Use of *Hydrellia* Flies as Biocontrol Agents for Management of Hydrilla

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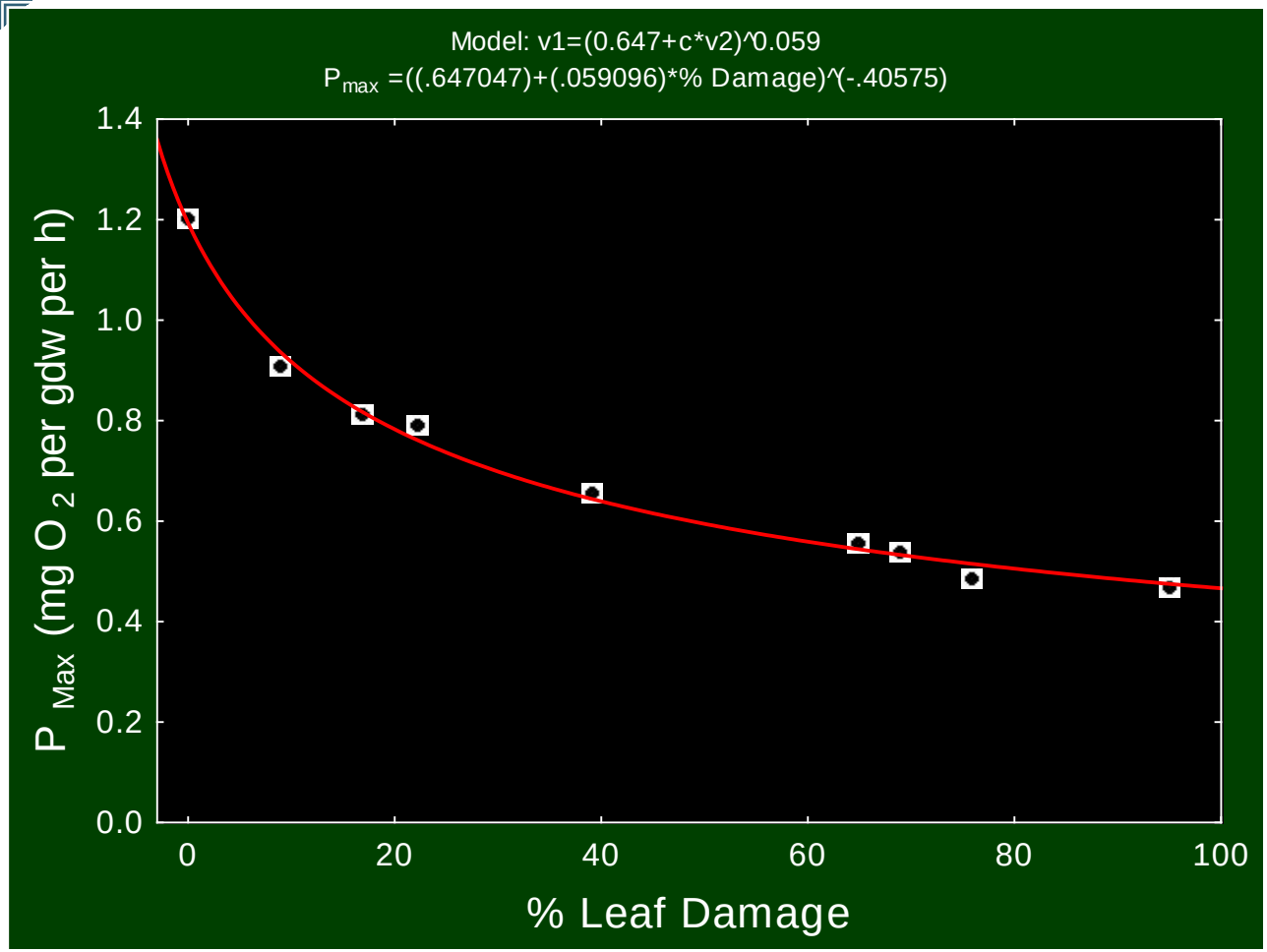
Introduction

- *Hydrilla verticillata*
  - Invasive & Exotic
  - Submersed
- Two Biocontrol Agents
  - Leaf – Mining Flies
  - Diptera : Ephydridae
    - *Hydrellia pakistanae*
    - *H. balciunasi*

