Tough to Control Emergents

Today's focus: invasive grasses

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What emergent plant control sometimes feels like…

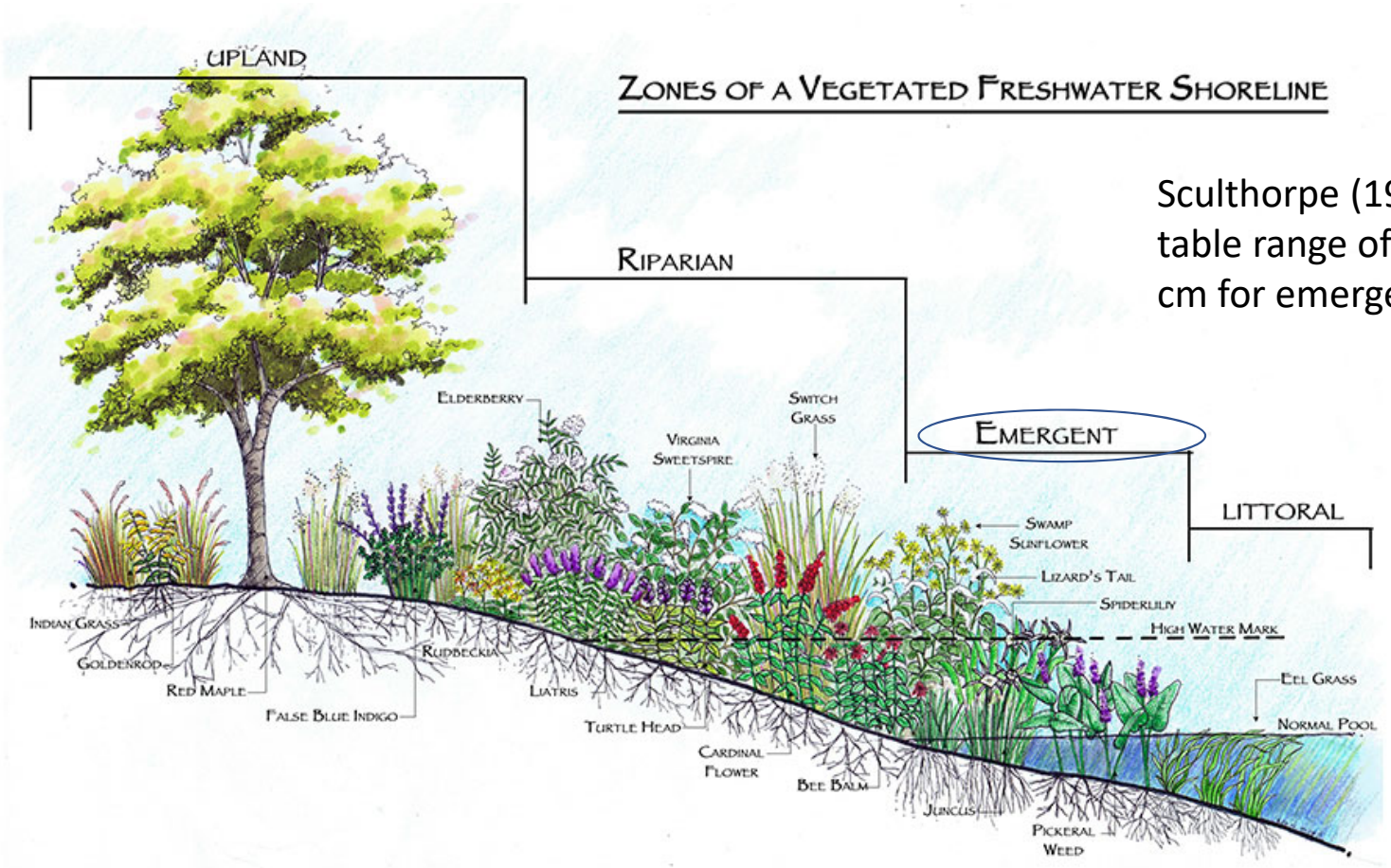
Common emergent problems of regional to national significance

- *Phragmites australis*
- *Panicum repens*
- *Phalaris arundinaceae*
- *Arundo donax*

- *Alternanthera philoxeroides*
- *Ludwigia* sp.
- *Lythrum salicaria*

- *Butomus umbellatus (Nov 4th webinar)*
- *Typha* sp.
- *Iris pseudacorus*

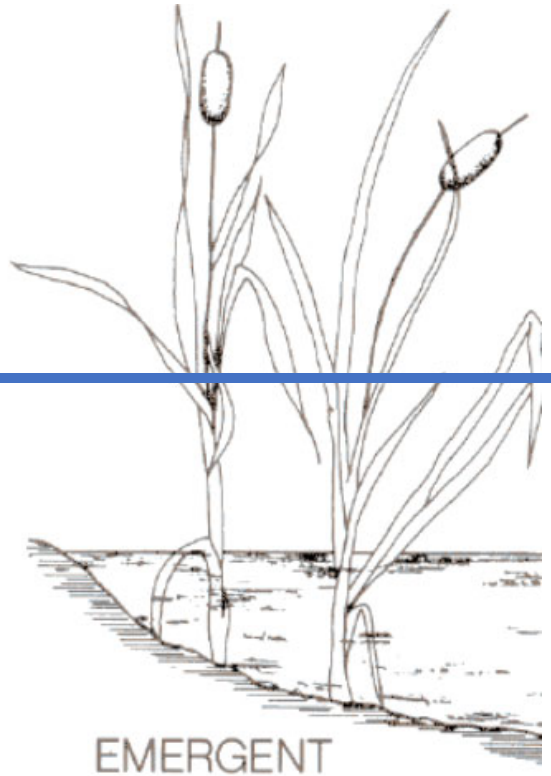
- Many local nuisance species (i.e., *Schoenoplectus, Pontederia, Nelumbo*)



