Ecology Impacts and Genetic Variability Research for Invasive Weeds

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Invasive Weed Research

- Characteristics that Contribute to Ecological Impacts
- Ecological Range Studies
- Genetic Variability

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Ecological Impacts of Invasive Weeds are Directly Related to Biological and Ecological Characteristics

- Reproduction
- Dispersal
- Habitat
- Inter-specific interactions
- Phenology
- Physiology
- Protection from Herbivores
- Tolerance to Environmental Stress

(Bryson & Carter. 2004. Weed Technol. 18:1216-1220.)

Ecological Impacts of Invasive Weeds

Reproduction

- Copious seed
- Profuse vegetative reproduction / fragmentation
- Self-compatible
- Cross pollinated - wind pollinated
- Unspecific pollinators
- Seed production under adverse conditions
- Seed size similar to crop or native plants
- Small inconspicuous flowers

Deeprooted Sedge (*Cyperus entrerianus* Boeckl.)

- Spreading at an alarming rate in SE U.S.
- Native to temperate South America
- Perennial
- Up to 1 billion seed/ha
- Currently in 65 counties in 6 states
- Several herbicides effective
- Mowing prevents seed head production
- $\geq$ 95% winter survival at Lat 33^{o}
- Threat to Natural & Agricultural Areas

(Bryson & Carter)

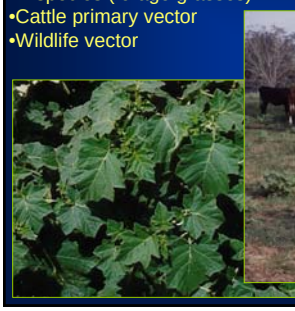
Ecological Impacts of Invasive Weeds

Dispersal

- **Multiple vectors**
- **Short- and Long-range mechanisms**
- **Structural modifications**

Tropical Soda Apple (Solanum viarum Dunal)

- Since 1988 spread to ca. 1 million ha in SE U.S.
- Displaced native and agriculturally important species (forage grasses)
- Cattle primary vector
- Wildlife vector



(Bryson)

Yellow Unicorn-Plant [*Ibicella lutea* (Lindl.) Van Eselt.]

- Nothing known about its life history in SE U.S.
- Non-native invasive from Brazil
- In CA for >70 yrs now spreading in SE
- Detected in Bt Corn and GR Cotton
- Unique dispersal mechanism
- Annual
- Plants up to 5 m wide
- 200 seed pods/season and ≥110 seed/pod
- Seed extended dormancy & discontinuous germination



(Bryson)

Ecological Impacts of Invasive Weeds

Habitat

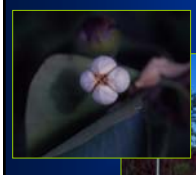
- **Ability to invade new habitats**
- **Germination and survival in a wide range of habitats**

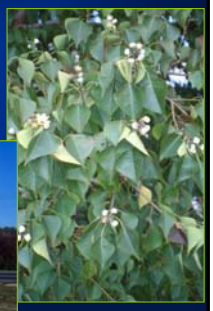
Japanese Honeysuckle (*Lonicera japonica* Thunb.)

- Ability to invade a wide array of habitats
- Thrives in full sun to heavy shade
- Displaces native plants
- Wildlife food

Chinese Tallow [*Triadica sebifera* (L.) Small]

- Invades disturbed and undisturbed sites
- Displaces shrub layer in bottomland hardwood forests
- Ornamental gone BAD!
- Prized by beekeepers
- Birds disseminated seed





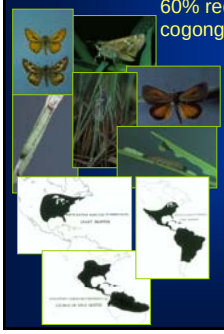
Ecological Impacts of Invasive Weeds

Inter-specific interactions

- **Parasitize other plants**
- **Shade other vegetation**
- **Alternate host for insect and pathogen pests of crops**
- **Resistance to pathogens**
- **Utilize all available moisture**

Cogongrass

Discovered 3 skipper butterfly larvae feed on Cogongrass
60% reduction of cogongrass foliage

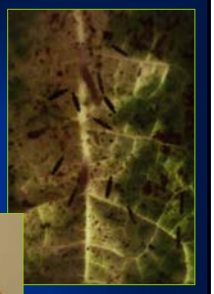


Problem:
All feed on crop and/or ornamentals (i.e. corn, sorghum, St. Augustine, bermudagrass, and many other native and non-native grasses)

(Bryson)

Tropical Soda Apple

- Suckfly (*Tupiocoris* sp.: Heteroptera)
- Vector pathogens
- 400 to 800 adults & nymphs / plant
- Late fall
- Leaf chlorosis & abscission
- TSA fruit/seed production reduced
- Pest of Tomato, Potato, Pepper, etc.



(Usnick & Bryson)

Ecological Impacts of Invasive Weeds

Phenology

- **Early maturation**
- **Extended seed dormancy**
- **Discontinuous germination**
- **Long life of propagules (in soil or during dispersal)**
- **Multiple generations annually**
- **Photoperiodic flowering**
- **Rapid growth**
- **Short juvenile period**

Bloodscale Sedge (*Cyperus sanguinolentus* Vahl)

- Potential threatened and endangered species (*Cyperus louisianensis* Thieret)? No!!!!
- Non-native species from Asia
- Life cycle differs from other annual sedges of Asian origin
- Photoperiodic - flowers and fruits late in fall (late Sept to frost)
- Thus, may not become a major weed problem in SE U.S.