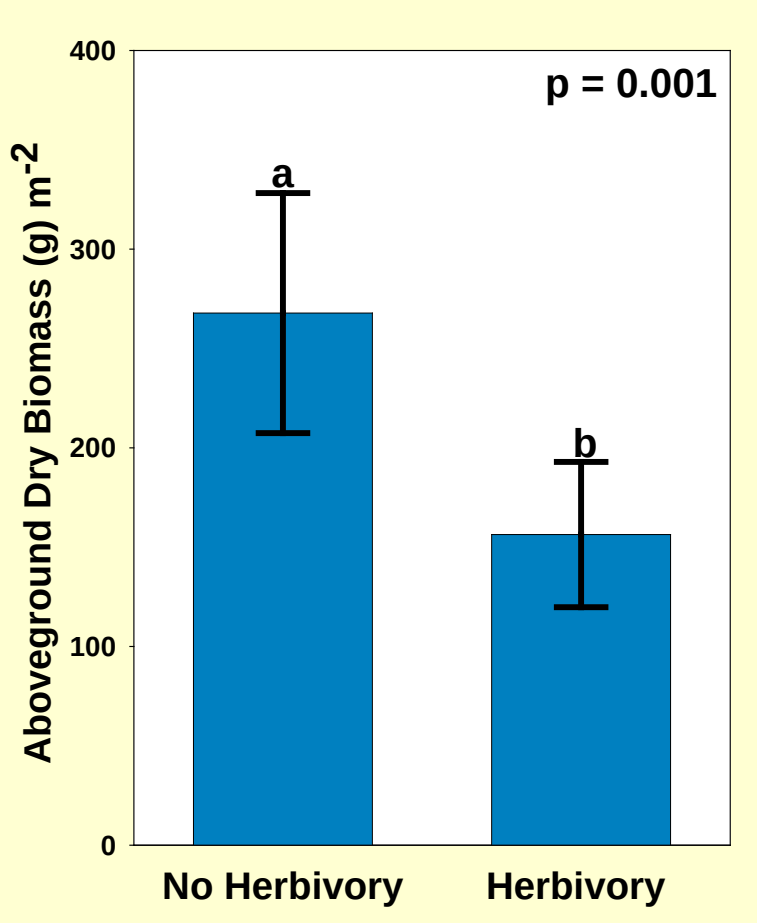
Photosynthesis



Biomass, Turions, and Tubers

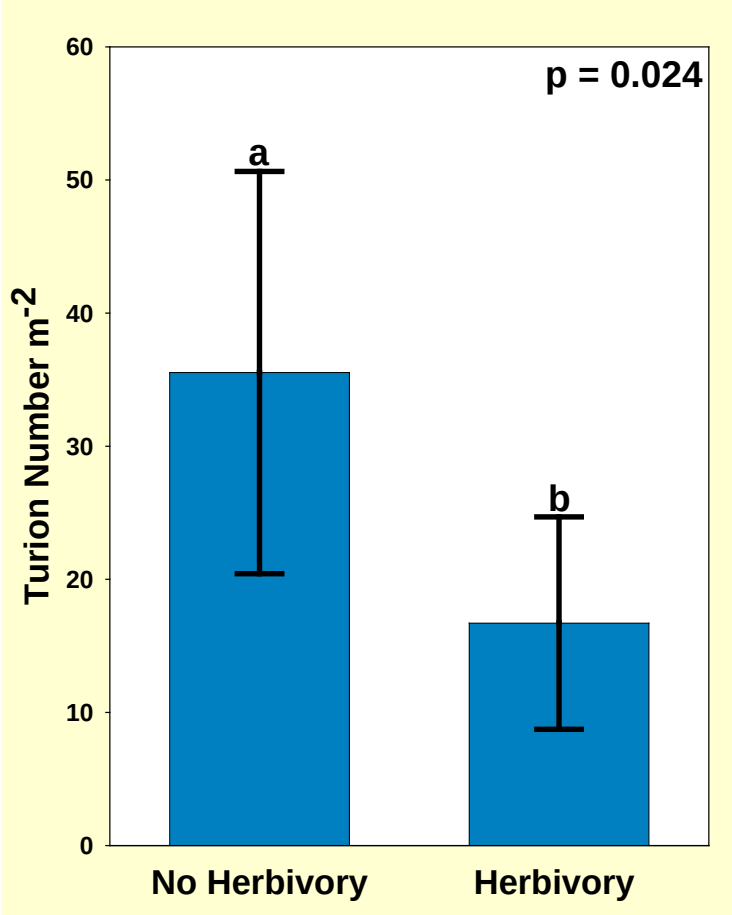
- 21 small ponds
  - 6m x 6m, depth of 1.3m
- Planted with hydrilla
- 2 x 2 factorial design
  - Herbivory
    - *Hydrellia* spp. present or absent
  - Competition
    - Native plants present or absent
      - *Vallisneria americana*
      - *Heteranthera dubia*
      - *Potamogeton nodosus*

