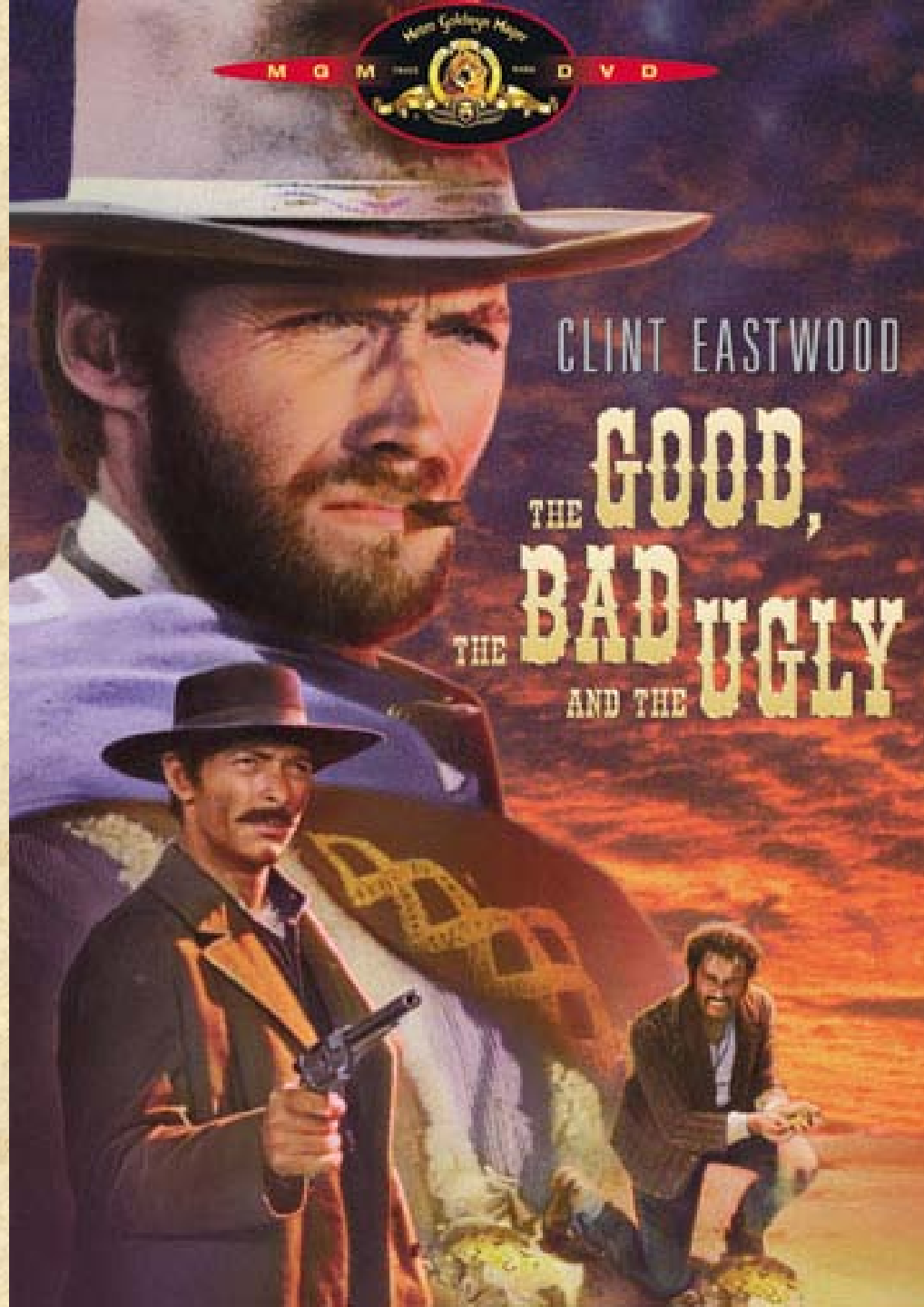


# The Good (Jojoba), The Bad (Jatropha) And The Ugly (Chinese Tallow)

Using Weed Risk Assessment To Select Non-Invasive Biofuel Crops in the Hawaiian Islands.