Sculthorpe (1967): water table range of -50 cm to +150 cm for emergent hydrophytes

https://hgic.clemson.edu/factsheet/shorescaping-freshwater-shorelines/

Emergent features



- Possess leaves more similar to terrestrial plants

Tolerant of flooding, seasonal high water

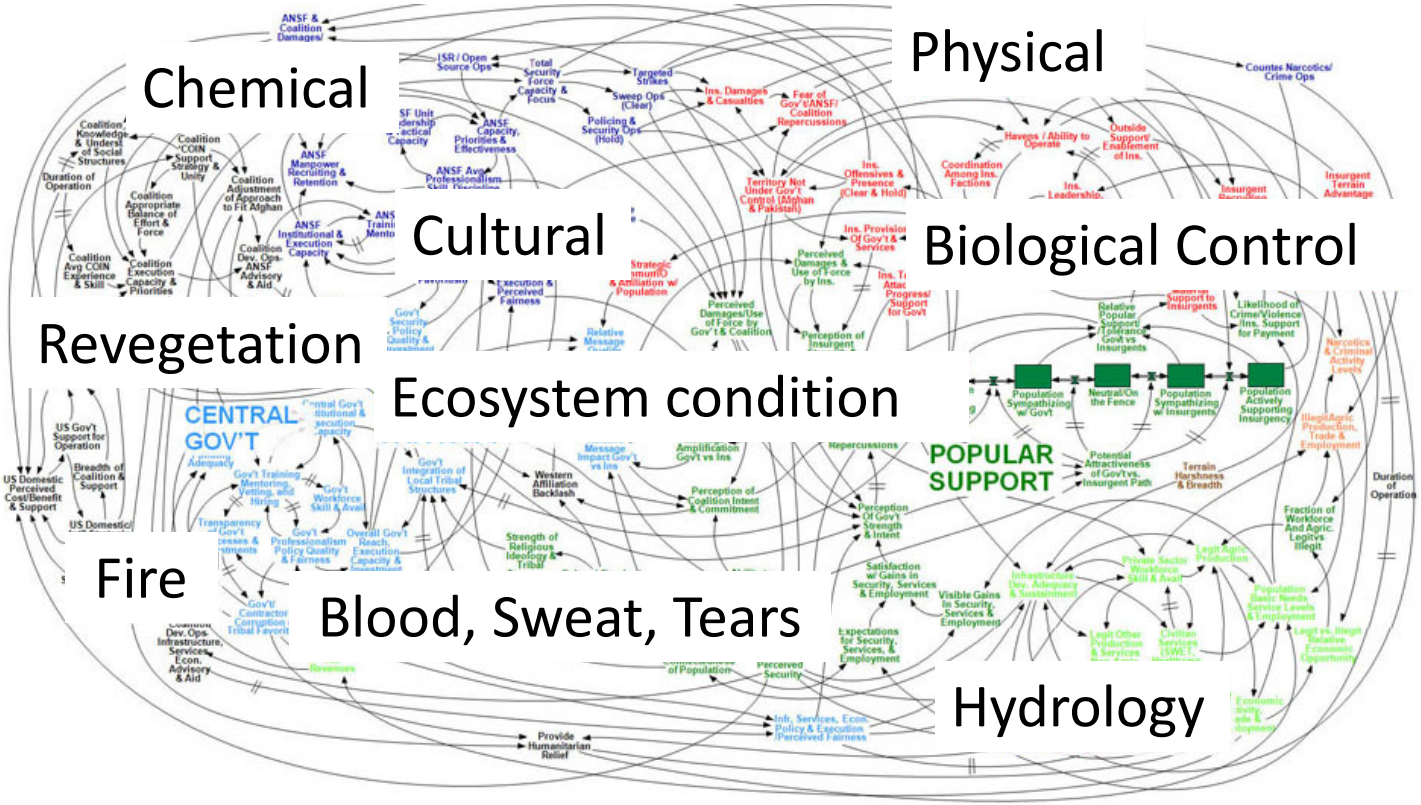
- Possess aerenchyma tissue for gas exchange