Hydrilla Biomass



- Herbivory
  - 42% reduction

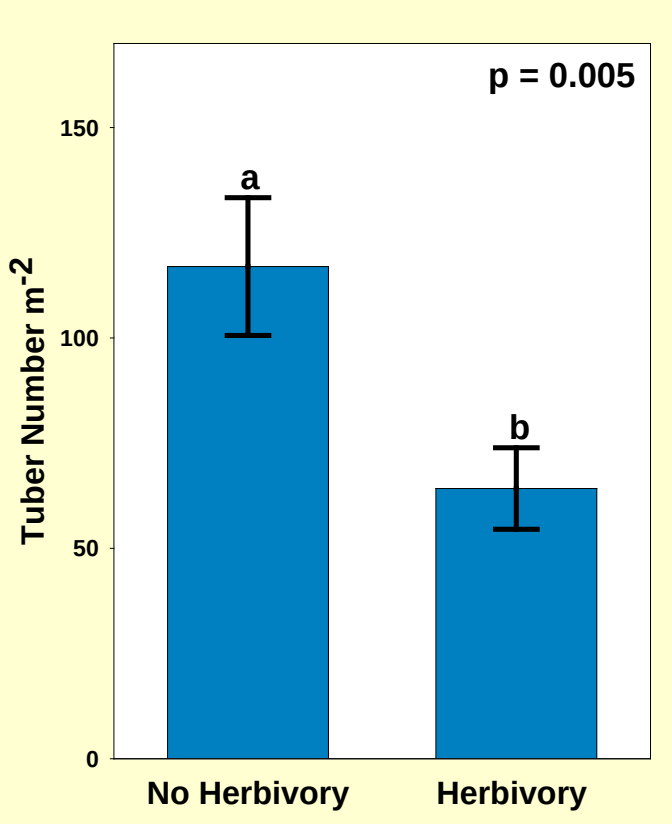
Turion Numbers



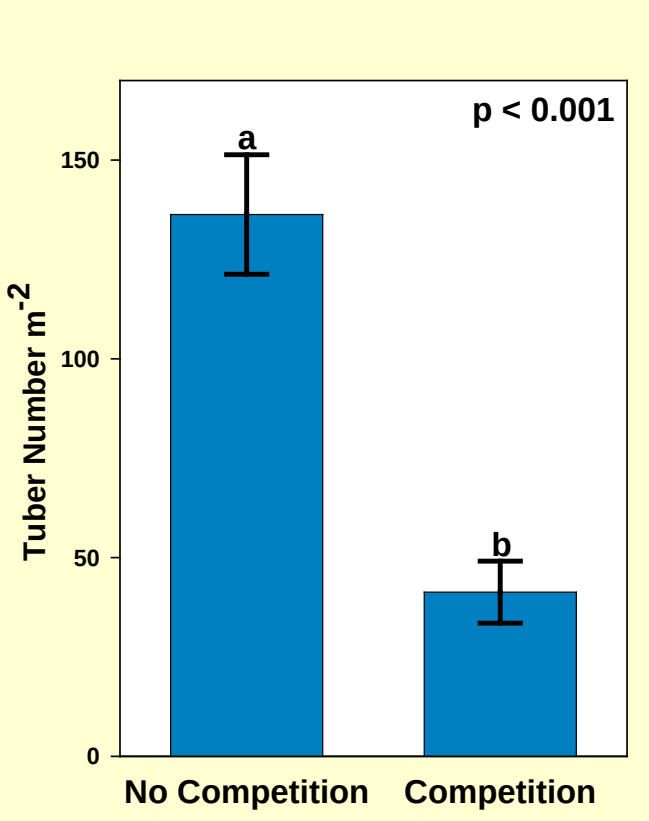
- Herbivory
  - 53% reduction

Tuber Numbers

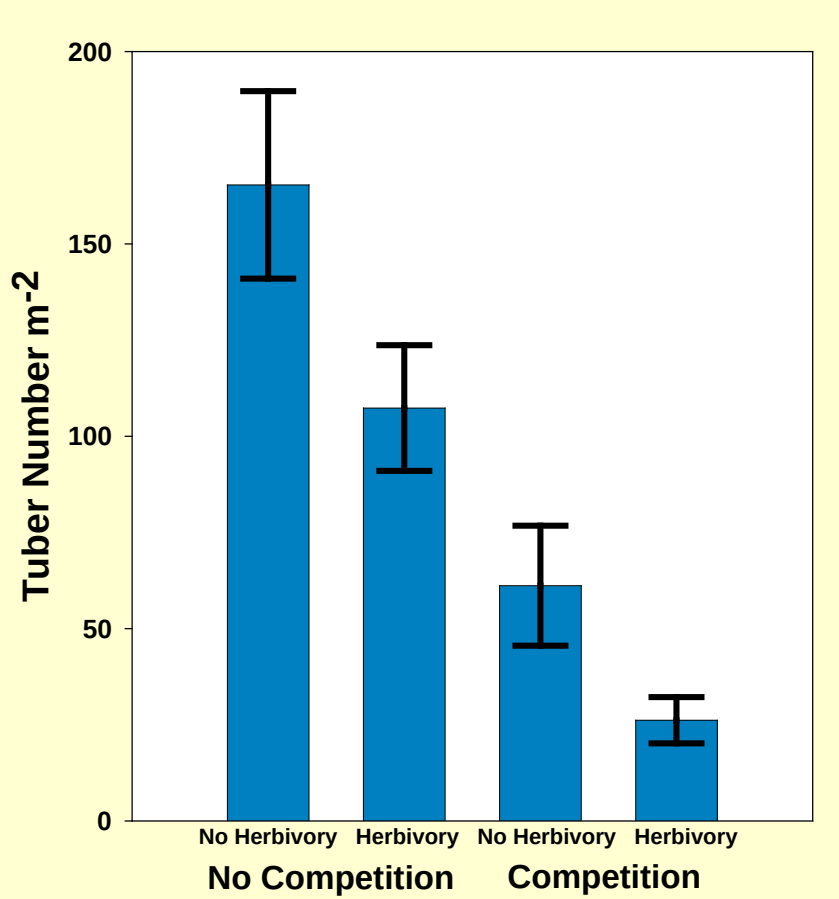
- Herbivory
  - 45% reduction



- Competition
  - 70% reduction