Chuck Chimera & Chris Buddenhagen



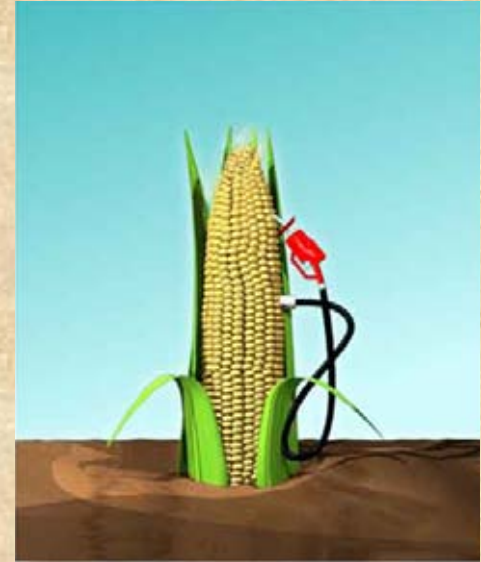


CLINT EASTWOOD

THE GOOD,  
THE BAD  
AND THE UGLY

# What are biofuels

- Plant-derived substitutes for petroleum
- Two categories of liquid biofuels
  - First generation
    - Ethanol (from plant starch, sugar)
    - Biodiesel (from plant & animal oils)
  - Second generation
    - Cellulose (Schubert 2006)





# Hawaii's Biofuel Goals

- 1994: Act 199
  - 10% ethanol content required in gasoline
- 2004: Act 95, Renewable Portfolio Standard
  - 20% net electric sales from renewable energy by 2020
- 2006: Act 240, Alternate Fuel Standard goals
  - 20% highway fuels from alternate fuels by 2020



# Purported Benefits of Biofuels

- Renewable
- Reduced greenhouse gas emissions
- Energy security & independence
- Support of agricultural industries
- Diversified economy





# Problems With Biofuels

- Technology & Markets
- Land & water use
- Soil depletion
- Chemical use
- Food vs energy
- Limited greenhouse benefits
- Biodiversity impacts
- **Weed risks**



Top Image: <http://www.greenpeace.org.uk>  
Bottom Image: [www.mygreenelement.com](http://www.mygreenelement.com)

# Adding Biofuels to the Invasive Species Fire?

S. Raghu,<sup>1\*</sup> R. C. Anderson,<sup>2</sup> C. C. Daehler,<sup>3</sup> A. S. Davis,<sup>4</sup> R. N. Wiedenmann,<sup>5</sup> D. Simberloff,<sup>6</sup>  
R. N. Mack<sup>7</sup>

- “traits deemed ideal in a bioenergy crop are also commonly found among invasive species”
  - Hardiness, water thrift, pest/disease resistance, ability to outcompete other plants



THE **WEEDY** TRUTH ABOUT  
**BIOFUELS**



TIM LOW & CAROL BOOTH  
*Invasive Species Council*

October 2007

<http://www.invasives.org.au/issues/biofuels.html>



# Invasive plants in natural areas

**Purposeful introductions** 91%

Crop/other use 56 52%

Ornamental 41 39%

**Accidental Introductions** 10 9%



Smith, C. W. 1985

- The plants that pose the greatest threats are ones that we brought in on purpose.

Photo by Forest & Kim Starr

# Methods: Species Evaluation

## BIODIESEL

### Biodiesel Crop Implementation in Hawaii



By

Michael D. Poteet  
Hawaii Agriculture Research Center  
Aiea, HI 96701

Prepared for:

The State of Hawaii  
Department of Agriculture

Under Contract Number  
HDOA-2006-2

September 2006

## BIOMASS

### Physicochemical Analysis of Selected Biomass Materials in Hawaii



Prepared for

State of Hawaii  
Department of Business, Economic Development  
and Tourism

by

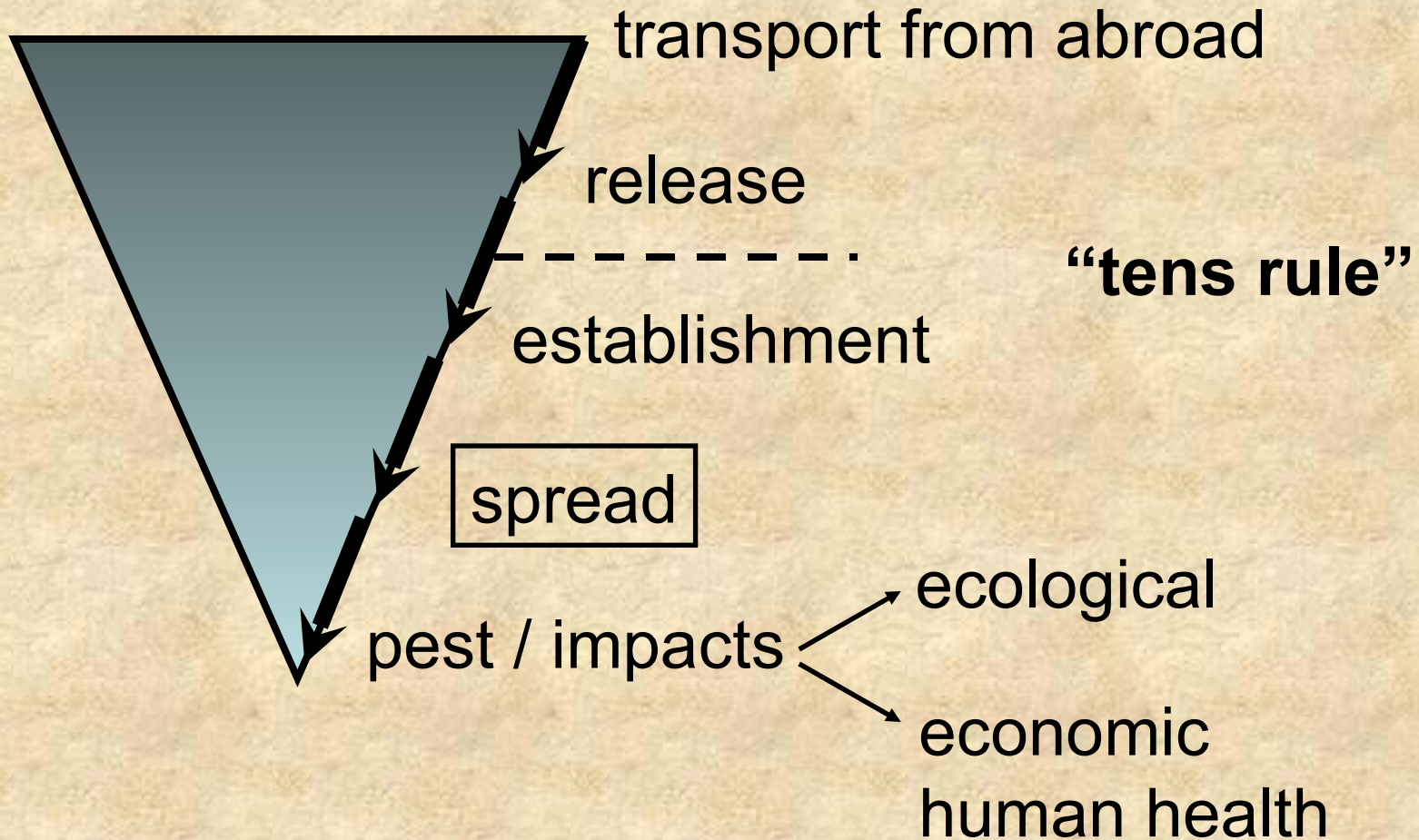
University of Hawaii  
Hawaii Natural Energy Institute  
School of Ocean and Earth Sciences and Technology

