Integrated Vegetation Management (IVM) Approach to Pollinator-Smart Brownfields Remediation

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IVM and the Virginia Pollinator-Smart Solar Industry Program

DCR Virginia Department of Conservation & Recreation

DEQ Virginia Department of Environmental Quality

5 INTEGRATED VEGETATION MANAGEMENT

Creating a self-sustaining herbaceous community composed of native pollinator species in Virginia is a challenging endeavor.

Figure 5-1: Solar facility in Virginia constructed on a prior agricultural field. This site did not use a Pollinator-Smart approach to vegetation management and, as a result, is dominated with aggressive weeds that are already overtopping the panels even before the first growing season is over.

Without active management, regenerating sites in this region will almost always follow a pattern of ecological succession directed toward some variant of an eastern deciduous hardwood forest (Monette and Ware 1983, Weakley et al. 2012) or mixed pine-hardwood forest (Ware 1970). This phenomenon is well-known to land managers in the Mid-Atlantic Region who are tasked with maintaining vegetation in a low-canopy or meadow-like condition, which is often the preferred cover type on sites like utility rights-of-way (ROW). For ROW managers, the primary objective is to keep trees from growing under powerlines or over buried utilities to promote safety and to avoid compromising the lines (Nowak et al. 1992). Land management concepts in ROW corridors can be directly applied to solar installations, because the goal in both cases is to promote a natural herbaceous cover type (perhaps with some interspersion of shrubs in the Open Area) that will ultimately inhibit tree regeneration and/or other undesirable plant species (Nowak and Ballard 2005). In landscape settings that have been heavily managed for various human activities such as agriculture, this is an even more difficult challenge due to the biotic and abiotic legacy effects of prior land uses, as well as recruitment from non-native weedy plants that abound in disturbed landscapes (Hobbs and Walker 2007, Cramer et al. 2008) (FIgure 5-1). Given the exposure of many Virginia solar installations to these pressures, the task of creating a natural, self-sustaining, Pollinator-Smart meadow at these facilities is a challenging endeavor.

What scientists and managers have learned from applied research in these scenarios is that an Integrated Vegetation Management (IVM) approach is the most practical way to achieve short-term and long-term goals, reduce costs, and ultimately promote successful re-vegetation projects (Nowak et al. 1992, USEPA 2017). This approach is based on the assumption that proactive vegetation management using targeted herbicide treatment and/or mechanical removal is an activity that not only controls pest species, but also minimizes its own use over time (Nowak and Ballard 2005). This is true of tree control in settings where management has promoted a dense herbaceous cover that reduces tree regeneration through competition (Bramble et al. 1996). The approach will also work to control weedy grasses and forbs in combination with activities that help to establish a diversity of native species (such as drill seeding), thereby reducing potential for non-native, aggressive species to colonize during the establishment phase on young sites (Kennedy et al. 2002). Finally, IVM uses the concept of adaptive management to modify the prescriptive approaches as the site develops, with the assumption that the need for active intervention should wane over

What is IVM?

EPA Definition:

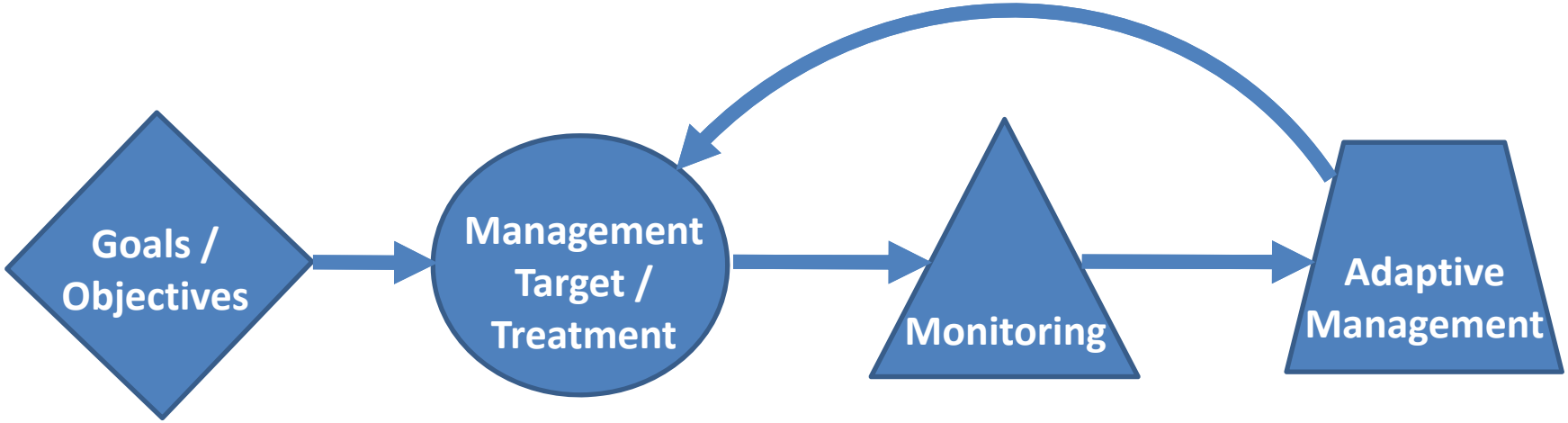
"**…the practice of promoting desirable, stable, low-growing plant communities that will resist invasion…through the use of appropriate, environmentally-sound, and cost-effective control methods.**"

