus cistoides* from Anguilla

This document presents an eradication plan for the false puncture vine *Tribulus cistoides* from Anguilla. The plants produce sharply spined fruits that can cause injury to the feet of humans and other animals. The fruits are sharp enough to puncture bicycle tires. The plan includes biosecurity actions to reduce the risk of reinvasion.

There are four main sections:

Section I Situation analysis: provides the background, justification and general information on the problem: why this species needs to be managed, who is concerned and who will be involved in implementing the action plan.

Section II Technical considerations: identifies and assesses the different management options available, with their respective pros and cons.

Section III Action plan: outlines the proposed procedure, based on the information and constraints outlined in Sections I and II.

Section IV Further information: references and links for further information on the target species and management methods considered.

Annexes include information on the target species, and any best practice guidelines appropriate for managing it.

Section I. Situation analysis

This section provides background, justification and general information on the problem.

Title	Response
Target species	(Give common and scientific names) False puncture vine <i>Tribulus cistoides</i>
Distribution in territory	(As detailed as possible) Occurs only on the main island, with between 1 and 3 populations, <1ha cover in total.
Why is the species a problem?	(Justify why this species needs to be managed, summarising it's impacts on biodiversity, the economy and/or public health) <i>T. cistoides</i> is a weed which forms dense smothering mats. The plants produce sharply spined fruits that can cause injury to the feet of humans and other animals. The fruits are sharp enough to puncture bicycle tires. <i>T. cistoides</i> has been reported to be poisonous to livestock, especially sheep.
Does the species provide any beneficial effects?	(Identify any benefits this species provides) <i>T. cistoides</i> can be used as a ground cover. The plant could serve as a natural barrier, discouraging creatures from walking across it. It has medicinal uses, treating ailments such as headache, nervous disorders, and constipation.
Previous or current management in the territory	(Summarise previous successes and failures at managing this species, if any) This species has not been managed before in Anguilla.
Pathways of entry	(How does this species arrive in the territory?) Deliberate introduction as an ornamental or ground cover plant. Accidental introduction as seeds stuck to footwear, machinery or tires. Seed is carried on sea currents and seabirds, and the principal means of introduction may be via oceanic currents.
Pathways of spread	(How does the species spread within the territory? This may be different for different life stages) Movement of the spiny fruits on farm machinery, livestock, vehicles (especially bicycles) and the clothes and shoes of humans. <i>T. cistoides</i> has a preference for growth in sandy, coastal habitats and invasion off shore cays is feasible through the spread of seed by ocean currents.
Gaps in knowledge?	(Identify any key areas where knowledge is lacking, if any)

	Mapping required to determine the current distribution and abundance.	
Legal framework	(Identify the legislation covering management actions for this species in terms of what can be done, gaps) <ul style="list-style-type: none"> • Plant Protection Act: <ul style="list-style-type: none"> ○ Can restrict the importation of plants that may pose a pest or disease risk 	
Key stakeholders affected by this species	(List the key stakeholders and note briefly their interest in this species – impacts or benefits. Add lines as necessary)	
	Stakeholder	Interests
	Community	Spiny seeds are a nuisance as they are painful to step on, affecting recreational activities and gardening. The plant also forms a dense smothering mat.
	Hoteliers	Their painful spiny seeds adversely affects tourists due to the plants preference for growing in coastal areas and dunes
	Agriculture	Spiny seeds are a nuisance as they are painful to step on, affecting farming. The plant also forms a dense smothering mat.
	Environment	Concerned about invasion to natural areas and offshore cays and its impact on native vegetation and ecosystems as a dense smothering mat. The spiny seeds would also restrict the movement of people engaged in conservation activities.
	National Trust	Concerned about invasion to offshore cays and its impact on native vegetation and ecosystems as a dense smothering mat. The spiny seeds would also restrict the movement of people engaged in conservation activities.
Agencies involved in management	(List the agencies or bodies who would be involved in managing this species. Add lines as necessary)	
	Agency	Role
	Environment	Lead agency Implement the action plan
	Agriculture	Assist in control measures

	Householders	Actively look out for and remove from premises
	Hoteliers	Landscaping crew assist in removals
Any other relevant information	<p>(Include any other information relevant to management of this species)</p> <p>Identified in the prioritisation exercise in March 2020 as a species with a high feasibility of eradication¹. However, control of <i>T. cistoides</i> is complicated by the long seed life and drought tolerance.</p> <p>Not a popular plant, so getting permission to remove it is likely.</p> <p>Risk of spread to Dog, Scrub and Prickly Pear islands.</p>	

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¹ See the workshop report at <http://www.nonnativespecies.org/downloadDocument.cfm?id=2285>

Section II. Technical considerations

This section assesses the different management options available.

