Classical Biological Control of U.S. Weeds by Foreign Plant Pathogens

(Successes, Prospects, and Barriers …)

William L. Bruckart III
USDA, ARS
Foreign Disease-Weed Sci. Res. Unit
Ft. Detrick, MD

Beneficial Plant Pathogens for Classical Biological Control of U.S. Weeds

(Successes, Limitations, and Challenges…)

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Focal Points for "Now"

- People
- Facilities
- Information
- Communication
- Support

1981

Biological control of weeds coming into own.

- *Entyloma compositarum*
  vs. *Ageratina riparia* (Trujillo, 1975)

- *Puccinia chondrillina*
  vs. *Chondrilla juncea* (Emge, 1976)

- *Colletotrichum gloeosporioides* f.sp. *aeschynomene* (Cga) near registration (1982) as first fungal active ingredient in the mycoherbicide "Collego" for biological control of Northern jointvetch (NJV)

Successes - Plant pathogens in the U. S. The 80s

- *Colletotrichum gloeosporioides* f. sp. *clidemiae*
  vs. *Clidemia hirta* (Trujillo, 1986)
- *Puccinia carduorum*
  vs. *Carduus nutans* (Bruckart, 1987)

Successes - Plant pathogens in the U. S. The 90s, and into the 21st Century

- *Septoria passiflorae*

  vs. *Passiflora taminiana* (Trujillo, 1993)
- *Colletotrichum gloeosporioides* f. sp. *miconiae*

  vs. *Miconia calvescens* (Killgore, 1997)
- *Puccinia jaceae* var. *solstitialis*

  vs. *Centaurea solstitialis* (Bruckart, 2003).

1981

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** **I got a job with USDA, ARS, PDRL** **

- Biological control of weeds by foreign plant pathogens
- (= Success and Prospects …)

People, Then

The Players (U.S.):

R. S. Emge (USDA, ARS)

W. L. Bruckart (USDA, ARS)

D. K. Berner (USDA, ARS)

E. E. Trujillo (Univ. Hawaii)

E. M. Killgore (HI Dept. Agr.)

D. Gardner (Nat'l Park Serv., HI)

C. S. Hodges (ARS, FS; Hawaii)

R. Charudattan (Univ. FL)

A. J. Caesar (USDA, ARS)

J. F. Shearer (USACE)

M. B. Rayamajhi (USDA, ARS)

D. C. Sands (Mont. St. Univ.)

T. L. Widmer (USDA, ARS)

The Players (Canadian):

A. K. Watson (McGill Univ.)

K. Mortensen (Agr. Can.)

S. F. Shamoun (Forestry Can.)

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People

- Necessary to get the job done.
- A limiting factor, currently?
- Don’t forget about
  - Overseas cooperators,
  - Botanists, and
  - Ecologists

1981

** I got a job with USDA, ARS, PDRL **

- Biological control of weeds by foreign plant pathogens

Containment Facility at Ft. Detrick

- Sealed, air-conditioned, strictly microbial
- Enables study of foreign candidate biological control agents.

Bldg. 374, Ft. Detrick, MD

The Containment Greenhouse Facility

Microbial Containment Facilities for Weed BC

University of Florida (Charudattan)

Hawaii Department of Agriculture (Killgore)

Montana State University (Sands)

USDA, ARS, IPRL, Ft. Lauderdale, FL (Rayamajhi)

USDA, ARS, FDWSRU, Ft. Detrick, MD (Bruckart)

McGill Univ., St. Anne de Bellevue, Canada (Watson)

Containment Facilities

- Necessary for success
- A limiting factor?

