The Seagrasses

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HCRI RESEARCH PROGRAM

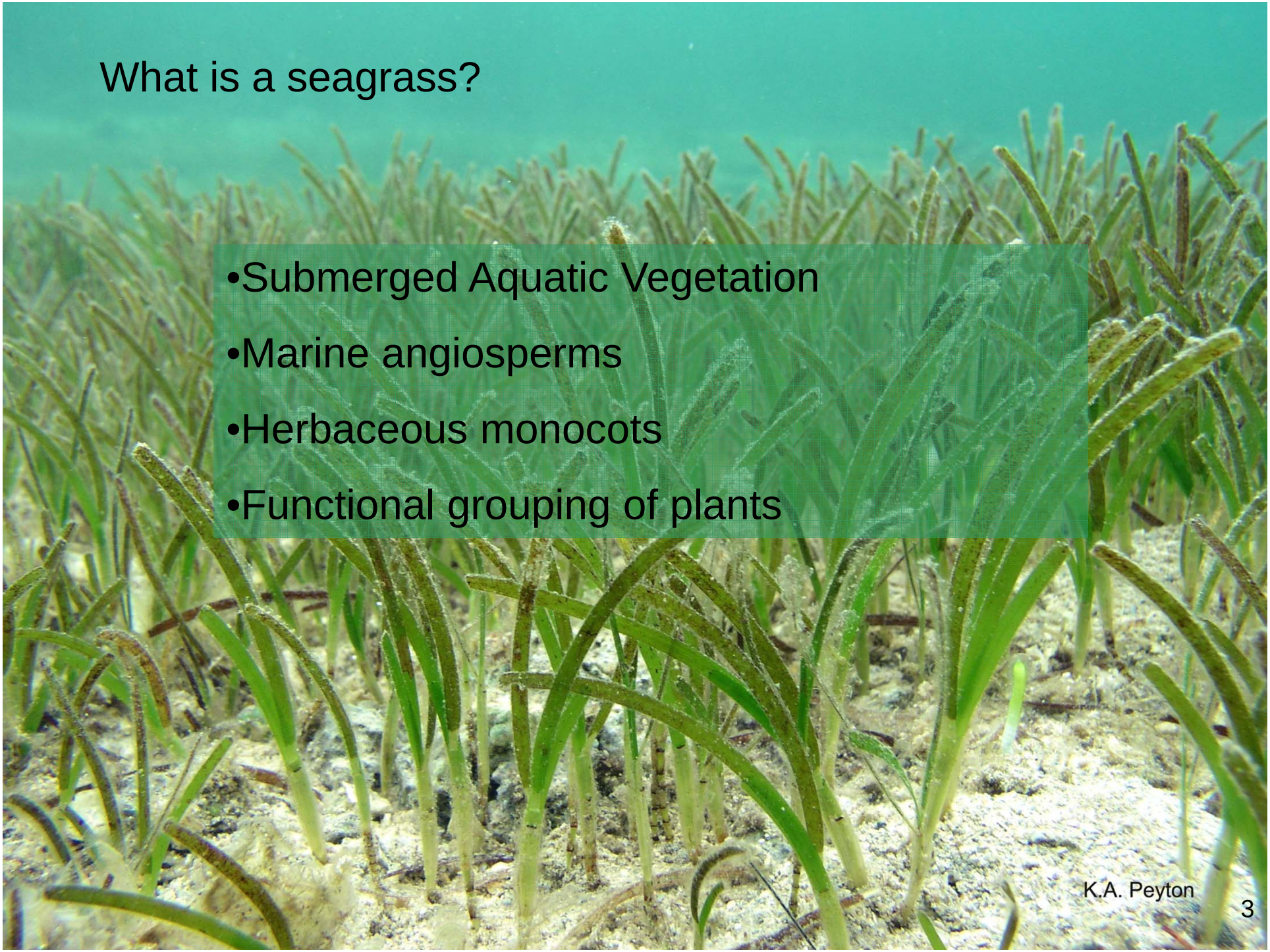
U.S. FISH & WILDLIFE SERVICE

Outline

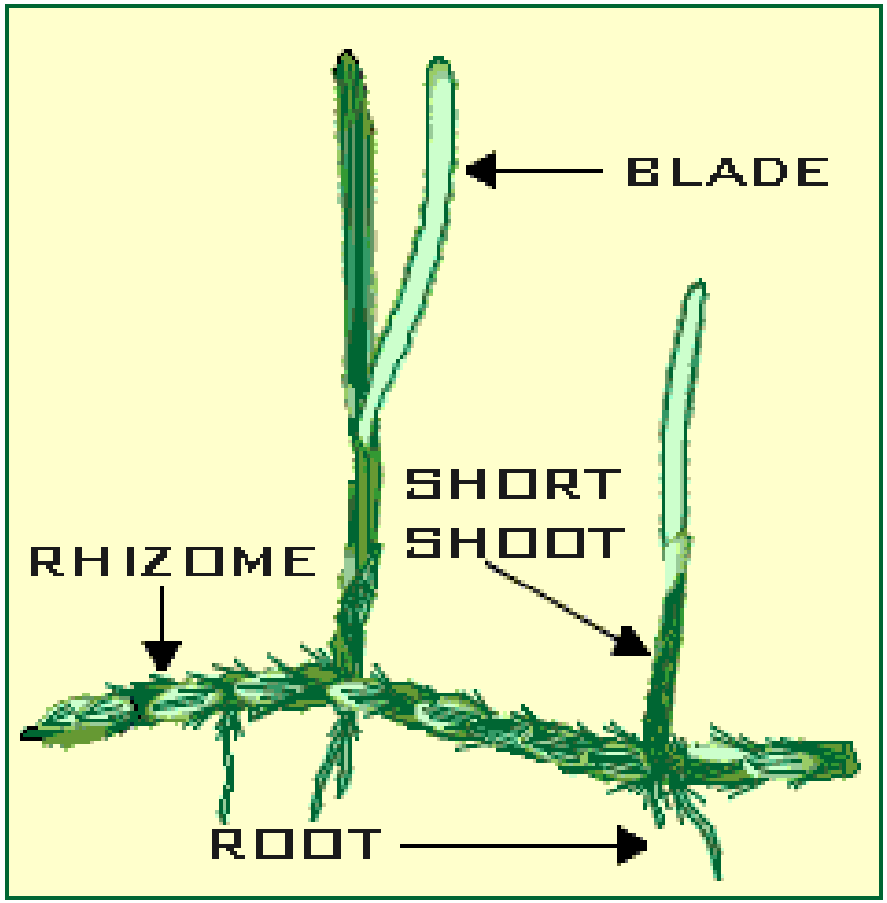
- Anatomy
- Characteristics
- Taxonomy, systematics, & evolution
- Distribution & diversity
- Habitats
- Reproduction
- Food sources
- Annual production
- Stressors
- Hawaiian seagrasses
- Seagrass research in Hawai‘i

What is a seagrass?

- Submerged Aquatic Vegetation
- Marine angiosperms
- Herbaceous monocots
- Functional grouping of plants