(Bryson & Carter)

Ecological Impacts of Invasive Weeds

Physiology

- **Accumulation of large food reserves (roots, rhizomes, etc.)**
- **High photosynthetic rate (C_4 photosynthesis)**
- **Increased water efficiency (C_4 photosynthesis)**
- **Production of phytotoxins to prohibit or suppress growth (allelopathy)**

Cogongrass [*Imperata cylindrica* (L.) Beauv.]

- Rhizomes produce Phytotoxic compounds (Allelopathy)
- Reduces germination and growth of other grasses & broadleaf plants

(Koger &Bryson)

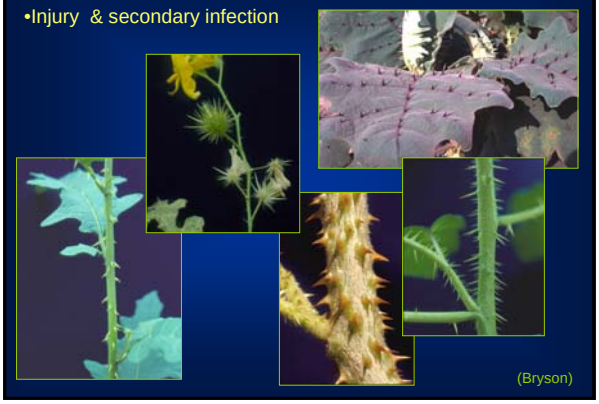
Ecological Impacts of Invasive Weeds

Protection from Herbivores

- **Production of toxic secondary compounds that deter herbivores**
- **Structural modifications that cause injury or repel animals or herbivores (**Thorns, Prickles, Spines, Urticating hairs, etc.)

Prickly Nightshades (*Solanum* spp.)

- Injury & secondary infection



(Bryson)

Ecological Impacts of Invasive Weeds

Tolerance to Environmental Stress

- **Germination and growth through harsh environmental zones**
- **Survive environmental and chemical extremes (fire, salinity, soil disturbance, heavy metals, herbicides, etc.)**

Cogongrass

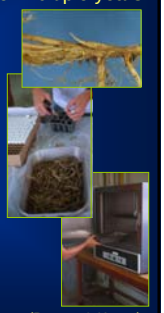
- Aggressive perennial
- Forms monocultures
- Alters fire regimes
- Displaces native species

Cogongrass

- Need for more economical control methods
- >$150/ha for multiple herbicide applications over multiple years

Heat treatment to kill rhizomes?

	Time of exposure (Min.)										
	0.5	1	1.5	2	2.5	5	10	15	20	25	30
Temp (C)	Control (%)										
52	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	97	98	99	100	100
79	0	0	0	0	50	100	100	100	100	100	100
93	0	0	0	0	100	100	100	100	100	100	100
107	0	0	0	68	100	100	100	100	100	100	100
121	0	0	13	99	100	100	100	100	100	100	100
149	0	41	99	100	100	100	100	100	100	100	100
177	0	42	99	100	100	100	100	100	100	100	100
187	0	100	100	100	100	100	100	100	100	100	100



(Bryson & Koger)

Invasive Weed Research

•Characteristics that Contribute to Ecological Impacts

•Ecological Range Studies

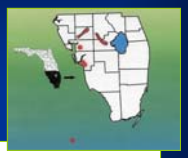
•Genetic Variability

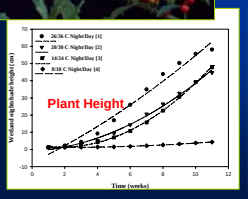
Ecological Range Studies

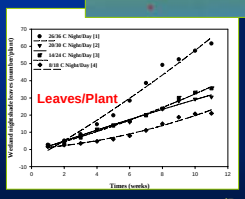
Used to Predict:
•Environmental / climatic requirements
•Reproductive potential
•Spread and establishment rates

Wetland Nightshade (*Solanum tampacense* Dunal)

Survive & reproduce at night/day temps ≥ 14/24 C







(Bryson & Fox)

Wetland Nightshade

Plants overwintering above water level
•33% survived - 6 winters
•New shoots from base of plants

Plants overwintering submerged
•80 and 100% survived - 2 winters
•Leaves from submerged stems and when water temp was ≥19 C

Conclusion: Winter survival adequate for additional spread in SE U.S. (to Lat 33º)

(Bryson & Fox)

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Genetic Variability

Determine:
- **•Diversity within and among populations**
- **•Source and number of introductions**
- **•Dispersal rate**
- **•Track herbicide-resistance**
- **•Search for host-specific biological control agents**
- **•Life events (i.e. photoperiodic, seed production….)**

Tropical Soda Apple

DNA fingerprinting
31 U.S. populations from 6 states (110 plants)
4 Brazil populations (22 plants)

No morphological differences – all populations

Two haplotypes detected (differed by 2 bases for a total of 0.38% sequence divergence)

•All U.S. populations same

•3 of 4 populations (17 of 22 plants) from Brazil same as U.S.

(Kreiser, Bryson, & Usnick)

Common Cocklebur (*Xanthium strumarium* L.)

Genetic alteration – Multi-seeded genotype from Texas

Typical – two embryo / fruit

Selection – up to 16 embryo / fruit

(Abbas – USDA-ARS, Stoneville)

Invasive Weeds Research Needs:

•Basic Biological and Ecological Processes
•Potential Ecological Range
•Vectors for Spread
•Genetic Diversity
•New Control Strategies
•Host-Specific Biological Control Agents