Information
Awareness of Problem

- Pest Plant Information
  - Weeds
  - Invasives
  - Plant Pathogens and Insects
- Needed for:
  - Research focus
  - Support
- Greatly facilitated by:
  - The Internet
  - Molecular tools

Federal Noxious Weed List (as of May 1, 2010)

http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist-2010doc.pdf

Terrestrial

- *Ageratina adenophora (crofton weed)*
- *Alternanthera sessilis (sessile joyweed)*
- *Asphodelus fistulosus (onionweed)*
- *Avena sterilis (animated oat, wild oat)*
- *Carthamus oxyacantha (wild safflower)*
- *Chrysopogon aciculatus (pilipiliula)*
- *Commelina benghalensis (Benghal dayflower)*
- *Crupina vulgaris (common crupina)*
- *Digitaria scalarum (African couchgrass),*
- *D. velutina (annual conchgrass)*
- *Drymaria arenarioides (lightning weed)*
- *Emex australis (three-cornered jack), E. spinosa (devil's thorn)*
- *Galega officinalis (goatsrue)*
- *Heracleum mantegazzianum (giant hogweed)*
- *Homeria spp.*
- *Imperata brasiliensis (Brazilian satintail),*
- *I. cylindrica Raeuschel (cogongrass)*
- *Ischaemum rugosum (murainograss)*
- *Leptochloa chinensis (Asian sprangletop)*
- *Lycium ferocissimum (African boxthorn),*
- *L. flexuosum (Maidenhair Creeper)*
- *Lygodium microphyllum (Old world climbing fern)*
- *Melastoma malabathricum*
- *Mikania cordata (mile-a-minute), M. micrantha*
- *Mimosa invisa (giant sensitive plant),*
- *M. pigra* var. *pigra (catclaw mimosa)*
- *Nassella trichotoma (serrated tussock)*
- *Opuntia aurantiaca (jointed prickly pear)*
- *Oryza longistaminata, O. punctata, O. rufipogon (red rice)*
- *Paspalum scrobiculatum (Kodo-millet)*
- *Pennisetum* (4 species)
- *Prosopis* (25 species)
- *Rottboellia cochinchinensis*
- *Rubus fruticosus* Aggregate *(wild blackberry)*
- *Rubus moluccanus (wild raspberry)*
- *Saccharum spontaneum (wild sugarcane)*
- *Salsola vermiculata (wormleaf salsola)*
- *Senecio inaequidens (South African ragwort)*
- *Senecio madagascariensis (Madagascar ragwort)*
- *Setaria pallide-fusca (cattail grass)*
- *Solanum torvum (turkeyberry)*
- *Solanum viarum (tropical soda apple)*
- *Spermacoce alata*
- *Tridax procumbens (coat buttons)*
- *Urochloa panicoides (liverseed grass)*

Invasive Species

National Invasive Species Information Center (http://www.invasivespeciesinfo.gov/plants/main.shtml)

Air Potato (*Dioscorea bulbifera)*
Autumn Olive (*Elaeagnus umbellata*)
Beach Vitex (*Vitex rotundifolia*)
Brazilian Peppertree (*Schinus terebinthifolius*)
Canada Thistle (*Cirsium arvense*)
Chinese Tallow (*Triadica sebifera*)
Cogongrass (*Imperata cylindrica*)
Common Teasel (*Dipsacus fullonum*)
Dalmatian Toadflax (*Linaria dalmatica*)
Diffuse Knapweed (*Centaurea diffusa*)
Downy Brome (*Bromus tectorum*)
Fig Buttercup (*Ranunculus ficaria*)
Garlic Mustard (*Alliaria petiolata*)
Giant Hogweed (*Heracleum mantegazzianum*)
Hairy Whitetop (*Lepidium appelianum*)
Houndstongue (*Cynoglossum officinale*)
Japanese Climbing Fern (*Lygodium japonicum*)
Japanese Honeysuckle (*Lonicera japonica*)
Japanese Knotweed (*Fallopia japonica*)
Japanese Spiraea (*Spiraea japonica*)
Japanese Stilt Grass (*Microstegium vimineum*)
Johnsongrass (*Sorghum halepense*)
Kudzu (*Pueraria montana* var. *lobata*)
Leafy Spurge (*Euphorbia esula*)
Medusahead (*Taeniatherum caput-medusae*)
Mile-A-Minute Weed (*Persicaria perfoliata*)
Multiflora Rose (*Rosa multiflora*)
Musk Thistle (*Carduus nutans*)
Old World Climbing Fern (*Lygodium microphyllum*)
Oriental Bittersweet (*Celastrus orbiculatus*)
Princess Tree (*Paulownia tomentosa*)
Purple Star Thistle (*Centaurea calcitrapa*)
Quackgrass (*Elymus repens*)
Russian Knapweed (*Rhaponticum repens*)
Russian Olive (*Elaeagnus angustifolia*)
Saltcedar (*Tamarix* spp.)
St. Johnswort (*Hypericum perforatum*)
Scotch Broom (*Cytisus scoparius*)
Scotch Thistle (*Onopordum acanthium*)
Spotted Knapweed (*Centaurea stoebe*)
Tree-of-Heaven (*Ailanthus altissima*)
Tropical Soda Apple (*Solanum viarum*)
Whitetop (*Lepidium draba*)
Witchweed (*Striga asiatica*
Yellow Star Thistle (*Centaurea solstitialis*)
Yellow Toadflax (*Linaria vulgaris*)