Scott Q. Turn  
Vheissu Keffer  
Keith Beers





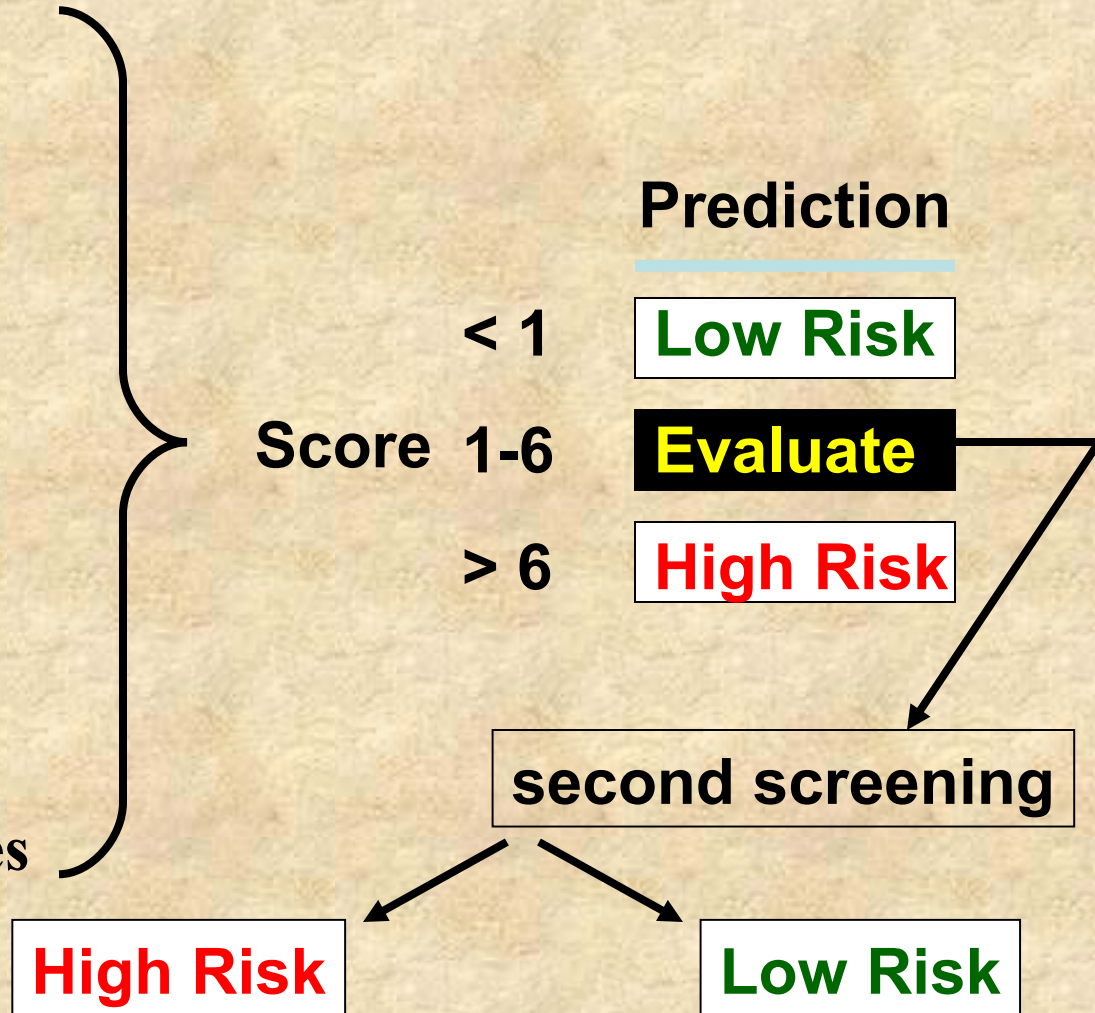
# Methods: Invasion Process



# Hawaii Weed Risk Assessment System

49 questions

- climate/distribution
- domestication
- weed elsewhere
- undesirable traits
- plant type
- reproduction
- dispersal
- persistence attributes