Goal	(Identify where you want to be in the future. For example: eradication of species X from Y Cay) The false puncture vine <i>Tribulus cistoides</i> will have been completely eradicated from Anguilla, with a low, managed, risk of reintroduction.			
Objectives	(What you want to happen in order to reach the goal. Add extra lines if required)			
	1. Removal of existing populations of false puncture vine from the main island.			
	2. Monitoring and removal of germinated seeds for at least 5 years.			
Assessment of possible management methods				
List the possible methods for management if there are more than one. Examples are: manual removal; using pesticides; biocontrol, etc.). Add extra lines if required.				
Method	Summary outline of the method	Pros	Cons	Conclusion on feasibility
		Consider: effectiveness, practicality, existing expertise, cost, negative impacts, and acceptability		
Manual removal	<p>Plants can be removed by hand, they can readily be pulled out of soil.</p> <p>Care needs to be taken to remove and bag seeds. This is a possible option for National Trust mobilisation.</p> <p>Shallow cultivation to sever the taproot is effective in controlling large plants but it may stimulate the germination of seed. Monitoring</p>	Very effective and practical, no negative impact	<p>Gloves are required to protect hands from the prickly fruits.</p> <p>Sites need to be checked for germinating seeds for up to 5 years.</p>	Very feasible

	<p>of control sites needs to continue to check for and remove germinating seeds for up to 5 years.</p> <p>Mowing is not effective due to the prostrate growth habit of this weed.</p>			
Chemical control	<p>Glyphosate and dicamba have been used with excellent results. 2,4-D also shows good results. A 1-2% solution of each of these with surfactant is recommended.</p> <p>Certain pre-emergent herbicides can kill puncture vine seedlings as they germinate, but their utility may be limited in natural areas due to soil persistence.</p>	Spot treatment on mature plants may be acceptable.	<p>Concerns about the use of herbicides on the high water table in Anguilla.</p> <p>Cost includes labour plus cutting equipment, and herbicides / herbicide application equipment / PPE</p>	Very feasible: would require communications actions with stakeholders to ensure acceptance.
Biocontrol	<p>Effective control reported with the stem-and-crown-mining weevil <i>Microlarinus lypriformis</i> (Coleoptera: Curculionidae) from Hawaii, St Kitts and elsewhere in the West Indies including the Bahamas and Jamaica.</p> <p><i>M. layeynii</i> has also been introduced as a biological control agent against <i>T. cistoides</i>, although it has proved to be less effective than <i>M. lypriformis</i></p>	Once established, a biocontrol agent requires no further action to deliver control.	<p>Biocontrol gives control, but not eradication.</p> <p>Initial costs are high.</p>	Feasible, if eradication is not the goal or considered impossible.

Section III Action Plan

This is the proposed procedure, based on the information and constraints outlined in Sections I and II.

Title	Response		
Strategy to be used	(Note that this may use a combination of the methods outlined in Section II) Manual removal by pulling plants, and spot treatment of mature plants in selected areas.		
Budget (add extra lines as required)	Item/action	Sources of funding	Cost \$
	Labour	TBC	\$ TBC
	Equipment, materials, fuel etc	TBC	\$ TBC
	Communications materials	TBC	\$ TBC

Actions

The objectives come from the table in Section II. Actions should include stakeholder engagement, and post-management surveillance. Add further objectives if required.

Objective 1. Removal of existing populations of false puncture vine from the main island.		
Proposed procedure (add more lines as necessary)		
Timeline	Action	Responsible
TBC	Map existing populations of false puncture vine.	TBC
TBC	Train teams in safe herbicide application techniques for spot treatment in the context of concerns about herbicide impact on the water table. Teams will also be trained in the disposal of cut plant material to minimise the spread of the spiny seeds.	TBC
TBC	Manual removal of mature plants, and bagging of plants with seeds for disposal.	TBC
TBC	Spot treatment of selected areas of mature plants where manual removal is not considered the best approach.	TBC

TBC	Mobilisation of a community programme to encourage removal of false puncture vine on private land.	TBC
TBC	Communications and awareness programme with the community to raise awareness and promote compliance.	TBC