Pest Plant Information

- Lists are large; many “very important” species
- Becomes a challenge for focus; diffusion of effort?
- Limited understanding of:
  - Botany,
  - Taxonomy,
  - Distribution,
  - Ecology, and
  - Community effects

Native range,
Pest locations

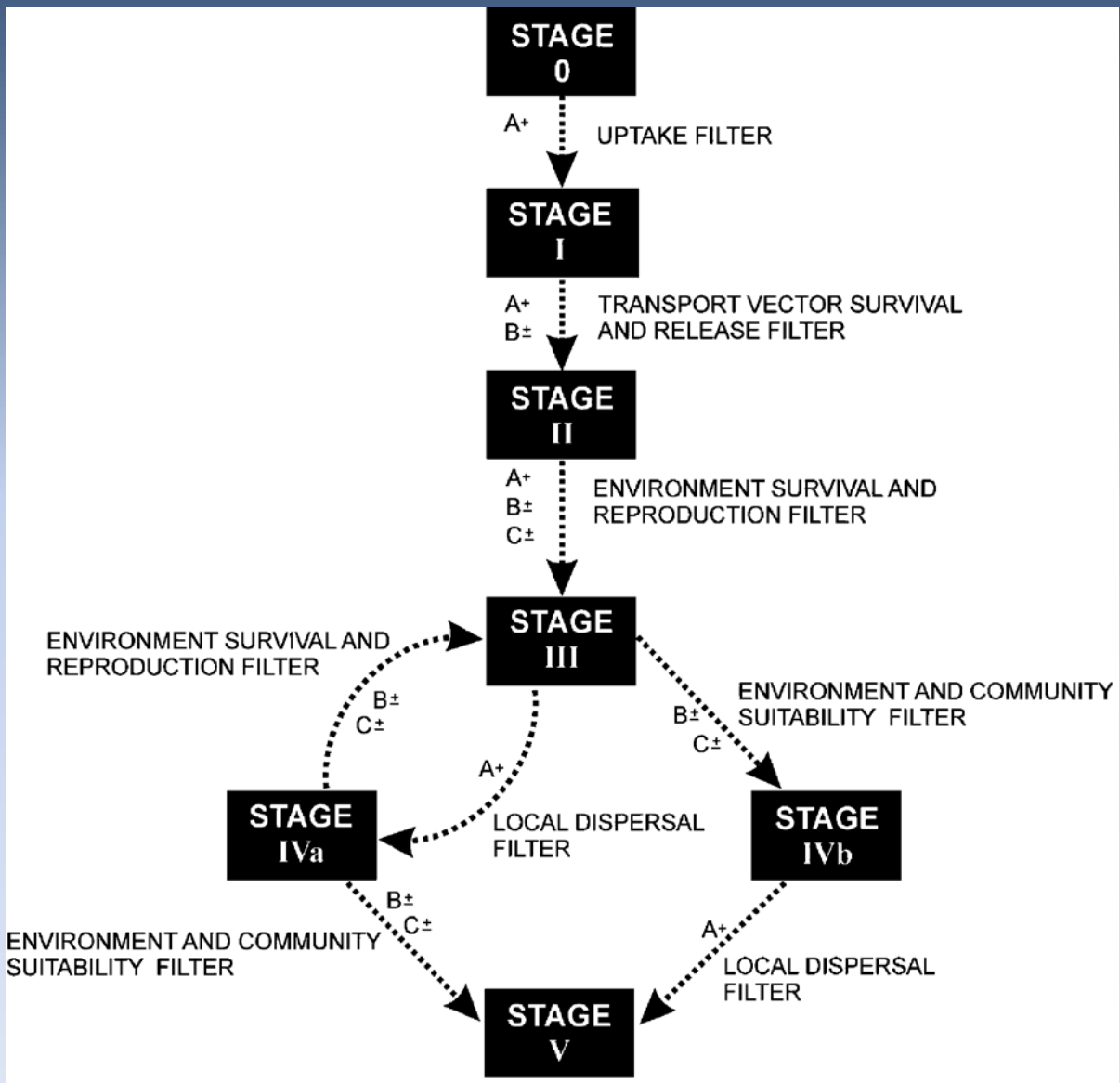
Ecological Information

Colautti, R. I. and MacIsaac, H. J. 2004. **A neutral terminology to define 'invasive' species.** *Diversity and Distributions* 10: 135 – 141.