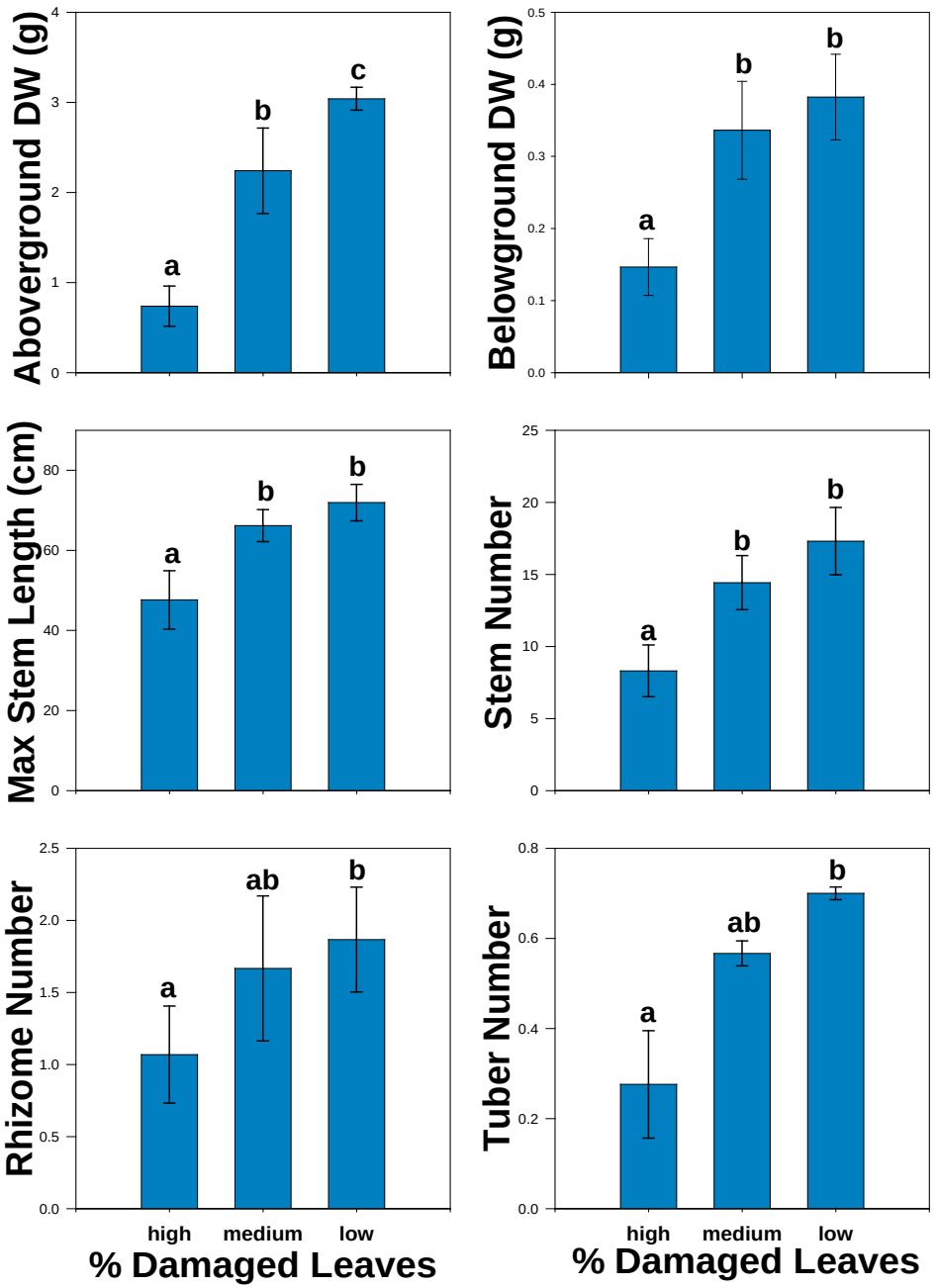
Tuber Numbers



- Competition & Biocontrol
  - 84% reduction

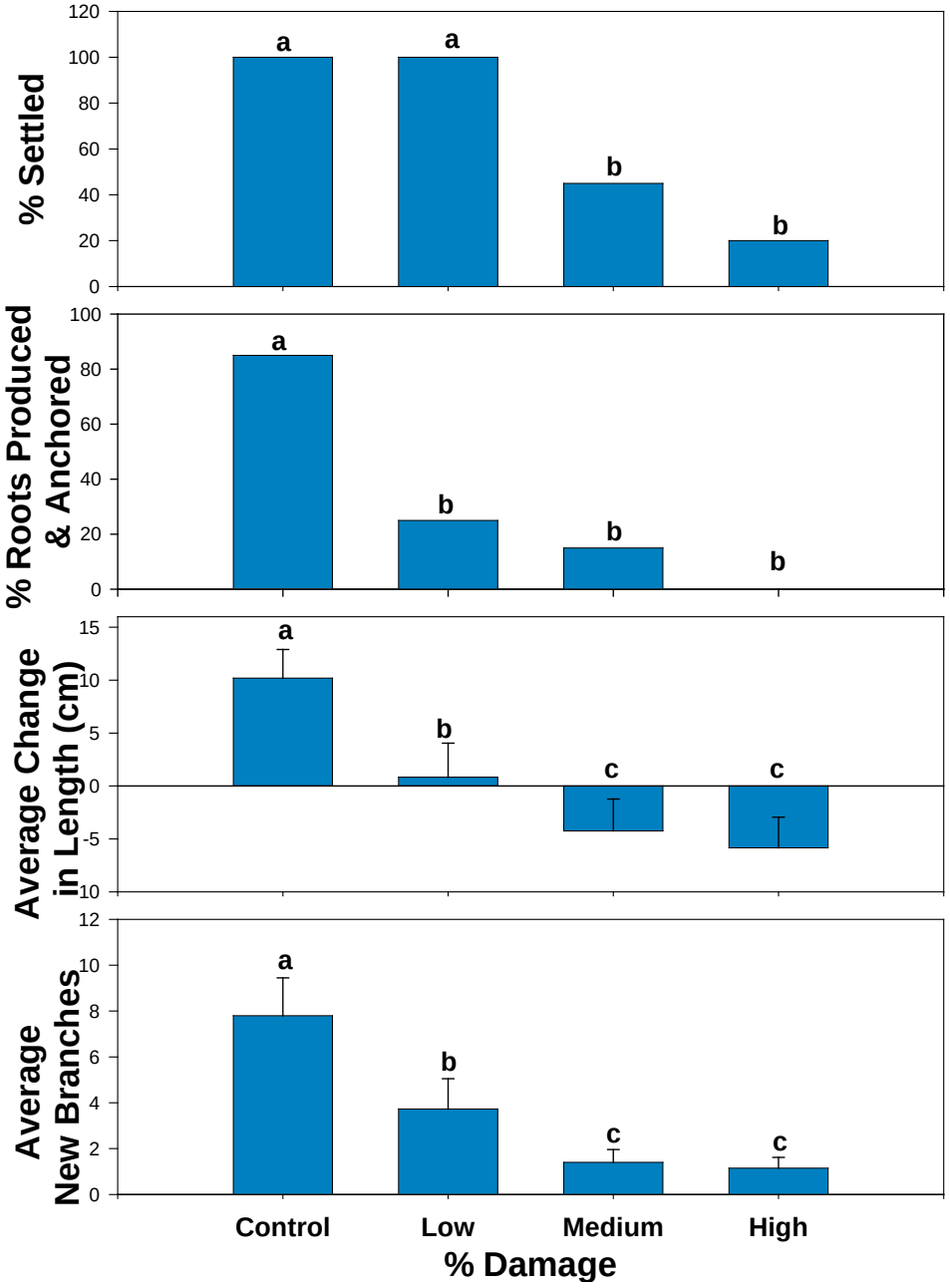
Fragments

- Best - Case Scenario
- Hydrilla fragments planted
  - 20 cm
  - 30 fragments per category
- Damage categories
  - Low
    - 0 - 30%
  - Medium
    - 40 - 60%
