Mapping the Invasive Species
Chinese Tallow
**Sapium sebiferum** (L) Roxb.

Common names: Chinese Tallow, Asian Tallow, Popcorn Tree, Florida Aspen, Chicken Tree.
- Introduced in 1700’s
- Aggressively competes
- Spread by birds and flood waters
- Sold as ornamental plants
- Sapping monetary reserves
- Once established, extremely difficult to eradicate
Distribution Has Never Been Mapped
A method to map Chinese Tallow has not been developed

- Monitor success of eradication efforts
- Control the further spread
- Understand the sensitivity
- Identify activities that increase the risk
Landsat Multispectral Images (185 km @ 30 m)

Multispectral Images (36 km @ 30 m)

Grating-based Hyperspectral Images (7.5 km @ 30 m)

Hyperspectral Atmospheric Correction (185 km @ 125 / 250 m)

705 km Altitude

AVIRIS Underflight (10 km @ 20 m)

Helicopter Underflight (Variable)

Landsat-7

EO-1

Less Than 1 Minute

USGS
Detecting and Mapping Chinese Tallow

- High spatial resolution color infrared photography
  - Collected in November 1997 in coastal Louisiana
  - Collected from an aircraft platform (about a 0.5 m IFOV)

- Moderate spatial resolution hyperspectral data
  - Proof of concept: Simulation of Hyperion sensor data
  - Restricted to visible and near infrared and about a 25 m IFOV

USGS
Chinese Tallow (*Sapium sebiferum*)
Leaf Reflectance

<table>
<thead>
<tr>
<th>Leaves</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Green</td>
<td>Green</td>
</tr>
<tr>
<td>B Bright Red</td>
<td>Pink</td>
</tr>
<tr>
<td>C Medium Red</td>
<td>Red</td>
</tr>
<tr>
<td>D Dark Red</td>
<td>Brown</td>
</tr>
</tbody>
</table>

Wavelength nm

Reflectance

- A Green
- B Bright Red
- C Medium Red
- D Dark Red
Hyperspectral Reflectance Signatures and Landsat Thematic Mapper (TM) Bands

47% With Red Tallow
37% No Leaves
~ 100% Tallow

Canopy and Leaf Reflectance

Wavelength

Green Leaf
Red Leaf
Canopy
Hyperspectral Canopy Reflectance Data

- Simultaneous collections with two radiometers
  - One collecting downwelling sunlight at a fixed position on the ground
  - One collecting light reflected from the vegetation taken from a helicopter platform about 230 m above the ground
  - Spectral data restricted to the visible to near infrared
  - The ground spatial resolution was about 25 m IFOV
  - Canopy reflectance data at over 30 sites were generated from the two radiometers
Classified 35-mm Color Photography Taken From Helicopter

Observed

35-mm Color Photography Taken From Helicopter
Radiative Transfer and Optimization model

- Inputs
  - Average red (tallow) and green (tallow and pine) leaf reflectances
  - Average ground reflectances (hardwood, pine, grassland)
  - Sun and view geometries (sun zenith and azimuth at the time of the helicopter collection at each site)
  - Relative skylight (estimated from airport visibilities)
  - Note: the optimization was not well conditioned and certain variables (e.g., leaf angle) went outside reasonable limits during many analyses
Radiative Transfer and Optimization model

- Prediction

  ▼ The amounts of red and green leaf reflectance, leaf area index, and leaf angle distribution were varied to give the closest match to the site-specific generated canopy reflectance.

  ▼ The closest match was the predicted canopy reflectance at each site.

  ▼ The amount of red leaf reflectance added in the optimization was the estimate of the percent of red tallow leaves at each site.
### EO1 Image Collections and Image Quality

<table>
<thead>
<tr>
<th>Date</th>
<th>Site</th>
<th>Path</th>
<th>Row</th>
<th>Image Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/11/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>95% clouds</td>
</tr>
<tr>
<td>4/27/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>90% clouds</td>
</tr>
<tr>
<td>5/13/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>Good Image</td>
</tr>
<tr>
<td>5/29/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>90% clouds.</td>
</tr>
<tr>
<td>6/14/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>85% clouds</td>
</tr>
<tr>
<td>8/1/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>100% clouds</td>
</tr>
<tr>
<td>8/17/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>100% clouds</td>
</tr>
<tr>
<td>9/18/01</td>
<td>Tallow West</td>
<td>24</td>
<td>39</td>
<td>80% clouds</td>
</tr>
<tr>
<td>8/26/01</td>
<td>Lafayette</td>
<td>23</td>
<td>39</td>
<td>95% clouds</td>
</tr>
<tr>
<td>7/2/01</td>
<td>Lake DeCade</td>
<td>22</td>
<td>40</td>
<td>95% clouds</td>
</tr>
<tr>
<td>8/3/01</td>
<td>Lake DeCade</td>
<td>22</td>
<td>40</td>
<td>100% clouds</td>
</tr>
<tr>
<td>5/8/01</td>
<td>Pascagoula</td>
<td>21</td>
<td>39</td>
<td>100% clouds</td>
</tr>
<tr>
<td>8/28/01</td>
<td>Pascagoula</td>
<td>21</td>
<td>39</td>
<td>100% clouds</td>
</tr>
<tr>
<td>9/29/01</td>
<td>Pascagoula</td>
<td>21</td>
<td>39</td>
<td>Good Image</td>
</tr>
<tr>
<td>10/20/01</td>
<td>Tallow Central</td>
<td>24</td>
<td>39</td>
<td>Good Image</td>
</tr>
</tbody>
</table>
Summary

- Red Chinese tallow leaves can be detected and mapped with very **high spatial** resolution CIR photography
  - The data volume and labor necessary are high, suggesting fairly high costs would be associated with mapping small areas
- Red Chinese tallow leaves percentages may be detected and mapped with **Hyperion type sensors** with about a 25 m IFOV
  - Results from the Radiative Transfer and Optimization analyses may not be directly applied to Hyperion image data. Initial starting points were not constant in all optimizations and some inversions resulted in negative array elements.
Summary, cont’d

- Problems occur in marsh and prairie landscapes, but some of these may be linked to the IFOV’s differences between the 35 mm slide and radiometer
- Use of spectral differencing (selective broad band) may also increase the detection and mapping capabilities in marsh and prairie landscapes
- Future addition of an endmember analysis tool should further advance the capabilities of detecting and mapping Chinese Tallow
- We hope for successful Hyperion and ALI collections on November 5, 2001