High degree of phenotypic plasticity is common

- Roots/tubers/rhizomes rooted in substrate

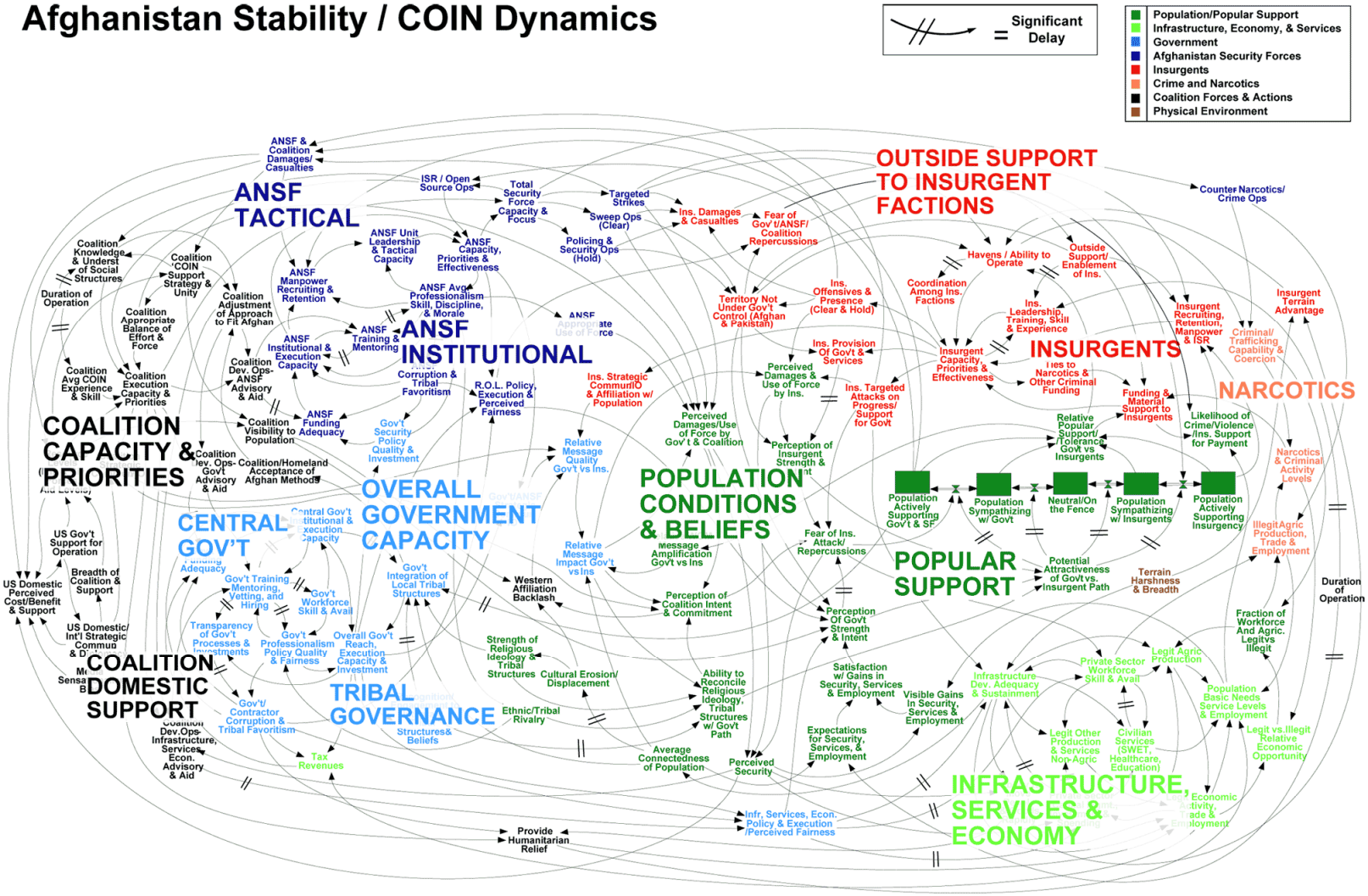
Tolerant of drier, seasonal low water conditions

Successful Model of Emergent Invasive Grass Management



Just Kidding…

Afghanistan Stability / COIN Dynamics



WORKING DRAFT – V3

Objectives

- Discuss important biological characteristics of reproduction and spread for troublesome emergents
- Relate these to management strategies
- Challenge us to think outside the box