(https://www.epa.gov/pesp/integrated-vegetation-management-fact-sheet)

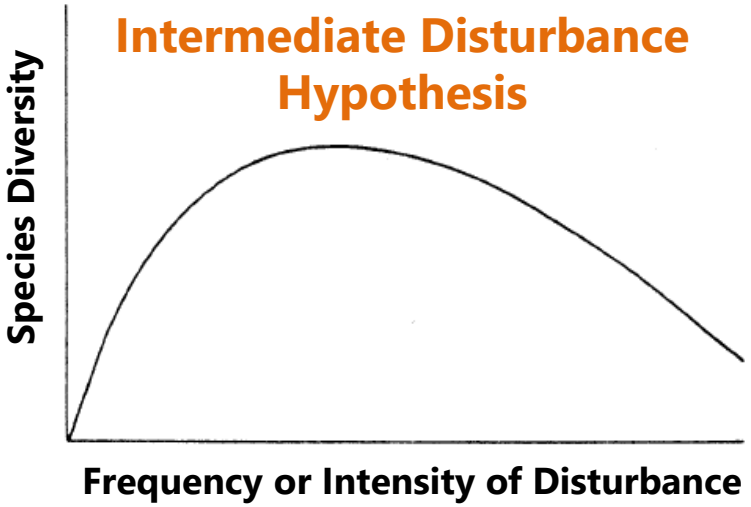
Techniques:

- **Chemical**
- **Biological**
- **Cultural**
- **Mechanical**
- **Manual**

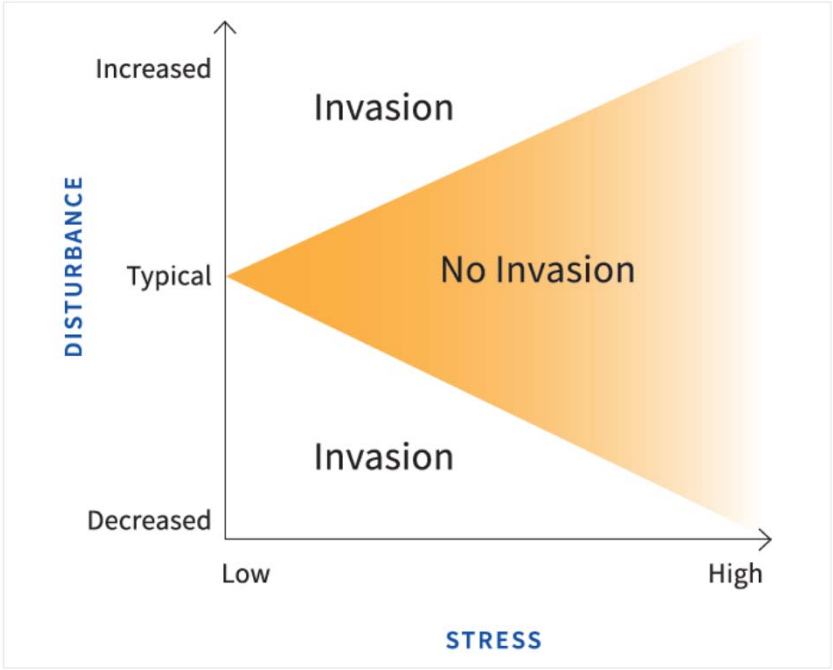
IVM is "…a treatment that minimizes its own use in the long run…" (Nowak and Ballard. 2005. J. Arboric. 31:28-37)



IVM and Invasion Ecology



Based on: Connell 1978. Science 199:1302-1310.



Based on: Alpert et al. 2000. Perspect. Plant Ecol. Evol. Syst. 3:52-66.

Relative intensity of STRESS →

Relative intensity of DISTURBANCE ↓

	Low	High
Low	Competitive strategy (**C**)	Stress-tolerant strategy (**S**)
High	Ruderal strategy (**R**)	No viable strategy (X)

Based on: Grime 1977. American Naturalist 111:1169-1194.

IVM maximizes the potential for native species richness by exploiting the stress-disturbance dynamic

Case Study: Metro D.C. Area Site

Project Details:

- Cleanup of historic chemical release
- Site capped with clean fill material
- Mandated re-vegetation with native species
  - no woody species
  - vegetation performance standard ("75/90" criterion, consecutive years)

Prior to our involvement, the original attempt included a limited seed mix and minor site prep…

“Year 0” Site Inspection

Relative cover 55% non-native species after initial re-vegetation attempt (low-diversity seed mix, improper site prep)