  - High
    - 70 - 100%
- Harvest at 4 weeks



Fragments

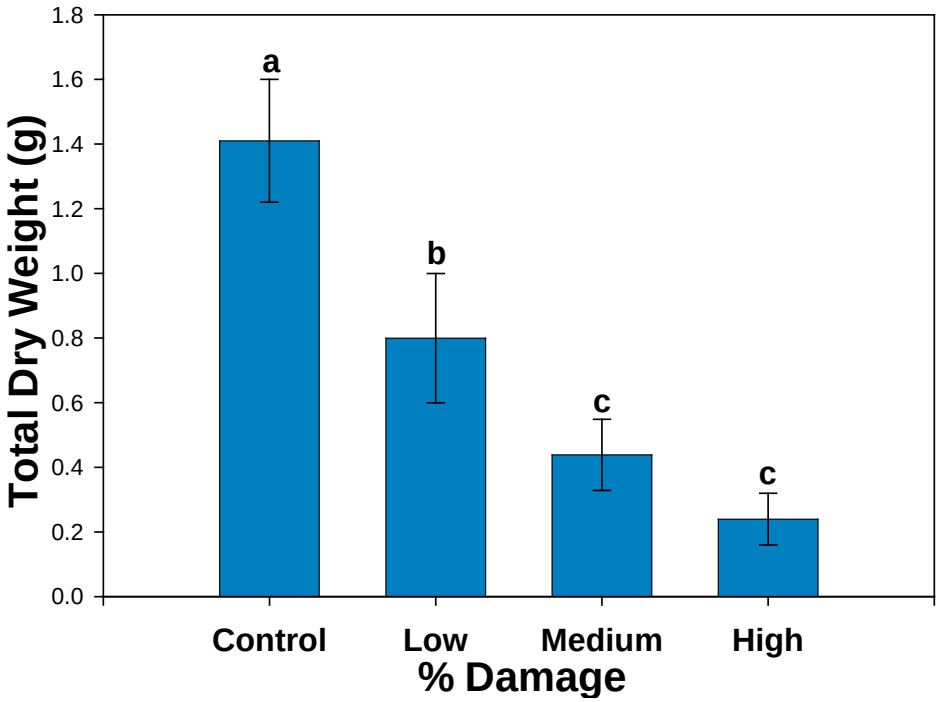
- Floating Hydrilla Fragments
  - 20 cm
  - 20 fragments per category
- Damage categories
  - Control
    - 0%
  - Low
    - 1 – 30%
  - Medium
    - 40 – 60%
  - High
    - 70-100%
- Harvest at 4 weeks