- Note: this is not a comprehensive review of management for every scenario

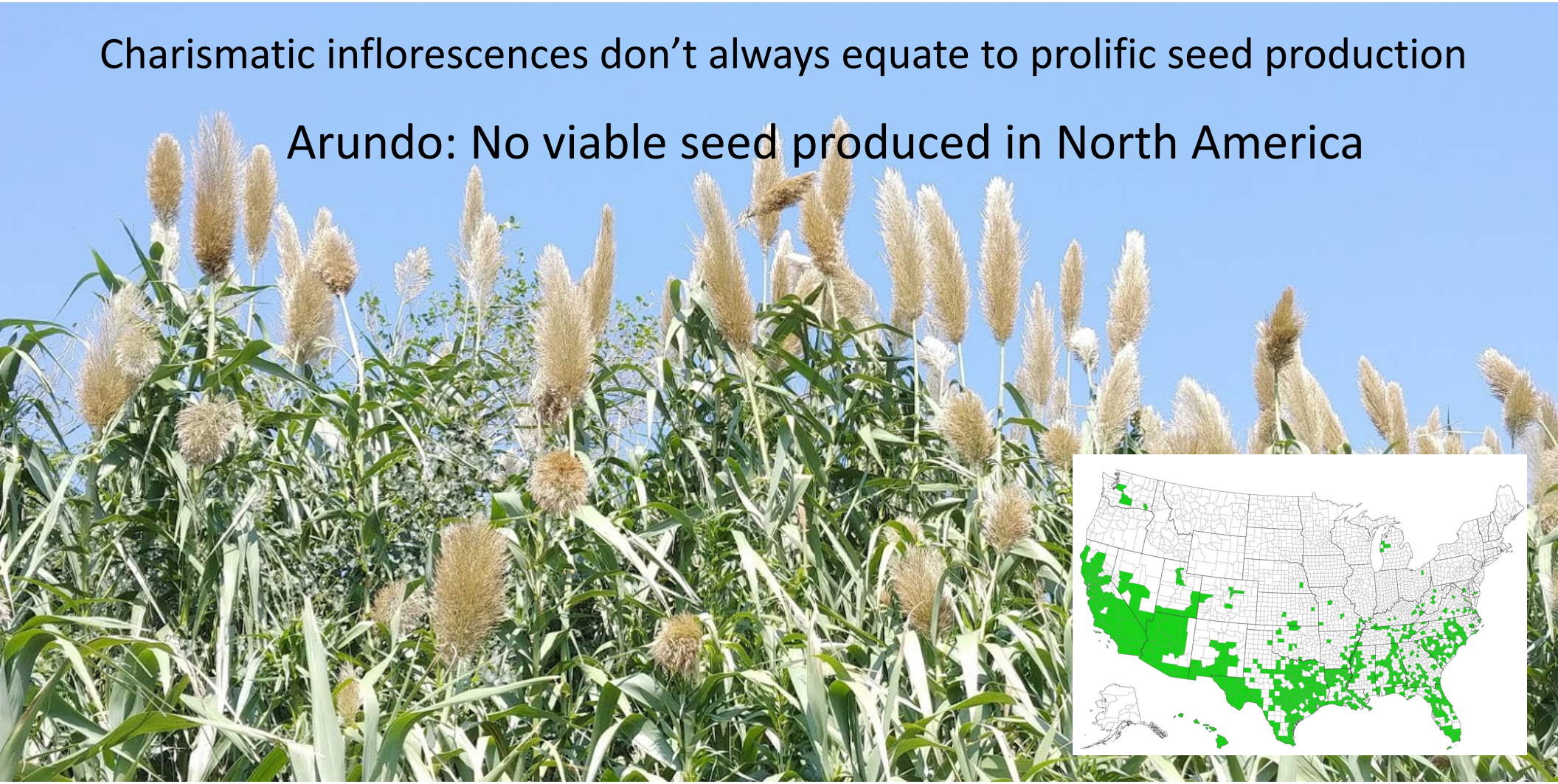
Emergents and Sexual Reproduction (Seed issues)

- Among invasive emergent grasses, seed production and viability are quite variable
- Seed banking varies tremendously
- Common for long distance dispersal by water, waterfowl and anthropogenic means
- There is as much variation in the published literature as there is in each species

Be careful in interpreting seed percentage data

Charismatic inflorescences don’t always equate to prolific seed production

Arundo: No viable seed produced in North America



Panicum repens: Seed viability appears to be extremely low

Phragmites australis: Seed production and viability are extremely variable across the US

Phalaris: Seed production and viability are abundant across the US

Do emergent invasive grass seeds successfully germinate and establish underwater?

Do soil residual herbicides kill dormant seeds?

- Answer: No
- Herbicides are absorbed through the coleoptile and radicle during germination and emergence

https://forages.oregonstate.edu/regrowth/how-does-grass-grow/developmental-phases/vegetative-phase/germination-and-seedling

Think about how seed production and viability are impacting your management strategies

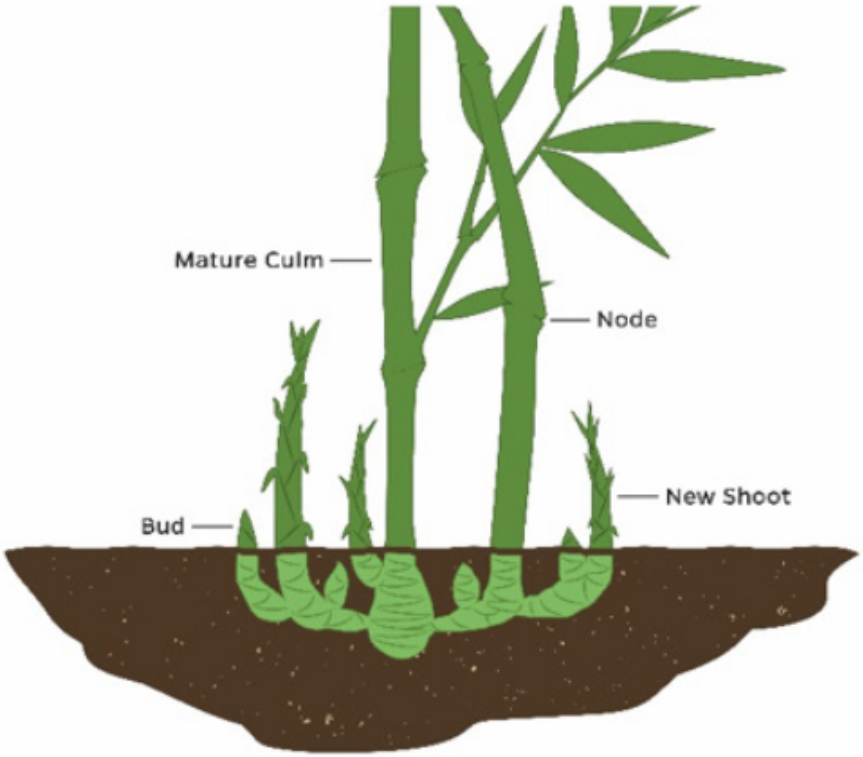
- If little to no seed production and viability:
  - Focus on asexual components, including prevention
- If high:
  - Avoid spreading seed- (avoid mowing or driving through patches)
  - Time treatments to prevent seed production
  - Time followup treatments to control new seedling flushes
  - Can hydrology be manipulated to prevent new seedling flushes?