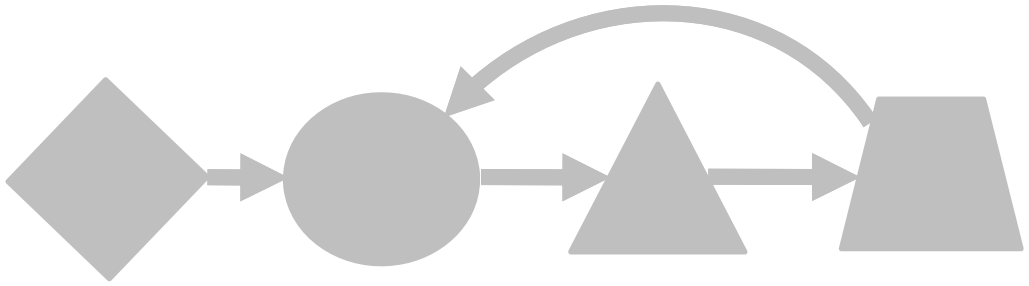
Scientific Name	Common Name	Family	Status*	Relative Cover**	Comments
Acalypha rhomboidea Raf.	Common Three-seeded Mercury	Euphorbiaceae	N	O	low forb; colonizer of disturbed sites; used by seed-eating songbirds
Andropogon gerardii Vitman	Big Bluestem, Turkeyfoot	Poaceae	N	S	tall clump-forming grass; provides herbaceous layer structure (including over-wintering stems)
Apocynum cannabinum L.	Indian Hemp, Hemp Dogbane	Apocynaceae	N	O	medium to tall forb; **beneficial for many types of pollinators** (bees, wasps, butterflies, moths)
Bidens bipinnata L.	Spanish Needles	Asteraceae	N	O	medium to tall forb; early colonizer of disturbed sites; seeds beneficial for some songbirds
Chamaecrista fasciculata (Michx.) Greene var. fasciculata	Common Partridge-pea	Fabaceae	N	C	medium forb; **returns nitrogen to the soil through N-fixation; beneficial for certain species of birds, mammals, and insects**
Chenopodium album L.	Lamb's-quarters, Pigweed	Amaranthaceae	N	O	medium forb; **seeds beneficial food source for many birds during fall/winter (particularly sparrows)**
Coleataenia anceps (Michx.) Soreng ssp. anceps	Beaked Panic Grass	Poaceae	N	O	medium grass; **used for soil stabilization; seeds beneficial for upland birds and deer**
Cynodon dactylon (L.) Pers. var. dactylon	Bermuda Grass	Poaceae	I	S	low stoloniferous grass; listed as a noxious weed in several states; minimal wildlife value
Dactylis glomerata L. ssp. glomerata	Orchard Grass	Poaceae	I	O	medium clump-forming grass; listed as a noxious weed in the northeast region; minimal wildlife value
Daucus carota L.	Queen-Anne's Lace, Wild Carrot	Apiaceae	I	S	medium forb; listed as a noxious weed in several regions; beneficial to some pollinators and insect larvae
Digitaria ischaemum (Schreb.) Muhl.	Smooth Crabgrass	Poaceae	I	S	low grass; listed as a noxious weed by the USDA; beneficial food source for several game birds and some songbirds
Eleusine indica (L.) Gaertn.	Indian Goosegrass, Yard Grass	Poaceae	I	C	low grass; listed as a noxious weed by the USDA
Erigeron strigosus Muhl. ex Willd. var. strigosus	Daisy Fleabane	Asteraceae	N	O	medium forb; early colonizer, providing structural diversity on disturbed sites; minimal wildlife value
Geranium molle L.	Dove's-foot Geranium, Dove's-foot Cranesbill	Geraniaceae	I	O	low forb; minimal value; some congeners (e.g., *G. carolinianum*) are beneficial as forage due to high protein content, but no data available on *G. molle*
Kummerowia stipulacea (Maxim.) Makino	Korean-clover	Fabaceae	I	O	low forb; listed as noxious weed in parts of the southeast region; important forage species for deer and several game birds
Lactuca sp. (not in flower or fruit)	Lettuce	Asteraceae	NA	O	medium to tall forb with overwintering rosette; provides structural diversity on open or disturbed sites; seeds and foliage used by some songbirds and mammals
Lamium amplexicaule L.	Henbit, Henbit Dead-nettle	Lamiaceae	I	S	low forb; common weed of lawns and disturbed areas; listed as a noxious weed in several regions; marginal benefit for pollinators (flowers), and small mammals and turtles (foliage)
Lespedeza cuneata (Dum.-Cours.) G. Don	Sericea Lespedeza, Chinese Lespedeza	Fabaceae	NNI	S	medium to tall forb; **highly invasive on VA and Mid-Atlantic lists**; fixes nitrogen; provides forage and cover for game birds
Lolium arundinaceum (Schreb.) Darbysh.	Tall Fescue, Alta Fescue	Poaceae	I	O	medium clump-forming grass; valued for soil stabilization and land reclamation due to its coarse, robust growth habit, but it can also out-compete more desirable native species; minimal wildlife value (mostly used as livestock forage, but susceptible to fungus)
Lolium multiflorum Lam.	Annual Rye Grass	Poaceae	I	S	medium clump-forming grass; listed as a noxious weed in some regions; used for soil stabilization and as a cover crop; minimal wildlife value
Medicago lupulina L.	Black Medick	Fabaceae	I	S	low forb; listed as a noxious weed in several regions; nitrogen fixer and somewhat beneficial for pollinators
Melilotus officinalis (L.) Lam.	Yellow Sweet-clover	Fabaceae	I	D	medium forb; listed as a noxious weed in several regions; nitrogen fixer and beneficial to several pollinators; foliage also eaten by herbivores to a limited extent
Oenothera biennis L. complex	Common Evening-primrose	Onagraceae	N	O	medium to tall forb; **early colonizer adding structural diversity to disturbed sites; beneficial for pollinators such as moths and butterflies**; seeds foraged by some game birds and songbirds
Panicum dichotomiflorum Michx. var. dichotomiflorum	Spreading Panic Grass, Fall Panic Grass	Poaceae	N	S	medium clump-forming grass; **important seed forage plant for upland game birds, songbirds, and waterfowl**; listed as weedy in some regions
Panicum virgatum L.	Switchgrass	Poaceae	N	S	tall clump-forming grass; **provides herbaceous layer structure (including over-wintering stems); used extensively for revegetation, soil stabilization, and cover; important seed forage for upland game birds, songbirds, and waterfowl**
Plantago lanceolata L.	English Plantain, Rib-grass	Plantaginaceae	I	O	low forb; listed as a noxious weed in several regions; little to no wildlife value
Rubus flagellaris Willd.	Common Dewberry	Rosaceae	N	O	low sub-shrub with scrambling, vine-like habit; **provides ground-level structure and cover for birds and small mammals; soft mast is a very important and beneficial food source for a large number of birds and mammals**
Rubus pensilvanicus Poir.	Pennsylvania Blackberry, Prickly Blackberry	Rosaceae	N	O	tall arching sub-shrub; **provides vertical structure and cover for birds and small mammals on open or disturbed sites; soft mast is a very important and beneficial food source for a large number of birds and mammals**
Rudbeckia hirta L.	Black-eyed Susan	Asteraceae	N	O	medium forb; provides structural diversity on open or disturbed sites; seeds occasionally eaten by songbirds
Rumex crispus L. ssp. crispus	Curly Dock	Polygonaceae	I	S	low to medium forb; listed as a weed in several regions; seeds occasionally taken by songbirds
Setaria faberi Herrm.	Nodding Bristlegrass, Japanese Bristlegrass	Poaceae	I	C	medium to tall clump-forming grass; listed as a noxious weed in several states; forage grass for upland game birds, song birds, and waterfowl
Setaria italica (L.) Beauv.	Foxtail-millet, Italian Bristlegrass	Poaceae	I	S	medium to tall clump-forming grass; listed as a noxious weed in several states; forage grass for upland game birds and song birds
Setaria parviflora (Poir.) Kerguelen	Knotroot Bristlegrass, Knotroot Foxtail	Poaceae	N	C	medium clump-forming grass; **provides cover and structural diversity in open or disturbed habitats; forage grass for upland game birds and song birds**
Sonchus asper (L.) Hill	Spiny-leaf Sow Thistle	Asteraceae	I	O	medium forb; listed as a weed in several regions; minimal to no wildlife benefits
Sorghastrum nutans (L.) Nash	Indian Grass, Yellow Indian Grass	Poaceae	N	D	tall clump-forming grass; **provides structural diversity in upland fields and disturbed sites; seeds consumed by songbirds**
Stellaria media (L.) Vill.	Common Chickweed	Caryophyllaceae	NNI	S	low forb; **listed as invasive in VA (medium invasive rank)**; beneficial to some pollinators and insect larvae
Symphyotrichum pilosum (Willd.) Nesom var. pilosum	Frost Aster, White Old-field Aster, Awl Aster	Asteraceae	N	S	medium to tall forb; **provides structural diversity in open fields and disturbed habitats; provides cover for small mammals and birds**
Taraxacum officinale G.H. Weber ex Wiggers	Common Dandelion	Asteraceae	I	S	low forb; listed as a noxious weed in several regions; beneficial to a variety of pollinators
Tragopogon pratensis L.	Meadow Salsify, Showy Goat's-beard	Asteraceae	I	C	low forb; beneficial to some pollinators
Trifolium repens L.	White Clover, Dutch Clover	Fabaceae	I	C	low forb; returns nitrogen to the soil via N-fixation; listed as a weed in several regions
Ulmus rubra Muhl.	Slippery Elm, Red Elm	Ulmaceae	N	O	tree seedlings; provides structural diversity on early successional sites where propagules are available from adjacent forested areas
Verbascum thapsus L. ssp. thapsus	Common Mullein	Scrophulariaceae	I	O	medium to tall forb; provides structural diversity in disturbed or open habitat
Vicia sativa L.	Narrow-leaf Vetch, Common Vetch	Fabaceae	I	S	low trailing forb with vine-like habit; seeds frequently eaten by game birds and songbirds; foliage consumed by a variety of herbivores