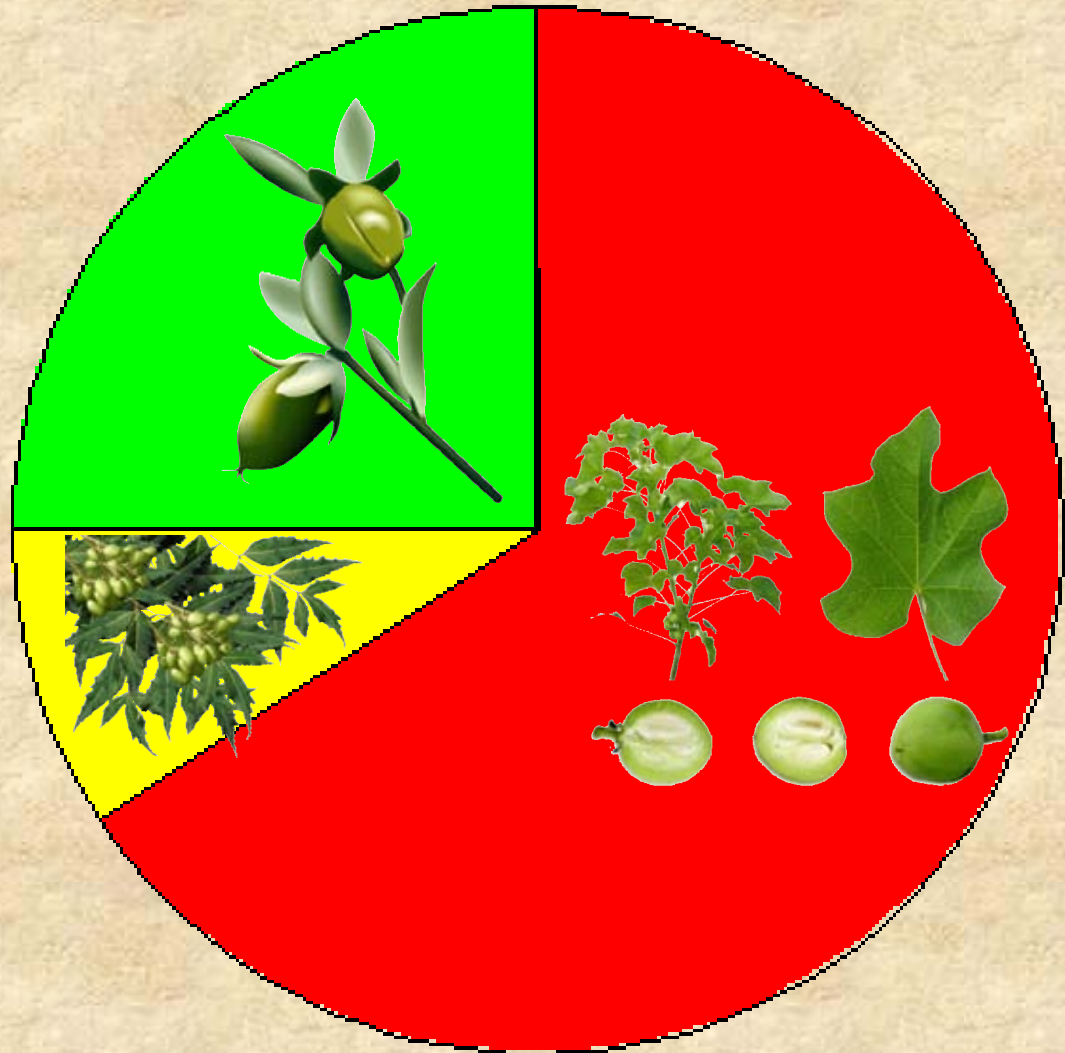




# Results

- **32 Species Evaluated**

- **21 High Risk**
  - 66%
- **3 Evaluate**
  - 9%
- **8 Low Risk**
  - 25%





# Results

- 30 of 32 Introduced
- **18 Naturalized**
  - 60% (e.g. Avocado)
  - 10% = ca. 3 spp.
- **12 Invasive**
  - 40% (Strawberry Guava)
  - 10% = <1



Photos by Forest & Kim Starr



# Results

- **WRA Analysis (n=32)**
- **27 Naturalized Somewhere (84%)**
- **20 Weeds (66%)**
  - Disturbance, Agriculture, Environmental



Photo by Forest & Kim Starr



# Results

- **“Weedy” Attributes**
  - Viable Seed Production (100%)
  - Broad climate suitability (81%)
  - Tolerates mutilation, cultivation, fire (75%)
  - Reproductive  $\leq 3$  Years (69%)
  - Tolerates wide range of soils (69%)
  - Self-compatible (56%)
  - Form dense thickets (53%)