Objective 2. Monitoring and removal of germinated seeds for at least 5 years.		
Proposed procedure (add more lines as necessary)		
Timeline	Action	Responsible
TBC	Set up a long-term monitoring programme of all affected areas to ensure all new plants are removed.	TBC
TBC	Set up a surveillance and pest Alert programme to check for new populations of false puncture vine, for removal.	TBC
TBC	Training of DECR, Public Works, Agriculture and National Trust staff on identification of false puncture vine, seedling and adult stages	TBC
TBC	Campaign of public engagement to check for and remove seedlings in private property	TBC

Biosecurity measures required to prevent reinvasion		
Proposed procedure (add more lines as necessary)		
Timeline	Action	Responsible
TBC	Biosecurity inspectors trained in identifying this species, and the high risk pathways of entry (seeds in machinery, tires, footwear and clothing).	TBC

TBC	Factsheets developed for biosecurity inspectors and customs officers. Information shared with all ports of entry.	TBC
TBC	Inter-island biosecurity measures put in place.	TBC

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Section IV Further information

For further information see the references and links below.

References

Booy, O. *et al.* (2020). Prioritising the management of established invasive non-native species in Turks & Caicos Islands: eradication and spread prevention. March 2020.

<http://www.nonnativespecies.org/index.cfm?pageid=650>

IUCN (2018). Guidelines for invasive species planning and management on islands. Cambridge, UK and Gland, Switzerland: IUCN. Viii + 40pp.

Links

- CABI Datasheet <https://www.cabi.org/isc/datasheet/54446>
- <http://tropical.theferns.info/viewtropical.php?id=Tribulus+cistoides>
- <https://plants.ifas.ufl.edu/plant-directory/tribulus-cistoides/>

Annex 1. Information on the target species

Species name	(Common and scientific names) False puncture vine <i>Tribulus cistoides</i>
Description	(Give details of all stages in the life cycle) <p><i>Tribulus cistoides</i> is a herbaceous, annual to short-lived perennial plant with branched stems around 50 – 180 cm long that are usually prostrate. It has a well-developed tap root and the stems tend to grow along the ground, forming mats.</p> <p>Leaves are opposite, pinnately compound, 10 cm long, divided into 6 to 8 pairs of elliptic leaflets ranging from 2 – 7 mm long.</p> <p>Solitary, bright yellow, 20 – 30 mm wide, 5-petalled flowers are produced.</p> <p>The fruit is disc-shaped with a stalk 20-30 cm long. The fruit (sometimes referred to as a burr) breaks up into four or five wedge-shaped segments, each with two lateral spines 5-10 mm long and two basal spines 2 mm long. Each segment contains 1-4 seeds.</p>
Similar species	(Give details of any other species which could be confused with the target species) <p><i>T. cistoides</i> closely resembles <i>T. terrestris</i> but the latter is an annual herb with smaller flowers 7-15 mm in diameter and with smaller leaflets.</p>
Life cycle	(Include seed bank longevity for plants) <p>The plant begins to flower and set seeds while only a few centimetres tall, continuing to do so throughout the year.</p> <p>Seeds are very persistent in the environment, able to remain dormant in the soil for up to 5 years.</p>
Ecology and behaviour	<p>It is known to flower from spring to fall in the sub-tropics and all year round in the tropics. Flowers open just after sunrise and close at sunset, lasting about two days. The plant's rapid growth allows it to form sizable radial patches very quickly.</p>
Habitats	<p><i>T. cistoides</i> is commonly found as a weed on sandy soils along coasts and also open places inland. It is found on roadsides, recreational areas and agricultural land.</p> <p>It prefers a position in full sun, though it tolerates partial shade and requires a well-drained soil. Established plants are drought tolerant.</p>
Any other relevant information	<p>The spiny fruits of <i>T. cistoides</i> are well equipped for dispersal from field to field by attaching to the fur and hides of wild and domestic animals. They are also dispersed on human clothes and footwear. The large and small spines on the fruit are arranged at different angles so that, no matter how the seed falls, one of the spines always points upward to meet the unwary foot, hoof or vehicle tire.</p>

The spiny fruits can be transported over some considerable distances because they are readily attached to the rubber tires of farm machinery.



Tribulus cistoides flowers and leaves (left) and spiny fruit (right). Images © Forest & Kim Starr – CC BY 4.0

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Annex 2. Best practice guidelines

A. General guidelines

General guidelines for weed control are:

- Timing is important, you need to hit weeds before they start flowering: “1 years weed is 7 years seed”
- Do not start without planning for follow-up.
- Look at the big picture: what will happen when the target weed is removed? Worse ones can come in, especially if removal results in disturbed land, and some weeds can be useful in sheltering newly planted endemic species.
- Pick the right method for the job - not just with regards the weed species but also taking into consideration the context. There are two main approaches:
 - Large-scale short-term action with relatively little input: typically for agricultural and pasture clearing.
 - Longer term action, of varying scale and often with high input: typically for conservation work.
- When tackling a widespread weed, start with the outliers. Remove these first, and then focus on the main area of infestation.
- Success can be achieved only by on-going removal. Don't think you can do it with a single one-off treatment.