* Status codes: N = Native; I = Introduced; NNI = Non-native Invasive; NA = Not Applicable (not enough information)

** Relative Cover codes: D = dominant (>20% cover); C = common (5-20% cover); S = scattered (1-5% cover); O = occasional (<1% cover).


Adjacent embankment dominated by
Lespedeza cuneata (sericea lespedeza)

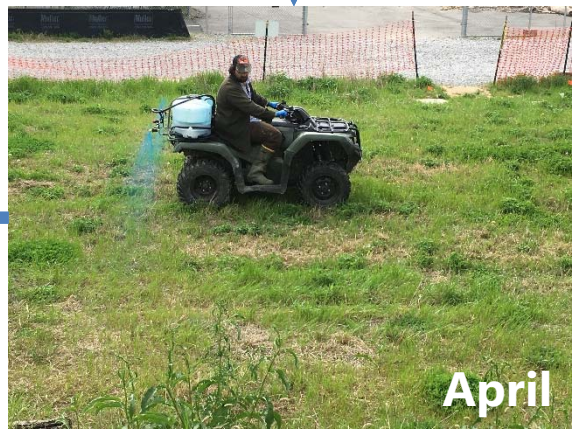
Re-vegetation Remediation Plan



Main Ideas:

- No-till site preparation
  - Herbicide "burn-down"
- Seed application (seed drill)
- Integrated Vegetation Management (IVM)
  - Use of adaptive management principles
- Revised and expanded species list (prior approved list = 8 spp.; proposed list = 21 spp.)
- Revised sampling strategy
  - Stratified-random design with sample adequacy (species-area)