Emergents and Asexual Reproduction (Rhizome/stolon issues)

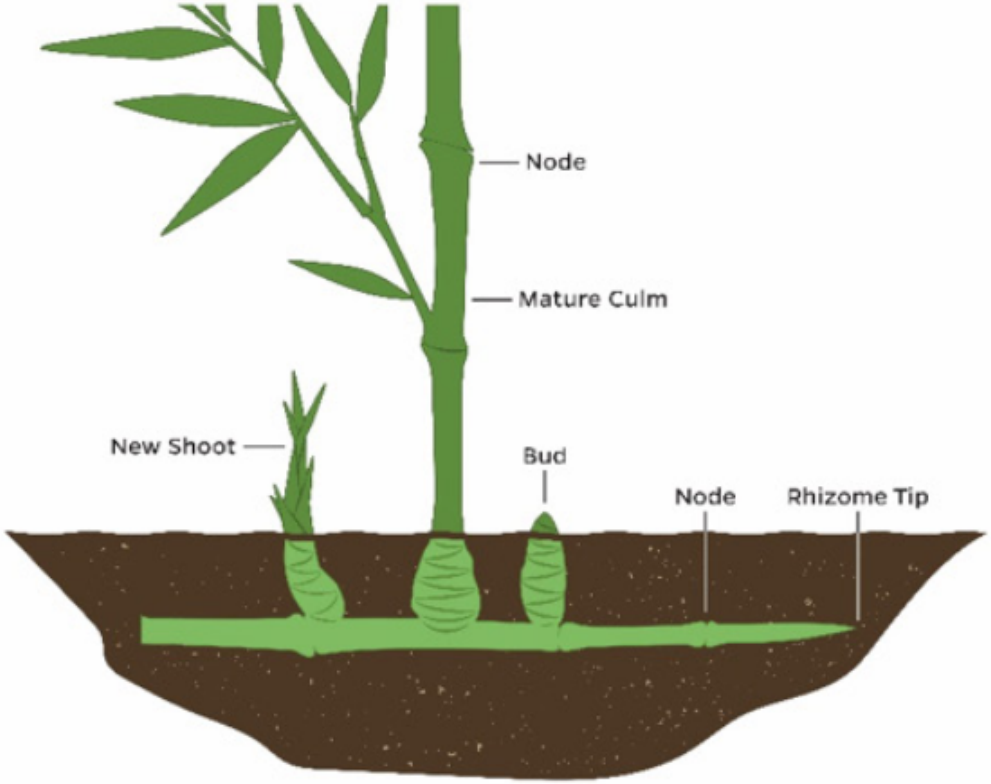
- Among invasive emergent grasses, rhizomes vary greatly in size, degree of spread
- Rhizome formation typically occurs early in the life cycle
- Natural and anthropogenic mediated dispersal by rhizome fragmentation is common
- Complete kill is often extremely difficult

What about asexual growth and spread?

Fig. 1. Rhizome structure of clumping and running bamboo. From Lieurance et al. 2018.



Pachymorphic type (sympodial growth)



Leptomorphic type (monopodial growth)

Clonal growth is local to a site. Grass rhizomes are NOT miles long (Prove me wrong)