# The Good

- 8 Species
  - Low Risk (WRA)
- ***Simmondsia chinensis***
  - Not naturalized or weedy anywhere
  - Slow to reproductive maturity
  - Seeds not easily dispersed



# The Bad

- 15 Species
  - High Risk (WRA)
  - Already naturalized
- ***Jatropha curcas***
  - “Weedy” elsewhere
  - Toxicity
  - Forms dense stands
  - Reproduces quickly
  - Seeds water-dispersed
  - Non-weedy traits
    - Large seeds



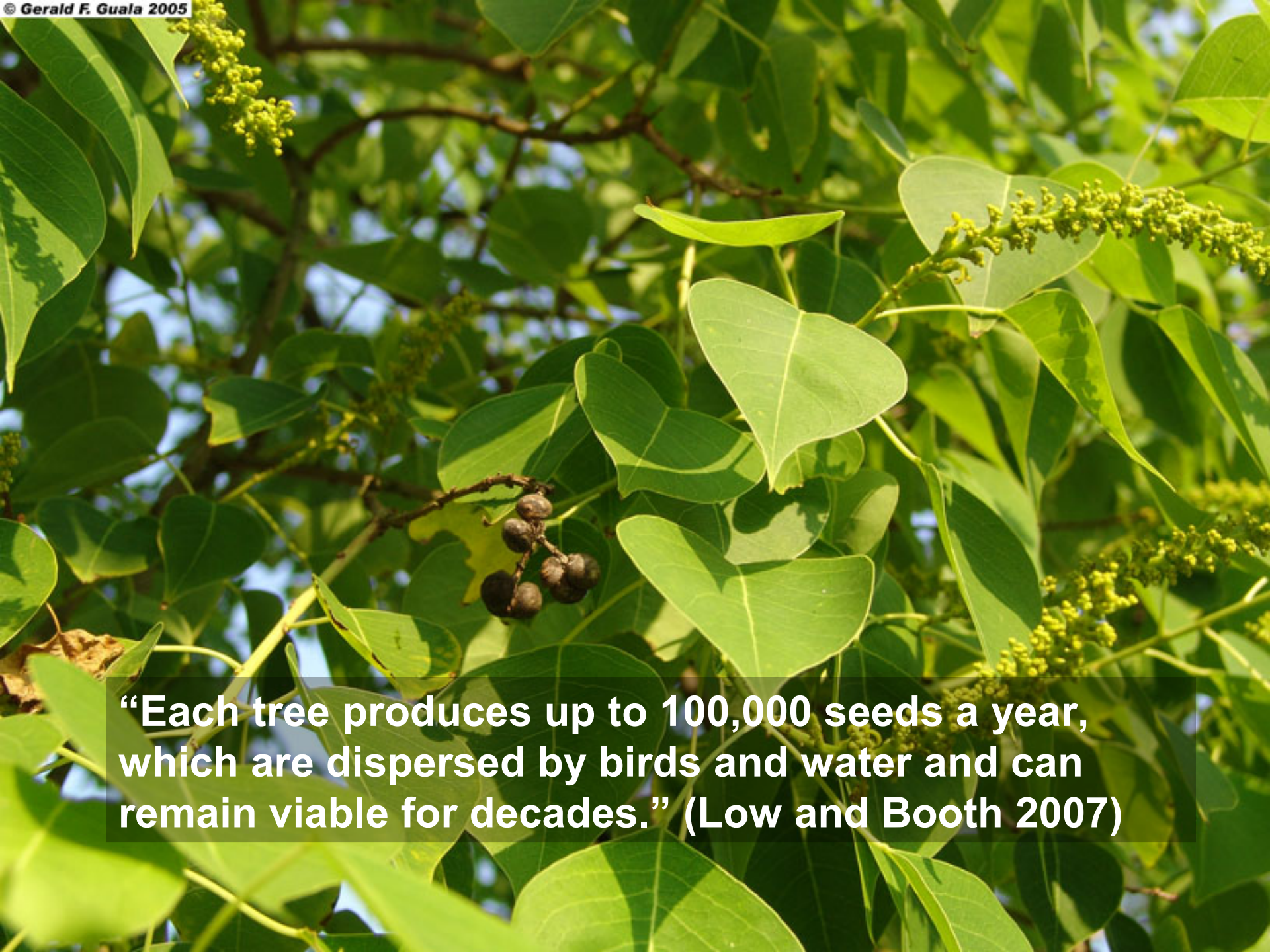


# The Ugly

- 5 species
  - High Risk
  - Weeds Elsewhere
  - Not Naturalized in Hawaii
- ***Triadica sebifera***
  - Environmental weed
  - Toxic
  - Shade tolerant
  - Forms dense stands
  - Prolific seed production
  - Bird-dispersed
  - Resprouts after cutting