“Year 1” Remediation Implementation



“Year 1” Remediation Implementation

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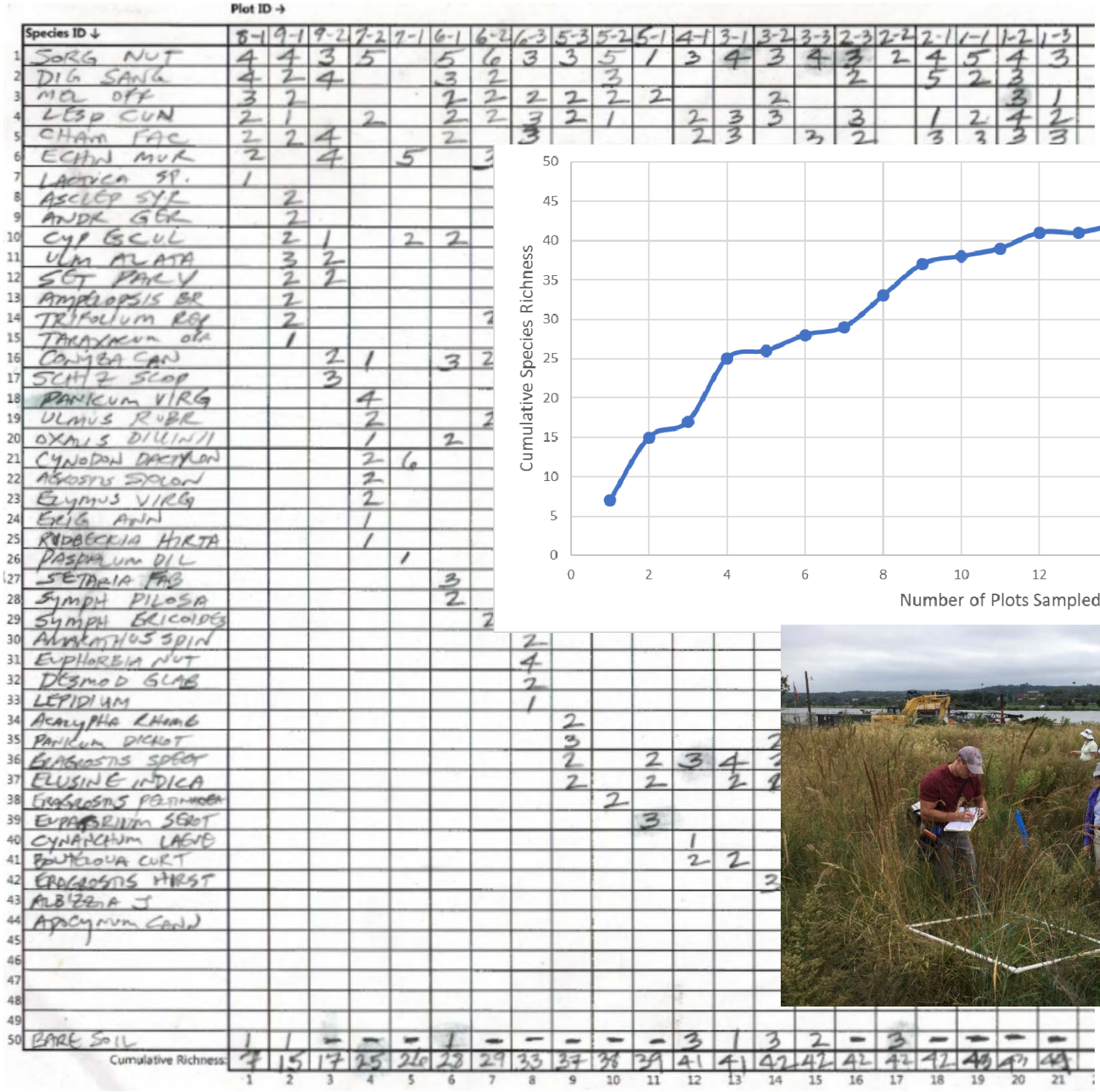
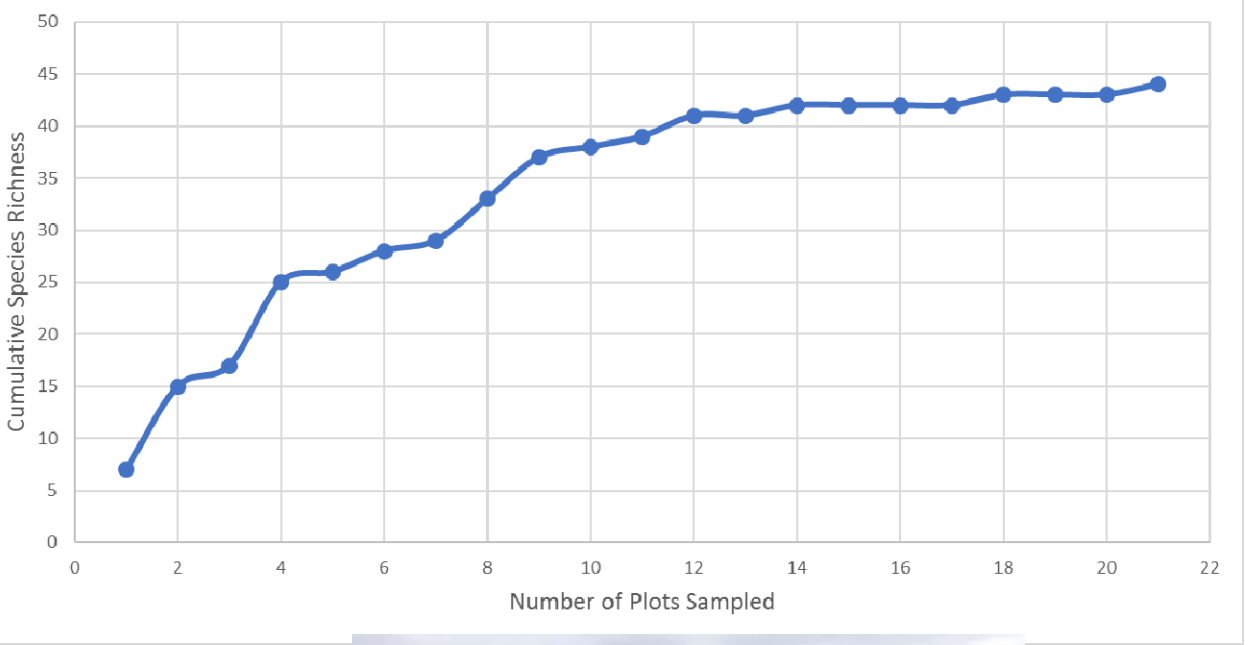
Sampling