Fragments

- Fly herbivory significantly decreases fragment
  - Productivity
    - Above & belowground biomass
    - Stem length & number
  - Vegetative reproduction
    - Rhizome number
    - Tuber number

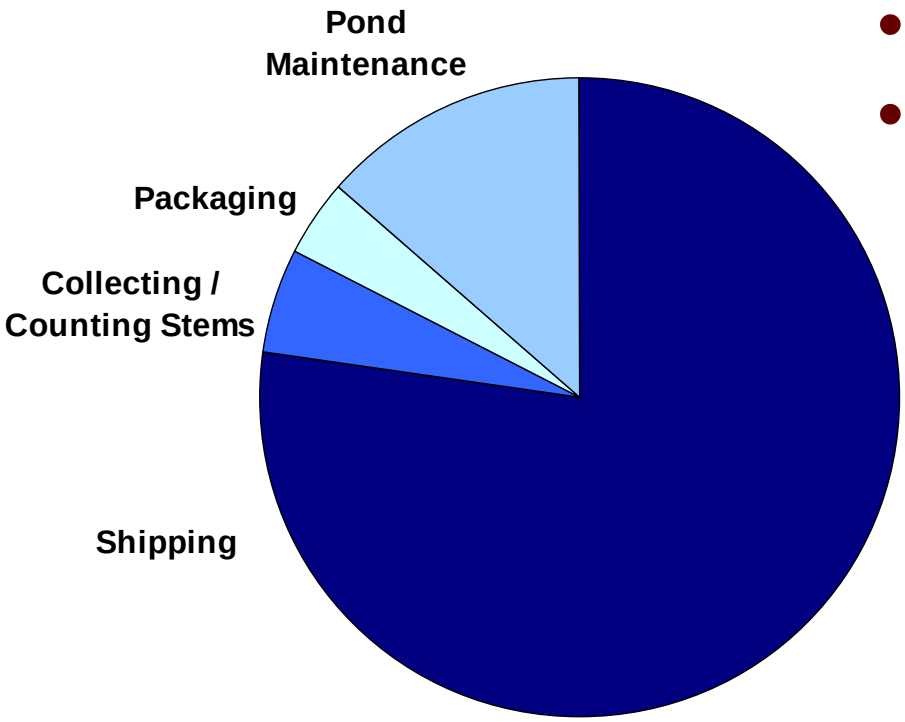
  AND ULTIMATELY
  - Establishment of hydrilla via fragments



Mass - rearing

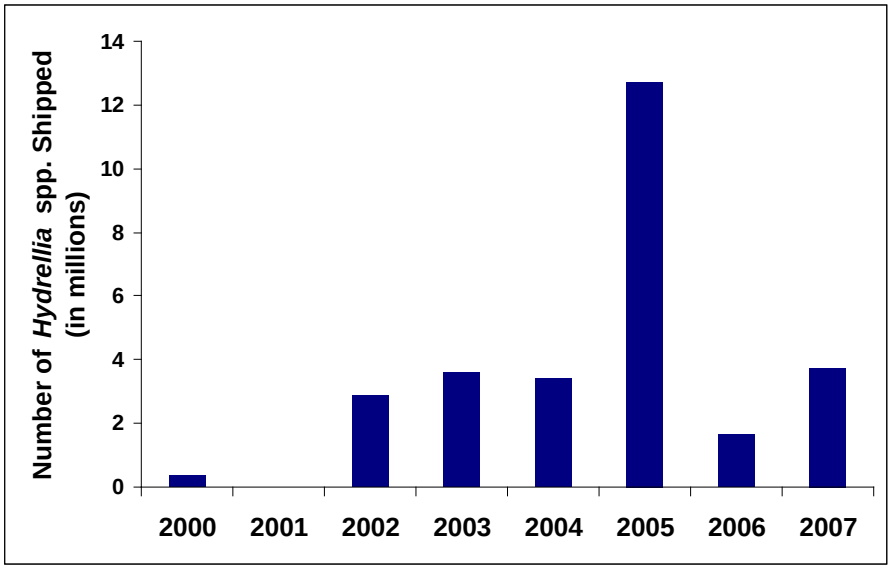
- Lewisville Aquatic Ecosystem Research Facility (LAERF)
  - 53 earthen ponds
    - 0.2 – 0.81 ha
    - average 1m depth
  - 21 lined ponds
    - 6m x 6m
    - depth of 1m
  - 18 flowing water raceways
  - Mesocosms
    - 30 – 6,000L
    - 24 – 1,850L
    - 18 – 14,000L
  - Research Greenhouse
  - Analytical Laboratory