A close-up photograph of a tree branch with vibrant green, heart-shaped leaves. Several clusters of small, yellowish-green flowers or seed pods are visible, extending from the branches. The background is a soft-focus blue sky. The text is overlaid on a semi-transparent dark grey box at the bottom of the image.

**“Each tree produces up to 100,000 seeds a year, which are dispersed by birds and water and can remain viable for decades.” (Low and Booth 2007)**



# The ???

- **4 Species**
  - Not weedy elsewhere
  - Not naturalized in HI
- **3 of 4 Species**
  - Evaluate (WRA)
  - Little information
- **1 of 4 Species**
  - High Risk (WRA)





# Algae as Biofuel

- Higher energy yield
- Smaller ecological footprint
- Currently more expensive
- Non-native algae can become invasive<sup>1</sup>



Photo: Reuters – Cindy Fernandez

<sup>1</sup>Smith et al. 2002



# Discussion

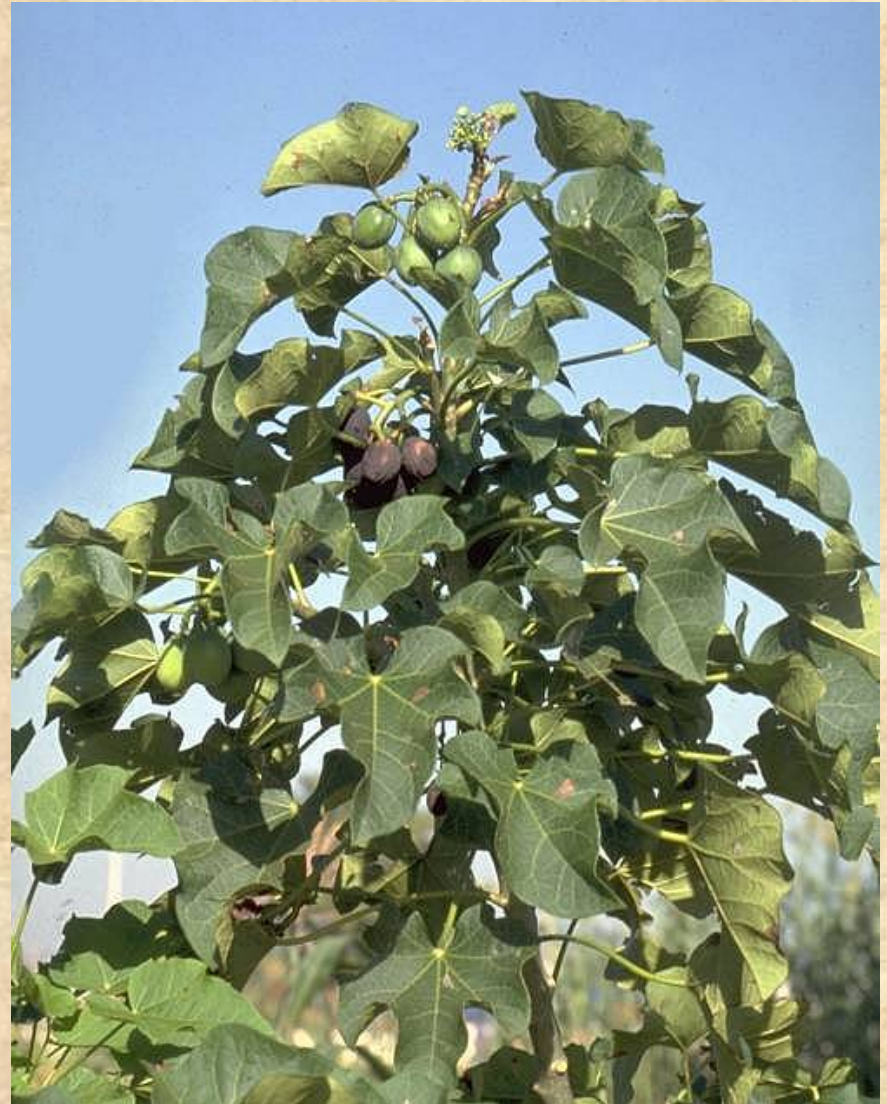
- Biofuels are high risk species
- Exceptions to “Tens Rule”
  - 21 of 32 High Risk (WRA)
  - 12 of 32 invasive in Hawaii
  - 21 of 32 weeds elsewhere
- Crop plants
  - “strongly selected to grow where they are cultivated”<sup>1</sup>