Plot ID →
Species ID ↓
SORG NUT
DIG SANG
MOL OFF
LESP CUN
CHAM FAC
ECHN MUR
LACTUCA SP.
ASCLEP SYR
ANDR GER
CYP ESCUL
ULM ALATA
SOL PAR V
AMPELOPSIS BR
TRIFOLIUM REP
TARAXACUM OFF
CONYZA CAN
SCHIZ SCOP
PANICUM VIRG
ULMUS RUBR
OXALIS DILLENII
CYNODON DACTYLON
AGROSTIS STOLON
ELYMUS VIRG
ERIG ANN
RUDBECKIA HIRTA
PASPALUM DIL
SETARIA FAB
SYMPH PILOSA
SYMPH ERICOIDES
AMARANTHUS SPIN
EUPHORBIA NUT
DESMOD GLAB
LEPIDIUM
ACALYPHA RHOMB
PANICUM DICHOT
ERAGROSTIS SPECT
ELUSINE INDICA
ERAGROSTIS PECTINACEA
EUPATORIUM SEROT
CYNANCHUM LAEVE
BOUTELOUA CURT
ERAGROSTIS HIRST
ALBIZZIA J
APOCYNUM CANN
BARE SOIL
Cumulative Richness:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cumulative Species Richness
0 5 10 15 20 25 30 35 40 45 50
0 2 4 6 8 10 12 14 16 18 20 22
Number of Plots Sampled