Arundo: strong, short rhizomes

Phragmites: Strong running rhizomes and stolons

Panicum repens: Both types of rhizomes and stolons

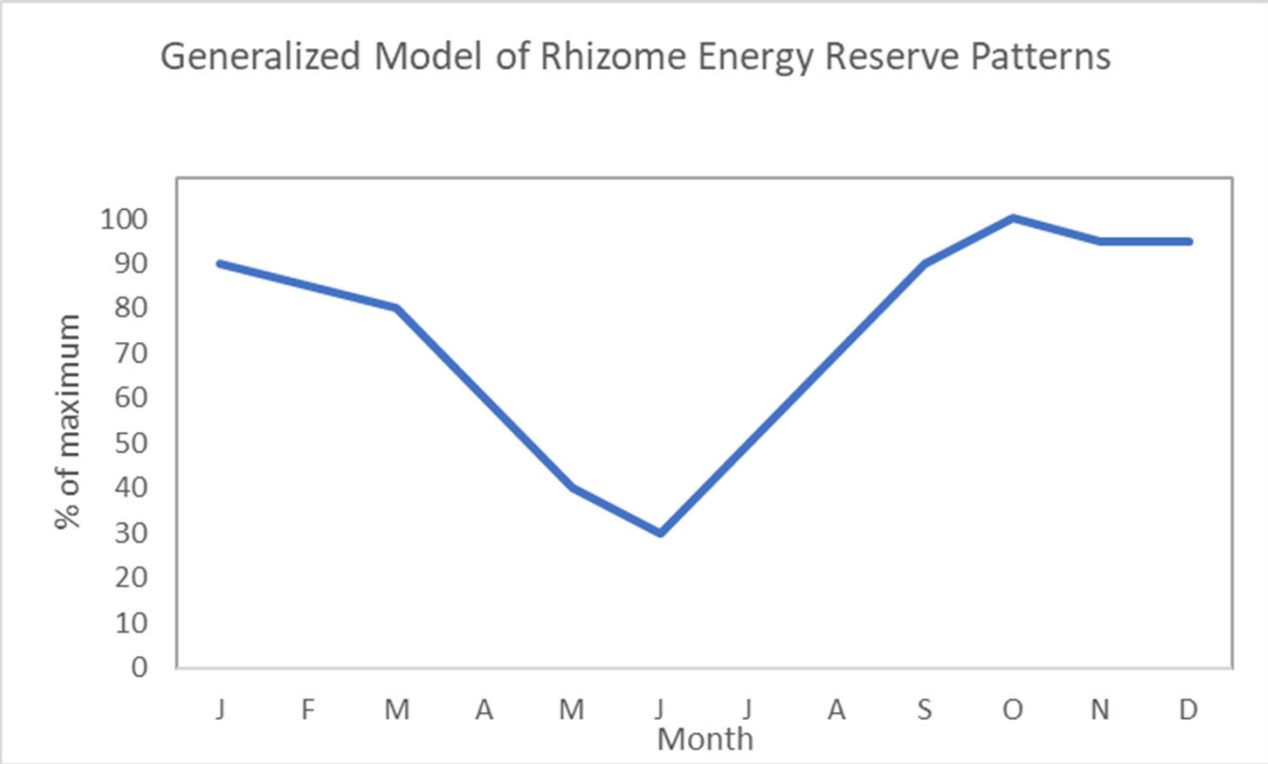
Phalaris: Short rhizomes

Just how deep do invasive grass rhizomes really go?

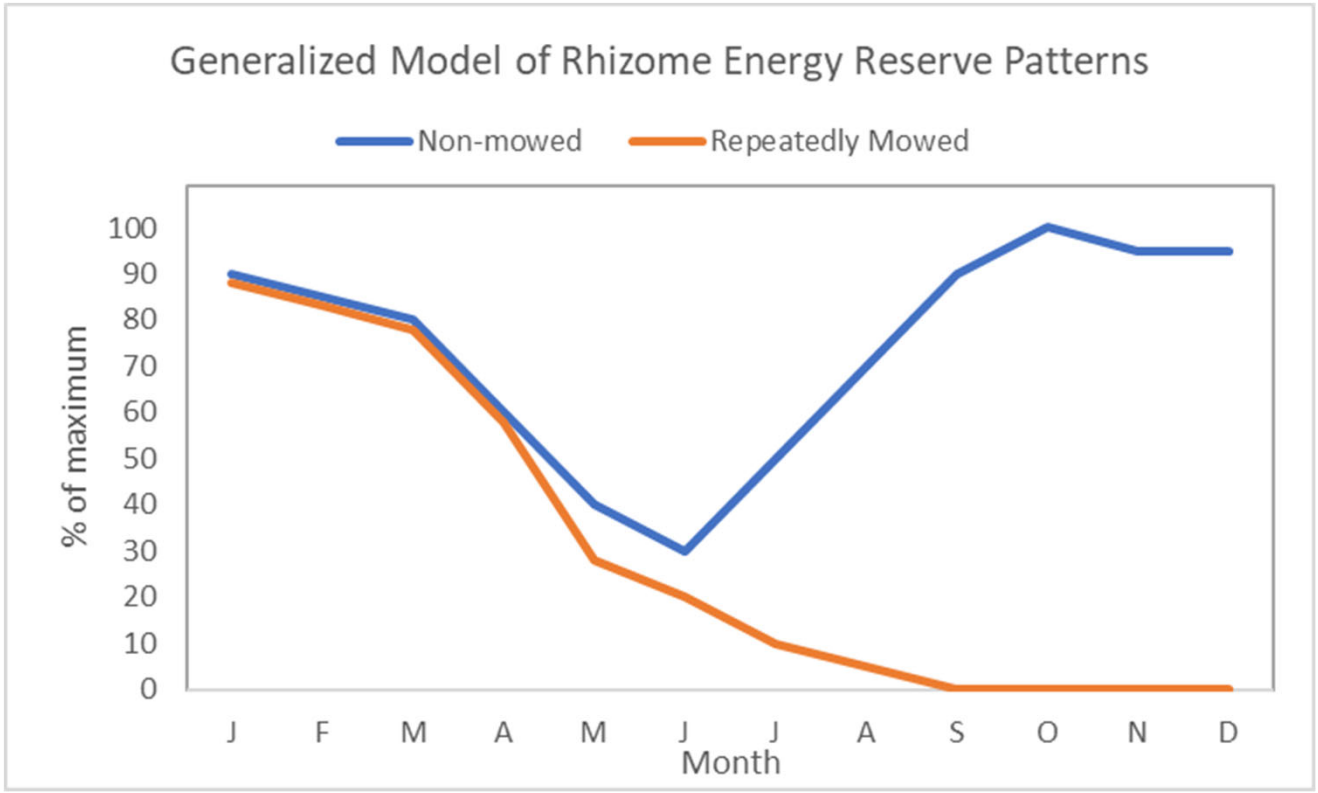
Yeah, not really…but wait…maybe

- This is a contentious topic
- Arundo, torpedograss and Phalaris are often relatively shallow (>30 cm) with the majority in the top 15 cm
- Phragmites has numerous reports of radically deep rhizome growth (>6 feet)
- Rhizomes can be deeply buried by heavy equipment, especially along roads
- Rhizomes can also be buried under sediments (alluvial deposition)
- Roots of all of these go MUCH deeper