Mass - rearing



- Began in 2000
- Cost
  - Laboratory & Greenhouse
    - $0.50 / fly
  - Pond rearing (mass rearing)
    - $0.0018 / fly

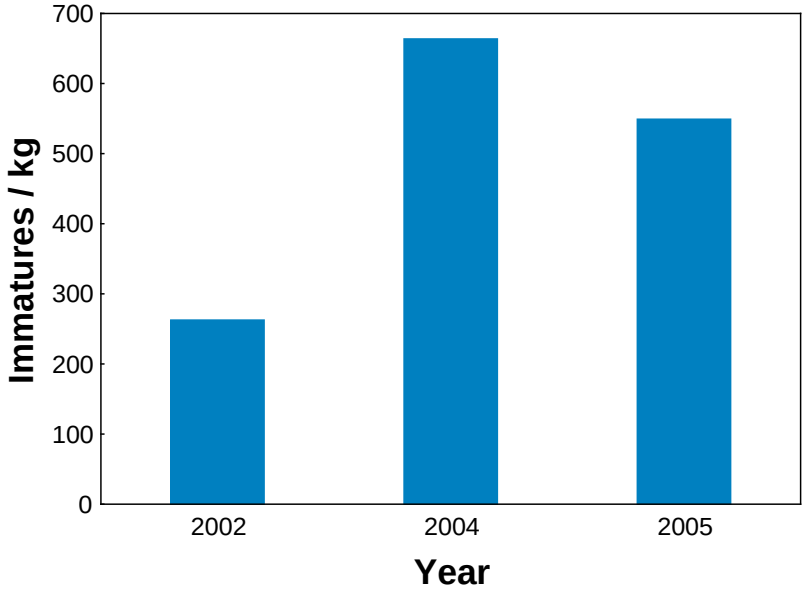
Mass - rearing

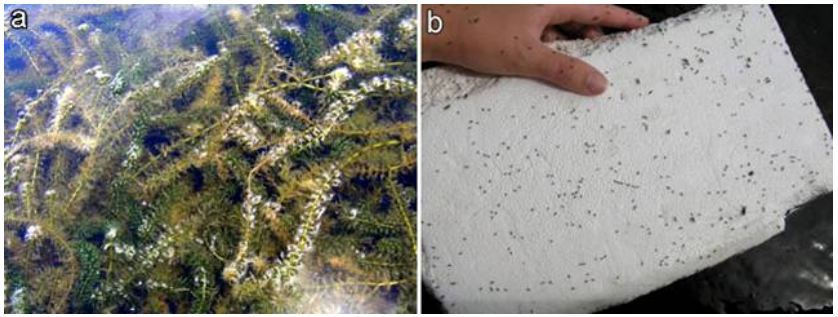


- From 2000 – 2007
  - > 28 million released
  - 6 states
    - Texas
    - Florida
    - North Carolina
    - Virginia
    - Georgia
    - Arkansas
- High establishment success
  - Present in 78% of sites in years following initial release

Sheldon Lake, TX

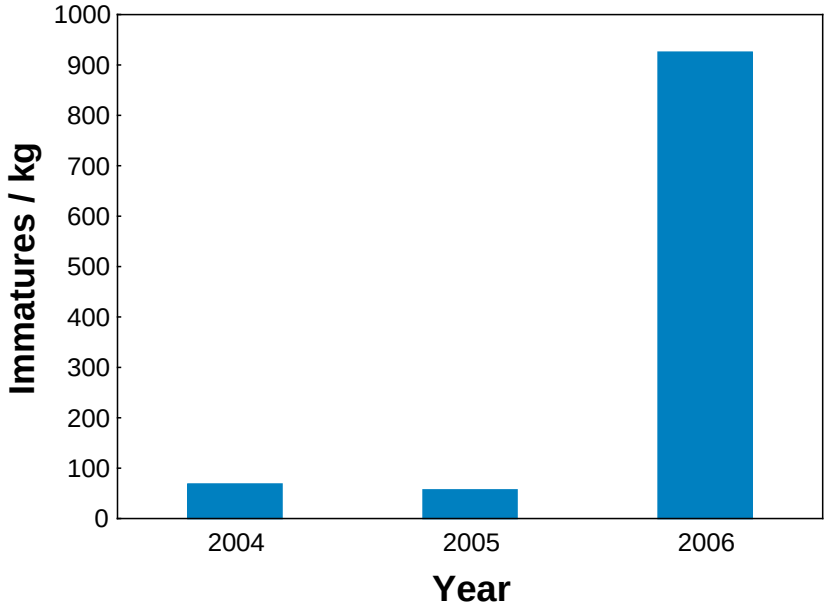
- *Hydrellia* spp. releases
  - 1991: 42,837 immatures
  - 1992: 32,066 immatures
- 2002
  - 262 immatures / kg
- 2004
  - 663 immatures / kg
  - 300,000 immature flies released
- 2005
  - Larval flies & adults at every site
  - 100% leaf damage common
  - 549 immatures / kg
- 2006
  - <20 strands of hydrilla found
  - 1 – 2 feet below water's surface