<sup>1</sup>Williamson and Fitter 1996

# Discussion

- Propagule Pressure
  - “A single consistent correlate of establishment success”<sup>1</sup>
- Lag Time
  - “long periods of seemingly consistent behavior can be poor predictors of what invaders will do in the future”<sup>2</sup>



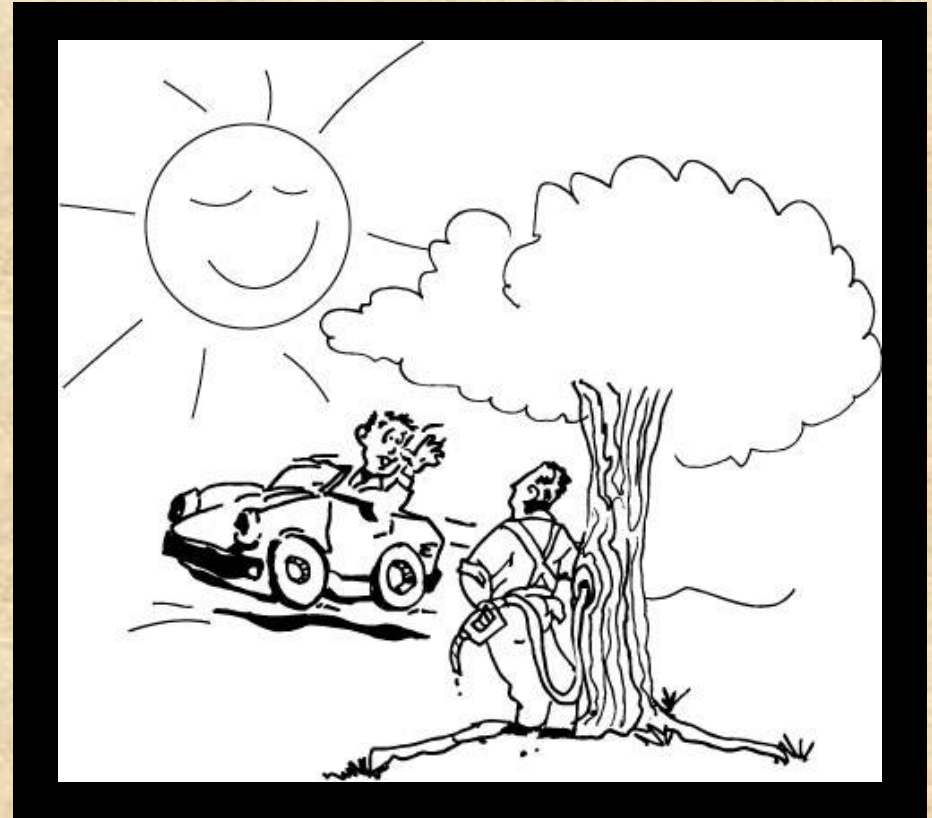
<sup>1</sup>Lockwood et al. (2005)

<sup>2</sup>Crooks, J. A. (2005)



# Conclusions

- Don't assume biofuel production is benign.
- Use low-risk species
- Proven technology prior to planting
- Employ "polluter pays" policy
- No planting near or conversion of important biological areas





# Acknowledgements

- Shahin Ansari
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- Sergio Leone