Year 1 results

Relative Cover Native Species: 79.1%

Relative Cover Non-native Species: 20.9%

Percent Bare Ground (from plots): 3.5%

				PLOTS																			
Scientific Name	Common Name	Family	N/I*	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	5-1	5-2	5-3	6-1	6-2	6-3	7-1	7-2	8-1	9-1	9-2	Relative Cover by Species
Sorghastrum nutans (L.) Nash	**Indian Grass**	**Poaceae**	**N**	63	38	15	38	3	15	38	15	38	15	0.5	63	15	63	85	15		63	38	38	15	**26.85%**
Echinochloa muricata (Beauv.) Fern. var. muricata	**Rough Barnyard Grass**	**Poaceae**	**N**			63						3	63	15		63		15	3	63		3		38	**13.12%**
Digitaria sanguinalis (L.) Scop.	**Hairy Crabgrass**	**Poaceae**	**I**	3	15		63		3						15		15	3				38	3	38	**7.81%**
Conyza canadensis (L.) Cronq. var. canadensis	**Horseweed**	**Asteraceae**	**N**			3		15						63	38	38	15	3			0.5			3	**7.12%**
Chamaecrista fasciculata (Michx.) Greene var. fasciculata	**Common Partridge-pea**	**Fabaceae**	**N**	15	15	15	15		3	15		15	3				3		15			3	3	38	**6.30%**
Lespedeza cuneata (Dum.-Cours.) G. Don	**Sericea Lespedeza**	**Fabaceae**	**I**	3	38	3	15		3	15	15		3		0.5	3	3	3	15		3	3	0.5		**5.02%**
Panicum virgatum L.	**Switchgrass**	**Poaceae**	**N**		3				38							3			15		38				**3.87%**
Cynodon dactylon (L.) Pers. var. dactylon	**Bermuda Grass**	**Poaceae**	**I**																	85	3				**3.51%**
Eragrostis spectabilis (Pursh) Steud.	**Purple Lovegrass**	**Poaceae**	**N**			3		3	3	38	3	15	15	3		3									**3.43%**
Andropogon gerardii Vitman	**Big Bluestem**	**Poaceae**	**N**	15	15		3		15	15			3										3		**2.75%**
Melilotus officinalis (L.) Lam.	**Yellow Sweet-clover**	**Fabaceae**	**I**		15	0.5					3			3	3	3	3	3	3			15		3	**2.17%**
Euphorbia nutans Lagasca y Segura	**Nodding Spurge**	**Euphorbiaceae**	**N**		15														38						**2.11%**
Panicum dichotomiflorum Michx. var. dichotomiflorum	**Fall Panic Grass**	**Poaceae**	**N**					15			3	15				15									**1.91%**
Desmodium glabellum (Michx.) DC.	**Dillenius' Tick-trefoil**	**Fabaceae**	**N**		3			3	38										3						**1.87%**
Setaria parviflora (Poir.) Kerguelen	**Knotroot Foxtail**	**Poaceae**	**N**	0.5			15	3			15												3	3	**1.57%**
Apocynum cannabinum L.	**Indian Hemp**	**Apocynaceae**	**N**			38																			**1.52%**
Ulmus rubra Muhl.	**Slippery Elm**	**Ulmaceae**	**N**	3	15	3					3					3		3			3				**1.32%**
Eragrostis hirsuta (Michx.) Nees	**Big-top Lovegrass**	**Poaceae**	**N**					15			15														**1.20%**
Setaria faberi Herrm.	**Nodding Bristlegrass**	**Poaceae**	**I**			0.5	3						3				15		0.5						**0.88%**
Ulmus alata Michx.	**Winged Elm**	**Ulmaceae**	**N**																				15	3	**0.72%**
Schizachyrium scoparium (Michx.) Nash var. scoparium	**Little Bluestem**	**Poaceae**	**N**						3															15	**0.72%**
Eupatorium serotinum Michx.	**Late Thoroughwort**	**Asteraceae**	**N**											15											**0.60%**
Bouteloua curtipendula (Michx.) Torr. var. curtipendula	**Side-oats Grama**	**Poaceae**	**N**					3	3	3		3	3												**0.60%**
Eleusine indica (L.) Gaertn.	**Indian Goosegrass**	**Poaceae**	**I**							3	3			3		3									**0.48%**
Cyperus esculentus L. var. leptostachyus Böckler	**Yellow Nutsedge**	**Cyperaceae**	**N**														3			3			3	0.5	**0.38%**
Ampelopsis brevipedunculata (Maxim.) Trautv.	**Porcelain-berry**	**Vitaceae**	**I**							3													3		**0.24%**
Trifolium repens L.	**White Clover**	**Fabaceae**	**I**															3					3		**0.24%**
Amaranthus spinosus L.	**Spiny Amaranth**	**Amaranthaceae**	**I**									3							3						**0.24%**
Oxalis dillenii Jacquin	**Southern Yellow Wood-sorrel**	**Oxalidaceae**	**N**						0.5	0.5							3				0.5				**0.18%**
Rudbeckia hirta L.	**Black-eyed Susan**	**Asteraceae**	**N**							0.5	3		0.5								0.5				**0.18%**
Asclepias syriaca L.	**Common Milkweed**	**Apocynaceae**	**N**																				3		**0.12%**
Agrostis stolonifera L.	**Creeping Bentgrass**	**Poaceae**	**I**																		3				**0.12%**
Elymus virginicus L. var. virginicus	**Virginia Wild Rye**	**Poaceae**	**N**																		3				**0.12%**
Symphyotrichum pilosum (Willd.) Nesom	**Frost Aster**	**Asteraceae**	**N**														3								**0.12%**
Symphyotrichum ericoides (L.) Nesom var. ericoides	**White Heath Aster**	**Asteraceae**	**N**															3							**0.12%**
Acalypha rhomboidea Raf.	**Common Three-seeded Mercury**	**Euphorbiaceae**	**N**													3									**0.12%**
Eragrostis pectinacea (Michx.) Nees var. pectinacea	**Tufted Lovegrass**	**Poaceae**	**N**												3										**0.12%**
Albizia julibrissin Durazz.	**Mimosa, Silk Tree**	**Fabaceae**	**I**	3																					**0.12%**
Lactuca biennis (Moench) Fern.	**Tall Blue Lettuce**	**Asteraceae**	**N**								0.5											0.5			**0.04%**
Taraxacum officinale G.H. Weber ex Wiggers	**Common Dandelion**	**Asteraceae**	**I**																				0.5		**0.02%**
Erigeron annuus (L.) Pers.	**Annual Fleabane**	**Asteraceae**	**N**																		0.5				**0.02%**
Paspalum dilatatum Poir.	**Dallis Grass**	**Poaceae**	**I**																	0.5					**0.02%**
Lepidium virginicum L.	**Virginia Pepperweed**	**Brassicaceae**	**N**																0.5						**0.02%**
Cynanchum laeve (Michx.) Pers.	**Honeyvine**	**Apocynaceae**	**N**										0.5												**0.02%**
			Total Cover By Plot:	106	172	144	152	60	125	131	78.5	92	109	103	123	152	126	121	111	152	118	101	78	157	
			Bare Ground:					38		0.5	15	3	15				0.5					0.5	0.5		3.48%

* N = Native; I = Introduced

Planted Species in Bold Type

Invasive Species in Red Type

Year 2 Adaptive Management

Activities:

- Woody stem removal (root wrench)
- Herbicide spot treatment

Year 2 results

* Relative cover of native species 92.6%

				PLOTS																			
Scientific Name	Common Name	Family	N/I*	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	5-1	5-2	5-3	6-1	6-2	6-3	7-1	7-2	8-1	9-1	9-2	Relative Cover by Species
Sorghastrum nutans (L.) Nash	**Indian Grass, Yellow Indian Grass**	**Poaceae**	N	0.5	63	85	3	85	38	63	15	0.5	38	38	15	63	98	15	63	0.5	85	85			35.15%
Symphyotrichum pilosum (Willd.) Nesom var. pilosum	Frost Aster, White Old-field Aster, Awl Aster	Asteraceae	N		38	0.5			85				3		63	38	3	63	63		15				15.30%
Panicum virgatum L.	Switchgrass	Poaceae	N		38	3	85				63			38					15						9.96%
Eragrostis spectabilis (Pursh) Steud.	Purple Lovegrass, Tumblegrass	Poaceae	N	0.5				15		85	3	15		63											7.47%
Chamaecrista fasciculata (Michx.) Greene var. fasciculata	**Common Partridge-pea**	**Fabaceae**	N	3	15	0.5			15				63		0.5	38			3						5.68%
Eupatorium serotinum Michx.	Late Thoroughwort	Asteraceae	N	15	3				15						63					38					5.52%
Cynodon dactylon (L.) Pers. var. dactylon	Bermuda Grass	Poaceae	I																	85					3.50%
Conyza canadensis (L.) Cronq. var. canadensis	Horseweed, Common Horseweed	Asteraceae	N	63																		15			3.21%
Lespedeza cuneata (Dum.-Cours.) G. Don	Sericea Lespedeza, Chinese Lespedeza	Fabaceae	I		3	3	3	0.5	0.5	3	3	15	15	0.5	3	3		15	3						2.90%
Rudbeckia hirta L.	**Black-eyed Susan**	**Asteraceae**	N	3	3			3	3	15	15	3	15									0.5			2.49%
Ulmus rubra Muhl.	Slippery Elm, Red Elm	Ulmaceae	N	38	3	3	3				3	3	0.5		3	3					0.5				2.47%
Andropogon gerardii Vitman	**Big Bluestem, Turkeyfoot**	**Poaceae**	N		15		15			15				3						3					2.10%
Strophostyles helvola (L.) Ell.	Beach Bean, Trailing Wild Bean, Amberique Bean	Fabaceae	N																	15					0.62%
Ampelopsis brevipedunculata (Maxim.) Trautv.	Porcelain-berry, Amur Peppervine	Vitaceae	I																	15					0.62%
Asclepias syriaca L.	**Common Milkweed**	**Apocynaceae**	N								15														0.62%
Ulmus alata Michx.	Winged Elm	Ulmaceae	N	15																					0.62%
Oxalis dillenii Jacquin	Southern Yellow Wood-sorrel	Oxalidaceae	N				0.5								0.5	3		0.5							0.19%
Desmodium glabellum (Michx.) DC.	Dillenius' Tick-trefoil	Fabaceae	N				0.5						3												0.14%
Schizachyrium scoparium (Michx.) Nash var. scoparium	**Little Bluestem**	**Poaceae**	N																			3			0.12%
Cynanchum laeve (Michx.) Pers.	Honeyvine, Sandvine	Apocynaceae	N																	3					0.12%
Persicaria pensylvanica (L.) M. Gomez	Pennsylvania Smartweed, Pinkweed	Polygonaceae	N																	3					0.12%
Andropogon virginicus L. var. virginicus	**Broomsedge, Broomstraw, Sedge Grass, Sage Grass**	**Poaceae**	I																	3					0.12%
Kummerowia striata (Thunb.) Schindl.	Japanese-clover	Fabaceae	I																		3				0.12%
Solanum carolinense L. var. carolinense	Horse-nettle, Carolina Horse-nettle	Solanaceae	N															3							0.12%
Setaria faberi Herrm.	Nodding Bristlegrass, Japanese Bristlegrass	Poaceae	I												3										0.12%
Bouteloua curtipendula (Michx.) Torr. var. curtipendula	**Side-oats Grama**	**Poaceae**	N									3													0.12%
Dichanthelium clandestinum (L.) Gould	**Deer-Tongue Grass**	**Poaceae**	N								3														0.12%
Ambrosia artemisiifolia L.	Common Ragweed	Asteraceae	N					3																	0.12%
Elymus virginicus L. var. virginicus	**Virginia Wild Rye**	**Poaceae**	N					3																	0.12%
Acalypha rhomboidea Raf.	Common Three-seeded Mercury, Common Copperleaf	Euphorbiaceae	N		0.5											0.5									0.04%
Echinochloa muricata (Beauv.) Fern. var. muricata	Rough Barnyard Grass	Poaceae	N											0.5											0.02%
Morus alba L.	White Mulberry	Moraceae	I				0.5																		0.02%
			Total Cover By Plot:	138	182	95	111	110	157	181	120	39.5	138	143	151	149	101	96.5	147	166	104	104			
			Bare Ground:																						0.00%

* N = Native; I = Introduced

Planted Species in Bold Type

Invasive Species in Red Type

How much does IVM cost?

- Year 1 – $25K (seeds, mowing, herbicide, seed drill application, IVM, adaptive management)
- Year 2 – $15K (spot application to control aggressive species and regenerating trees, some manual removal)
- Year 3 – ?

What are the benefits?

- Long-term savings in cost and O&M
  - **Establishment phase** = 1-3 years (most intensive)
  - **Maintenance phase** = 4-5 years
  - **Self-sustaining phase** = 5+ years – this is the period in which the initial costs are recouped and savings begin to be realized
- Protection of infrastructure
- Water quality/E&S benefits
- Stewardship and public relations/public perception
- Cutting edge science and management

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