Determinants affecting probability an invader may pass through a filter:

(A) propagule pressure;
(B) physicochemical require'ts of the invader;
(C) community interactions.

Determinants may positively (+) or negatively (–) affect the number of propagules that successfully pass through each filter.



Colautti, R. I. and MacIsaac, H. J. 2004. **A neutral terminology to define 'invasive' species.** *Diversity and Distributions* 10: 135 – 141.

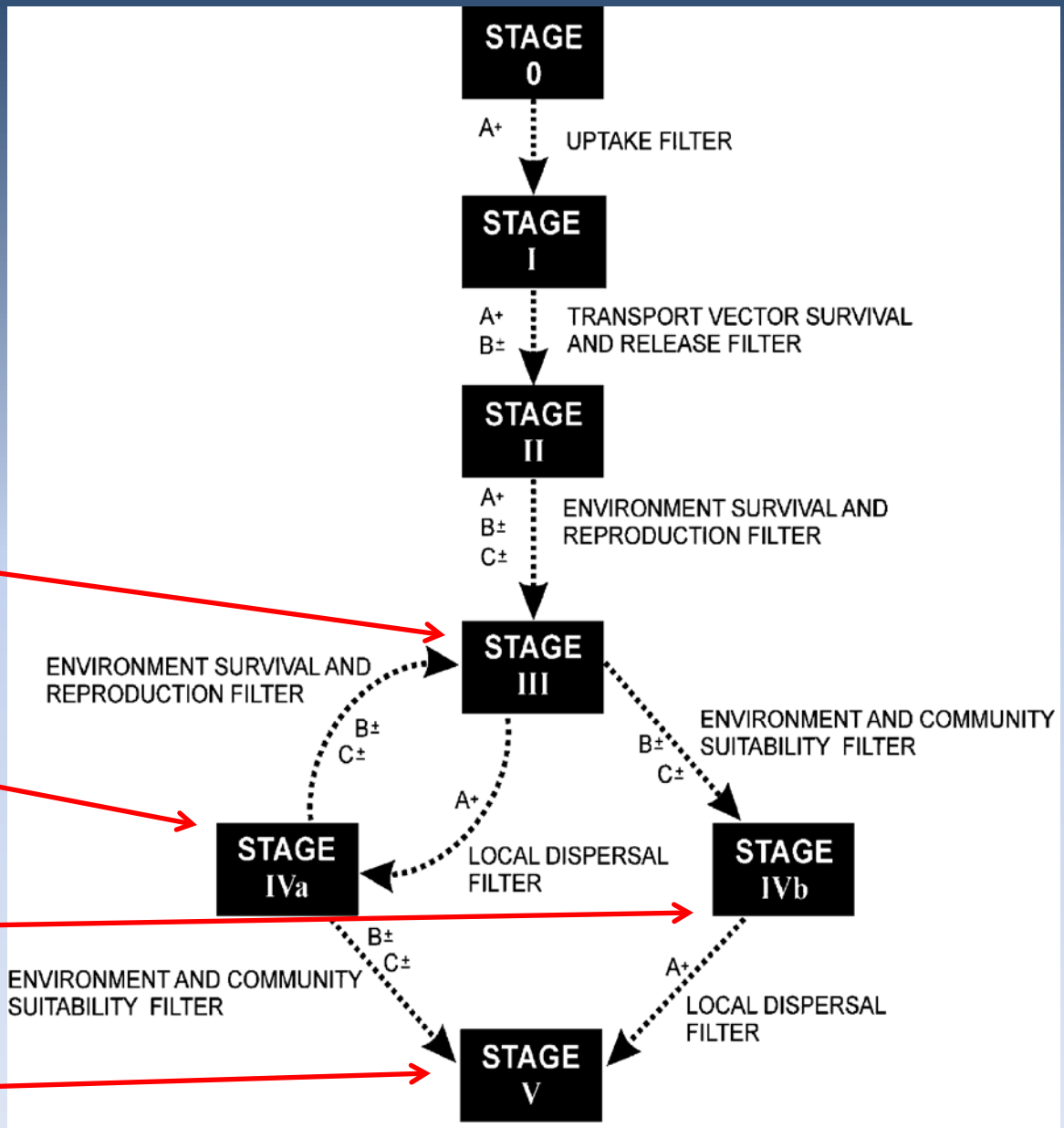
Target PEST species may be:

Localized and numerically rare (stage III),

Widespread but rare (stage IVa),

Localized but dominant (stage IVb), or

Widespread and dominant (stage V).



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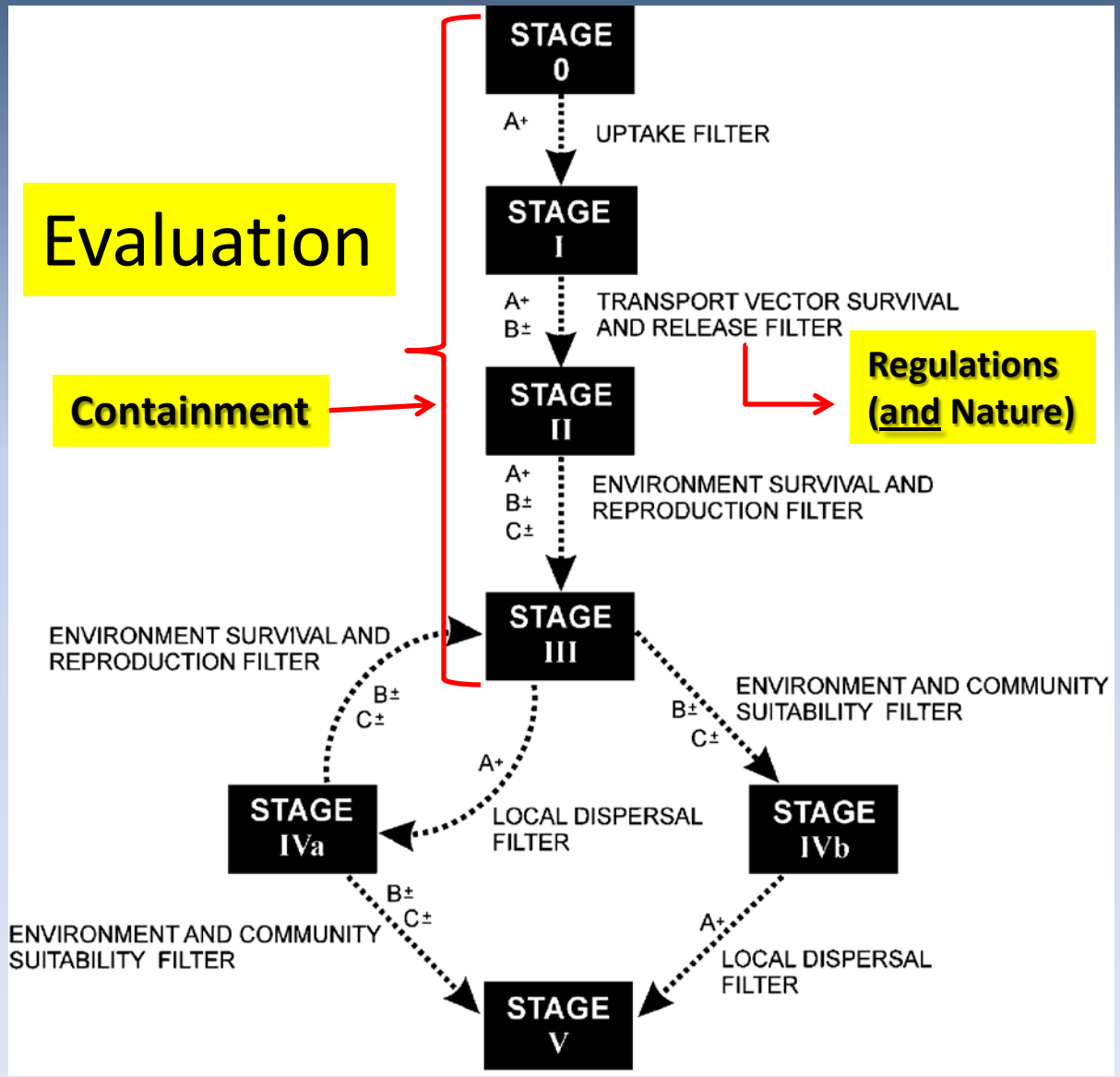
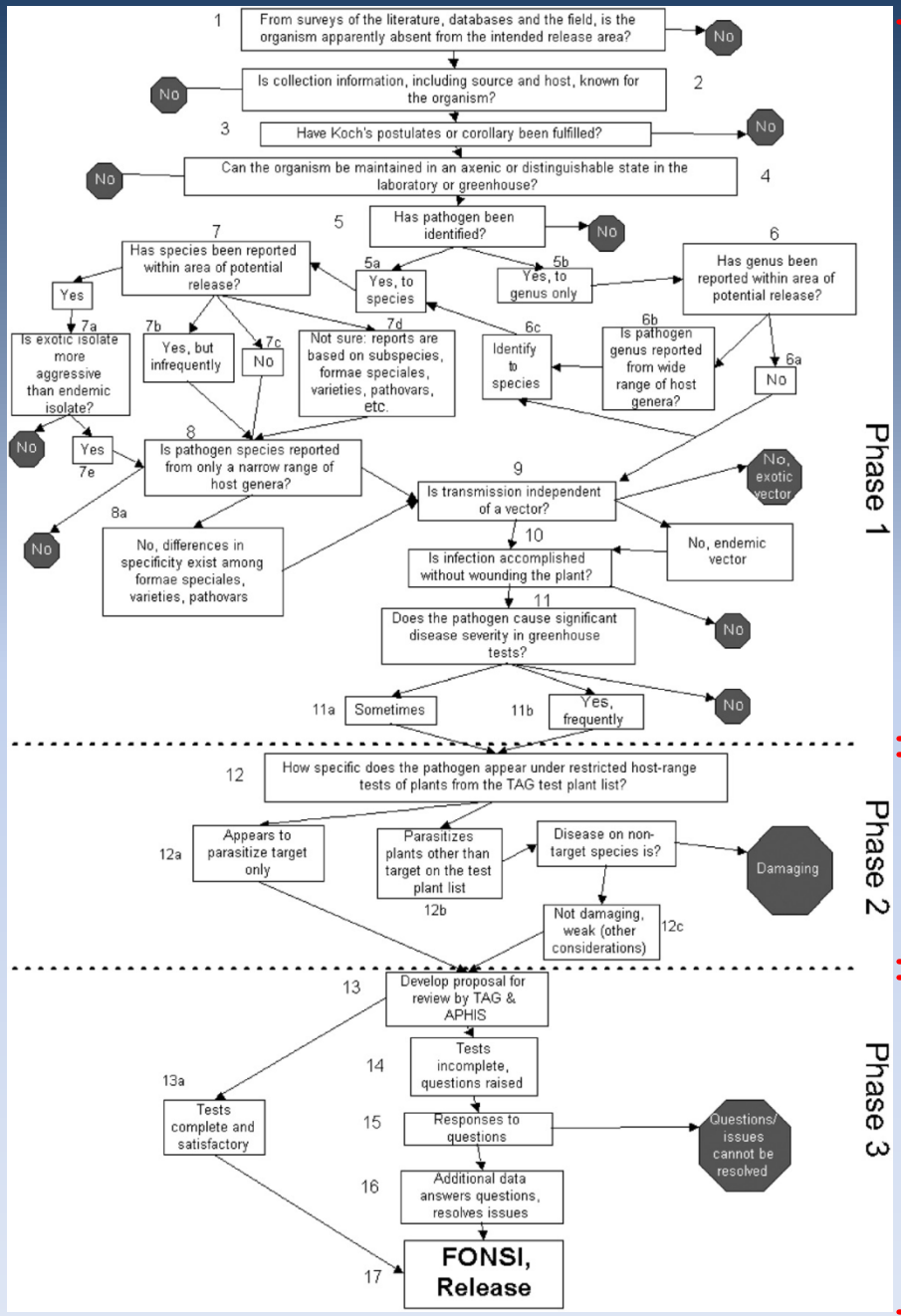
Candidate Agents