B. Best practice guidelines on disposing of cut weeds

Poor disposal, such as dumping green waste over a fence or in the forest is one of the main ways that weeds escape from gardens and start spreading. Some of the ways to minimise the spread of weeds through responsible disposal of green waste include:

- Drying (any weed):
 - Leave weeds in the sun to dry before disposing of them.
 - Rhizomes or tubers can be hung up in trees in dry regions to wither. Then burn them or take them to the landfill site.
- Burning (rushes, grasses, woody weeds):
 - Dry cut weeds and then burn them in a bonfire or simple incinerator made from a 40 gallon oil drum. Be careful not to create a large fire which can go out of control.
- Bagging and rotting down (weed with seeds, weeds with bulbs and tubers):
 - Dispose of weeds that are already seeding or readily able to reproduce vegetatively, including through suckers and bulbs, by placing them in a black plastic bag, sealing it and 'baking it' in the sun until destroyed.
- Composting (any small weeds, the leafy parts of larger weeds and woody weeds)
 - Remove any problem parts (tubers, rhizomes, berries & fruit) and either take them to the landfill site, rot them down in a black bag or dry them for burning, as described above. Compost the other parts of the plant.
 - Cover your compost so that seeds cannot be distributed by wind or animals.
 - Do not compost tubers or roots such as ginger that are likely to re-sprout and are not likely to be killed in compost heaps.
- Mulching and chipping (larger leafy and woody weeds):
 - Finely shredding weeds in a garden mulcher before burying or composting will increase the rate of breakdown.
 - Mulched weeds make an excellent slow-release feed for fruit trees.
 - Mulches and wood chip ground covering help suppress new weed growth and hold moisture in.
- Transporting to the landfill site (any weed material):
 - Always cover trailers when transporting plant material to prevent seeds and other live plant material falling off.
 - Don't fill the trailer or truck so full that weeds can fall off.
 - Never transport weeds in full seed or you will just spread seeds across the land. Bag up any plants with seeds before transporting them off the site.
- Leaving in situ (any weed with seed heads or fruit, any weeds where moving cut plant material would cause damage):
 - Cut weeds can be piled, or left lying as they fall, depending on the situation.
 - Note that rats can use piles of cut plant stems as refuges.

C. Best practice guidelines for spraying herbicides

Main points are:

- Always read the product label for dose rate, conditions of use and the personal protective equipment required.
- The standard minimum personal protective equipment is: rubber boots, nitrile gloves and coveralls. A face shield is also recommended, especially when mixing the herbicide in the tank.
- Never spray when it is windy or when it is wet.
- The best time to spray is early in the morning or late in the day.
- Most herbicides only work on growing plants, they need to be lush and green at the time of spraying.
- Most herbicides are applied by spray set at low pressure, and fitted with a solid cone nozzle. This is a different nozzle to what would be used to apply insecticides.
- Spraying drought stressed plants should be avoided as plants in this condition will not absorb sufficient herbicide to kill them.
- Try to ensure an even coverage of spray, including on the undersides of the leaves.
- Always check the product label.

Some herbicides commonly used:

Glyphosate (eg Roundup, Roundup Probioactive)

- A general broad-spectrum herbicide which kills a wide range of weeds and is particularly good at annual broadleaf weeds and grasses.
- Has systemic action, absorbed mainly through the leaves. There is little absorption through the roots.
- Binds strongly to soil and can persist for up to 6 months. Water pollution is minimal. Under the right conditions it is also readily degraded by soil microorganisms.
- May be carcinogenic to people, but does not pass easily through the skin.
- Pure glyphosate is low in toxicity to fish and wildlife, but some products containing glyphosate may be toxic because of the other ingredients in them.

Triclopyr (eg Garlon 480, Garlon Max)

- More selective than glyphosate, particularly good at annual broadleaf weeds and woody weeds. It will not kill grasses or conifers if used at the correct dose as prescribed by the label.
- Has systemic action, absorbed through the leaves, green stems, and roots.
- Does not bind to soil, and risk of water pollution exists, but sunlight rapidly breaks down triclopyr in water. It is readily degraded by soil microorganisms.
- No evidence of carcinogenic action in people, and not very toxic to people, animals or aquatic organisms.