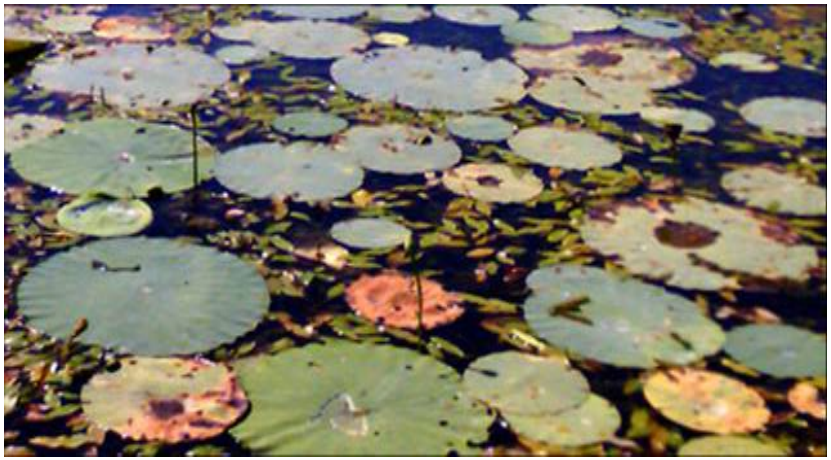
Choke Canyon Reservoir, TX

- 2004
  - 68 immatures / kg
  - 300,000 immature flies released
- 2005
  - 57 immatures / kg
  - 710,000 immature flies released
- 2006
  - Hydrilla in weakened state
  - Immatures and damage observed at release sites and new sites
  - 925 immatures / kg
  - Callahan swimming area
    - Coverage reduced by about 50%
  - *Heteranthera dubia* competing against hydrilla



Lake Seminole, FL

- 1990 – 1993
  - > 2,250,000 immatures released
- 1998 – 1999
  - Large-scale reductions in hydrilla
  - Increases in native diversity
  - Correlated to increases in flies
- 2001 – 2004
  - Hydrilla re-populated lake
- 2005
  - No flies detected
  - 740,000 immatures released
- 2006
  - 75% of sites hydrilla decreasing, natives increasing
  - 345 immatures / kg



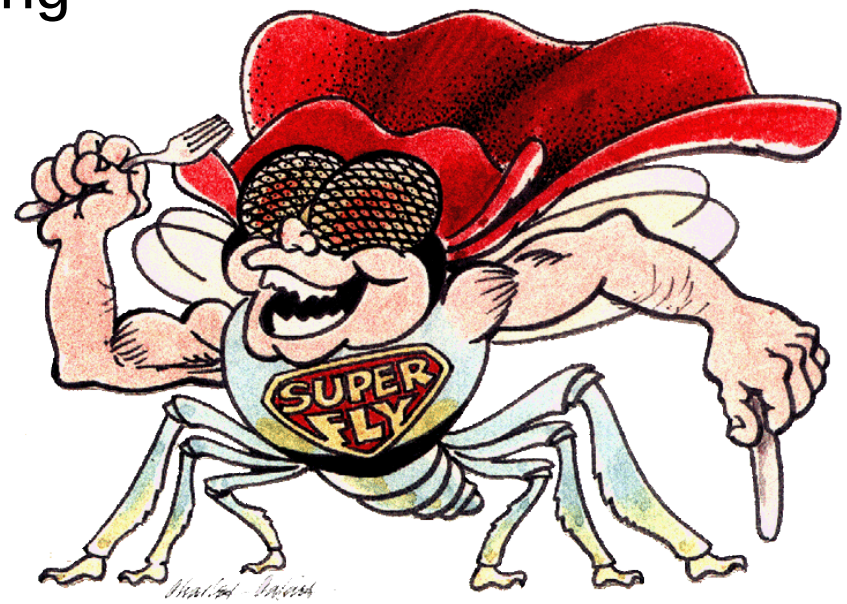
- 2007
  - Large – scale hydrilla reductions
  - Increases in natives

Lake Conroe, TX

- New release methods – Early season
- June 2007
  - No flies detected
  - Released 1,110,521 immatures in 2 coves
- August 2007
  - Larvae and adults in both coves
  - No Name Cove
    - 91 immatures / kg
  - Big Ski Cove
    - Fly damage on almost every stem sampled
    - 1,832 immatures / kg
- Flies established quickly

Conclusions

- Flies suppress hydrilla by causing reductions in
  - Ability to photosynthesize
  - Biomass
  - Tuber numbers
  - Turion numbers
  - Fragment establishment
- Success at field releases
  - Reductions in surface coverage
  - Weakened competitive ability



Current Research

- Competition & Biocontrol
  - Large ponds with native plant preemption
  - Field Sites
- Overwintering behavior of flies
- Biocontrol Agent Mass-rearing
  - Salvinia weevil
    - *Cyrtobagous salviniae*
  - Waterlettuce weevil
    - *Neohydronomus affinis*