Determinants
(A) propagules;
(B) physicochem.;
(C) community.

Candidate Agents

Berner, D. K. and Bruckart, W. L. 2005. A decision tree for evaluation of exotic plant pathogens for classical biological control of introduced invasive weeds. Biological Control 34: 222–232



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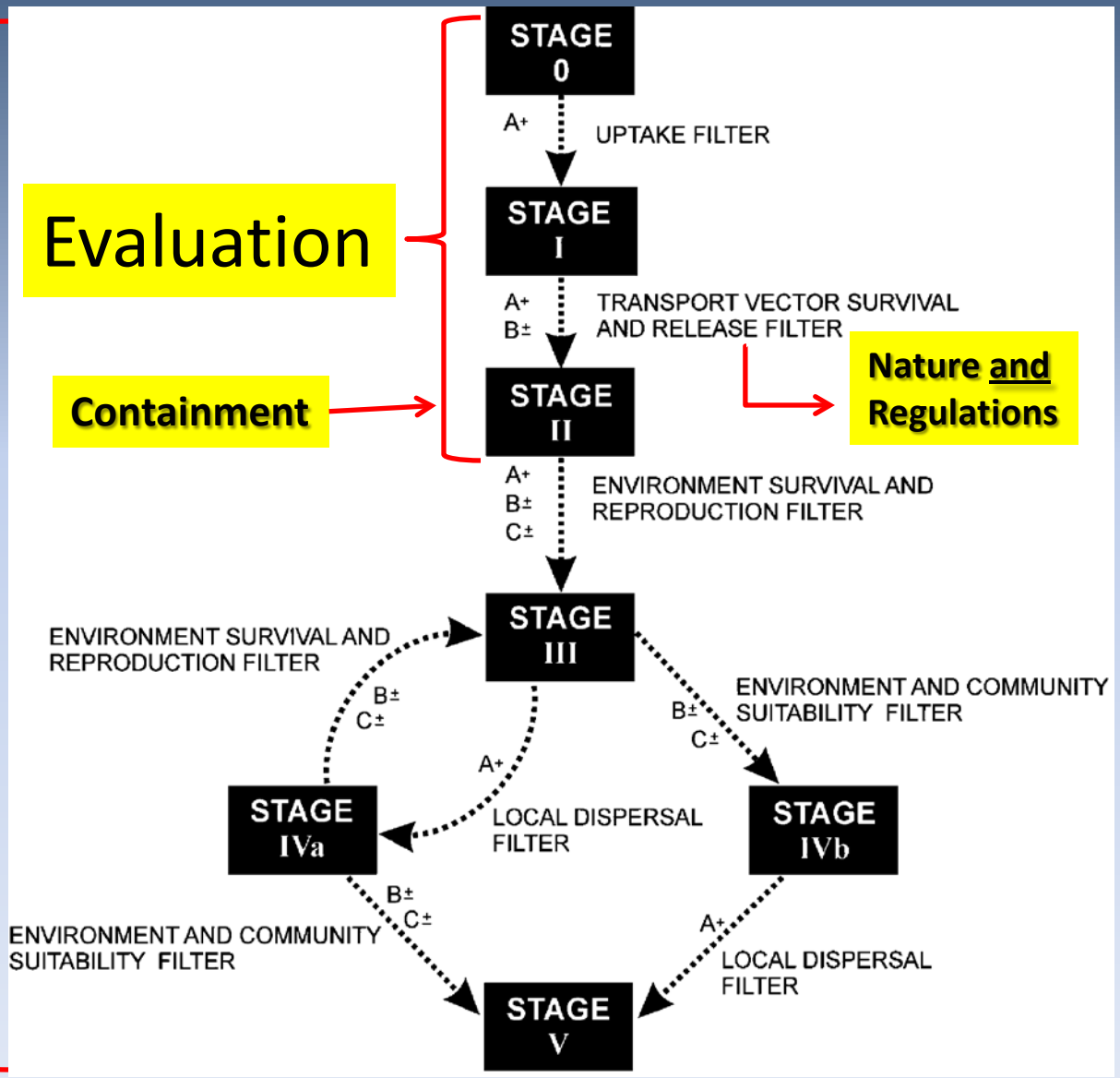
Candidate Agents

Introduction

Evaluation

Containment

Nature and Regulations



Determinants
(A) propagules;
(B) physicochem.;
(C) community.

Overall Goals

- Find the match between:
  1. Target plant,
  2. Plant pathogen, and
  3. Environment.
- Make release of qualified candidates.
- Get before-and-after photographs.

Conclusions

Process of biological control is:

- Very complex,
- Time-consuming,
- Convoluted,
- Multi-layered …

This, without evaluation of community- and ecosystem-wide effects.

Is the “tens rule” easier to break?

Summary

To paraphrase Ernest Delfosse (2003):

[Biological control] is certainly not rocket science …

… it's a lot harder!

Second Summary

… the central problem with releasing effective biological control agents is the **lack** of comprehensive and objective risk-to-benefit analysis.

… pathogens are primarily selected for low risk and not, necessarily, high benefit in the U.S.

Questions

- How can “benefit” be considered?
- Can we talk about “Beneficial Plant Pathogens” in the context of biological control?
- What would constitute “acceptable risk” in a risk-to-benefit analysis, i.e., does benefit ever override risk?

Answers?

***Thursday, October 7th Symposium* 10. Review of Nontarget Ecological Effects and Unwanted Agent Spread from Classical Biological Control Agents.**

- **9:50-10:10. Don Strong**. Ecologists ponder the evolving regulatory climate of biological control. Section of Evolution and Ecology, University of California, Davis, CA

***Thursday, October 7th Symposium* 11. Host Range Determination and Risk Assessment.**

- **10:30-10:50. Dan Simberloff.** Risk assessment of biological control introductions: will the ecologists ever be satisfied? Department of Ecology & Evolutionary Biology, University of Tennessee, Knoxville.

“If you are not part of the solution, you are part of the precipitate.”

Guilty!
(until proven innocent)

To?

Awaiting Release
For
Good Behavior