Rhizome Energy Patterns



What About Rhizome Energy Depletion and Shoot Removal?



Question: Can physical shoot removal strategies (cutting, mowing grazing, burning) actually succeed?

Answer: how much time and money do you have?

Do herbicide treatments “deplete” rhizome energy reserves?

- This has NOT been well studied
- “Chemical mowing” used to suppress topgrowth
  - Prevent energy storage? NO. Chemical mowing can facilitate it!
- Following translocation, herbicides operate according to their mode of action to directly kill the living tissue
- Surviving rhizomes may still contain high levels of carbohydrates
- Sublethal herbicide quantities may temporarily inhibit rhizome sprouting and delay new shoot emergence

Do herbicides translocate differentially among rhizome types?

- Pachymorphic vs leptomorphic: Not well studied
- Phloem mobile herbicides move in a source to sink manner which is likely more important than rhizome type

Do herbicides translocate below the water line?

Do herbicides translocate below the water line?

- Anecdotally, poor control observed when treating in “deeper” water
- Recent mesocosm studies have demonstrated reduced control in flooded versus saturated conditions
- Radioisotope studies of many perennial weeds grown hydroponically indicate herbicide translocation to roots and rhizomes
- Mechanistic possibilities
  - Physiological: Is flooding a stressor that reduces allocation to roots/rhizomes?
  - Physical: anatomical issues?
  - Other possibilities?

The many hammers of integrated aquatic management (For tough to control emergent plants)

- **Preventative**
- **Grass carp** ☒
- **Classical Biocontrol**
- **Revegetation**

- **Aquatic dyes** ☒
- **Herbicides**

- **Nutrient management**

Expectation

Reality

- **Aeration** ☒
- **Benthic barriers** ☒
- **Dredging**
- **Drawdown**
- **Flooding**
- **Hand pulling**
- **Mechanical harvesting**
- **Prescribed fire**
- **Grazing**

Are herbivores the answer to invasive emergent grasses?

What about biocontrol?

- Progress on Arundo, lacking for other grasses

https://www.ibwc.gov/Files/CF_LRG_BIO_Control_Arundo_Donax_050819.pdf

What about prescribed fire?

What herbicides have some utility for emergent invasive grass control?

	General Efficacy	Soil Residual	Upland	Aquatic	Selective
Glyphosate	Good	No	Yes	Yes	No
Imazapyr	Excellent	Yes	Yes	Yes	No
Sethoxydim	Moderate	No	Yes	Yes (FL only)	Yes
Fluazifop	Moderate	No	Yes	No	Yes

What about triclopyr and imazamox for Phragmites control? It is listed on their labels.

- Both herbicides have some activity (True et al. 2010; Rapp 2012)
- Triclopyr has demonstrated some short-term visual control (3 MAT) of shoots
- Imazamox has demonstrated similar effects
  - Tank mixes with glyphosate or imazapyr have not yielded viable results

- Likely strong rate dependence for more consistent control
- Both need additional study to clarify efficacy and prospective use patterns

Herbicides Rates and Concentrations (Product Examples)

Active	Product Example	Broadcast Rate	Spot Treatment % v/v	Max label Rate
Glyphosate	Roundup Custom	96-120 oz/A	1.5%	120 oz/A
Imazapyr	Polaris	32-96 oz/A	0.5-1.5%	96 oz/A
Sethoxydim	TIGR	40 oz/A	3-5%	40 oz/A
Fluazifop	Fusilade II	24 oz/A	0.5%	24 oz/A

Application timing(s) for herbicides with foliar activity

- Apply to actively growing grasses
  - Affected by dry/drought situations, cold snaps and frost
  - Affected by seasonality of growth
- Late spring through early fall is generally acceptable when optimal timings cannot be achieved
  - Anything delaying the onset of new growth in the spring can push this back
  - Optimal timings often late summer into early fall
- Water depths can influence herbicide efficacy (Prince et al. 2020)

Bottom line: Late fall through early spring often a poor treatment timing

Are Application Volumes Important?

- Broadcast (aerial, tractor mounted boom sprayers)
  - 20 GPA is AMPLE coverage
- Backpack (single adjustable cone nozzle)
  - 30-60 GPA is common
  - Tendency is to over apply
- High volume handgun sprayers
  - 80-100+ GPA
  - This is “spray to runoff”

Lower volume = high herbicide concentration in the droplet = better

Rainfastness and Adjuvants

- 1-4 hours for foliar treatments to be rainfast
  - Adjuvants can help
- Non-ionic surfactants
- Methylated seed oils
- D-limonene based
- Blends
- Defoamers, spray indicators, water conditioning agents also useful

Water quality issues

- Hard water can reduce glyphosate efficacy
  - Water conditioning agents can overcome
    - Ammonium sulfate
- Turbidity
  - Glyphosate is strongly bound to suspended soil and organic matter in water

Is Eradication Feasible?

- Local Patches: Yes
- Large landscapes: not likely

Beyond small patches, is successful management feasible?

Estuaries and Coasts (2013) 36:626–632
DOI 10.1007/s12237-013-9593-4

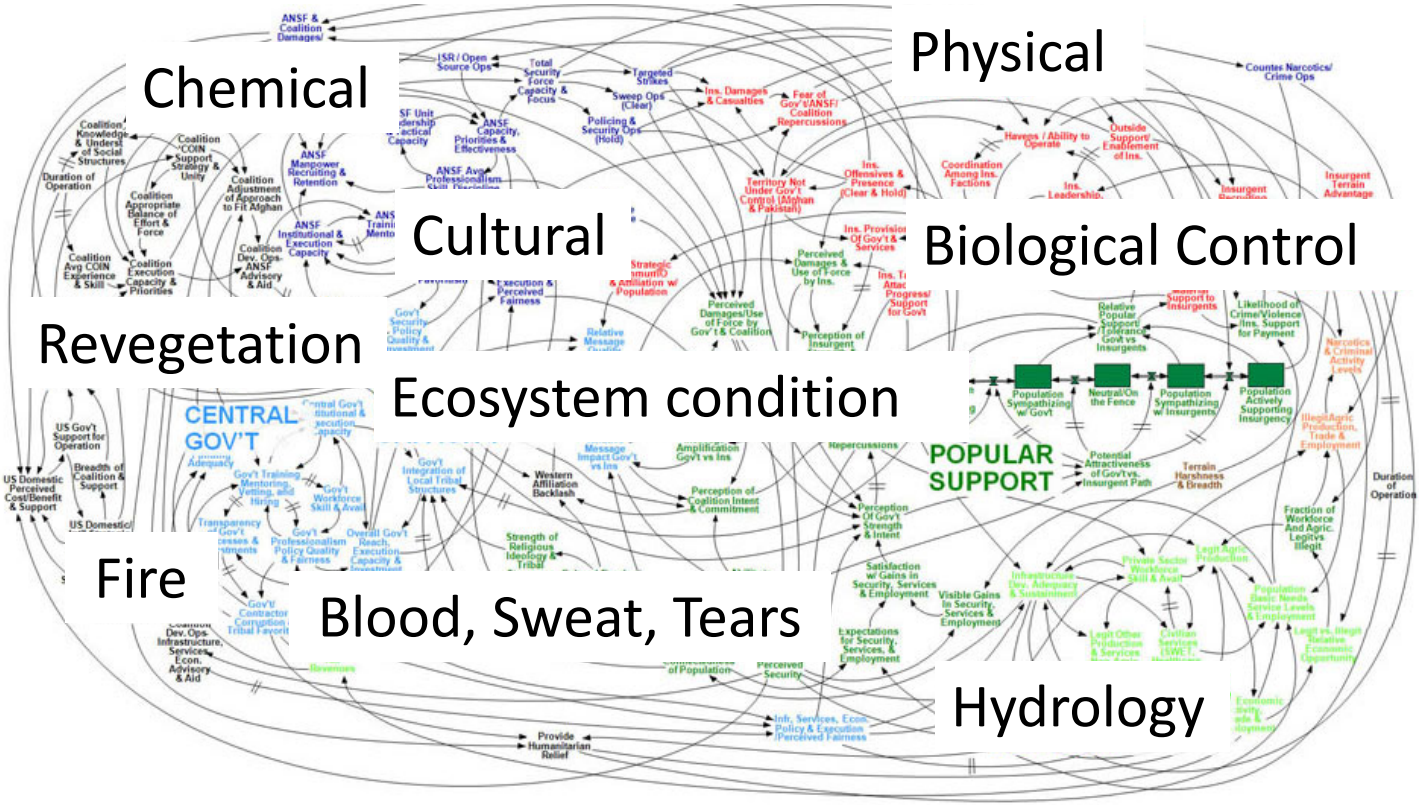
NOTE

The Runaway Weed: Costs and Failures of *Phragmites australis* Management in the USA

Laura J. Martin · Bernd Blossey

Abstract. While public funding of invasive species management has increased substantially in the past decade, there have been few cross-institutional assessments of management programs. We assessed management of Phragmites australis, a problematic invader of coastal habitats, through a cross institutional economic survey of 285 land managers from US public and private conservation organizations. We found that from 2005 to 2009, these organizations spent >$4.6 million per year on P. australis management, and that 94 % used herbicide to treat a total area of ~80,000 ha. Despite these high expenditures, few organizations accomplished their management objectives. There was no relationship between resources invested in management and management success, and those organizations that endorsed a particular objective were no more likely to achieve it. Our results question the efficacy of current P. australis management strategies and call for future monitoring of biological management outcomes.

Successful Model of Emergent Invasive Grass Management



Just Kidding…maybe not

Questions?

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http://plants.ifas.ufl.edu