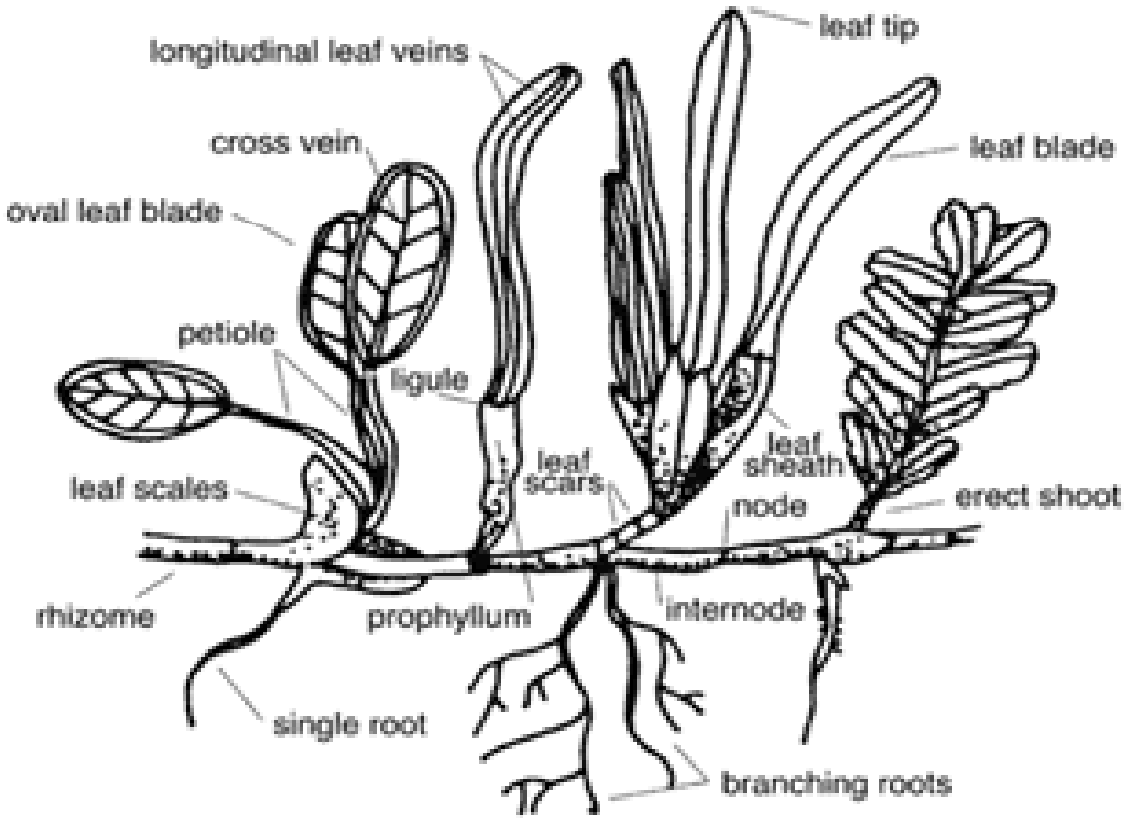


Anatomy



- **Blades** -
  Photosynthesis
  Nutrient uptake
- **Short shoot** = stem
- **Rhizomes** -
  Anchoring
  Propagation
  Nutrient absorption
  Gas exchange
- **Roots** -
  Nutrient uptake
  Anchoring
  Gas exchange

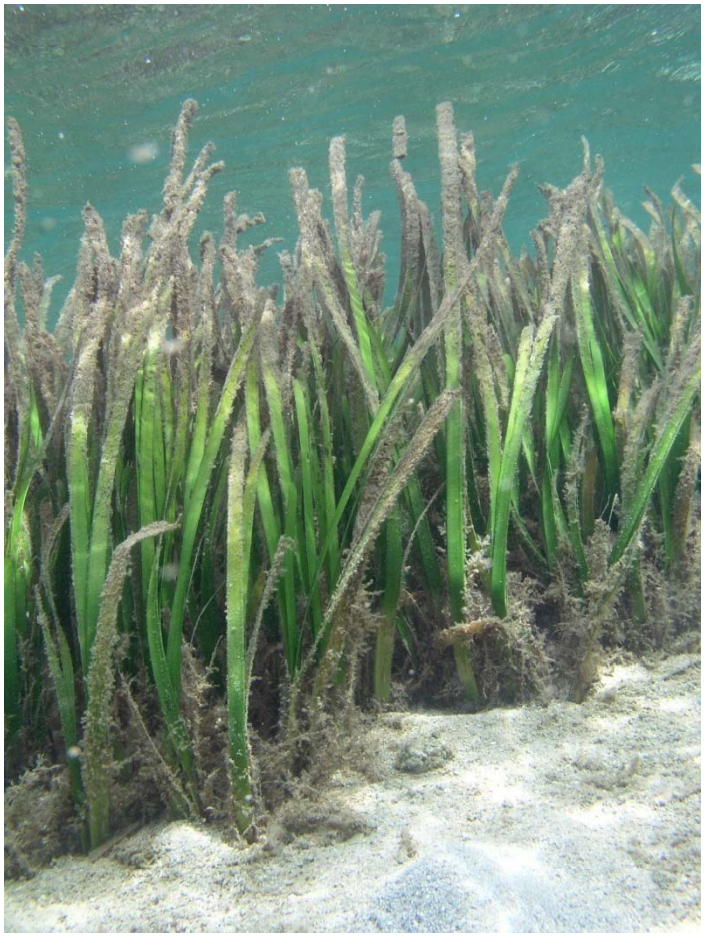
Vegetative Morphology



Morphological features of seagrass (composite diagram)

- Leaves: strap-like to oval
- Leaf bundles
- Short shoots

Conveyor-belt growth



Characteristics of Seagrasses: Functional Group

Arbor (1920) & den Hartog (1970)

1. Adapted ecologically to varying salinities = osmoregulation
2. Able to grow while completely submerged
3. Resistant to waves & tidal currents
4. Adapted to pollinate underwater = hydrophilly
5.

How extraordinary are seagrasses? How common is hydrophily?

- 130 species of 300,000 species
- Hydrophiles = 0.04%
- 60 species are marine = seagrasses
- Seagrasses = 0.02%
- Reflects difficult evolutionary transitions

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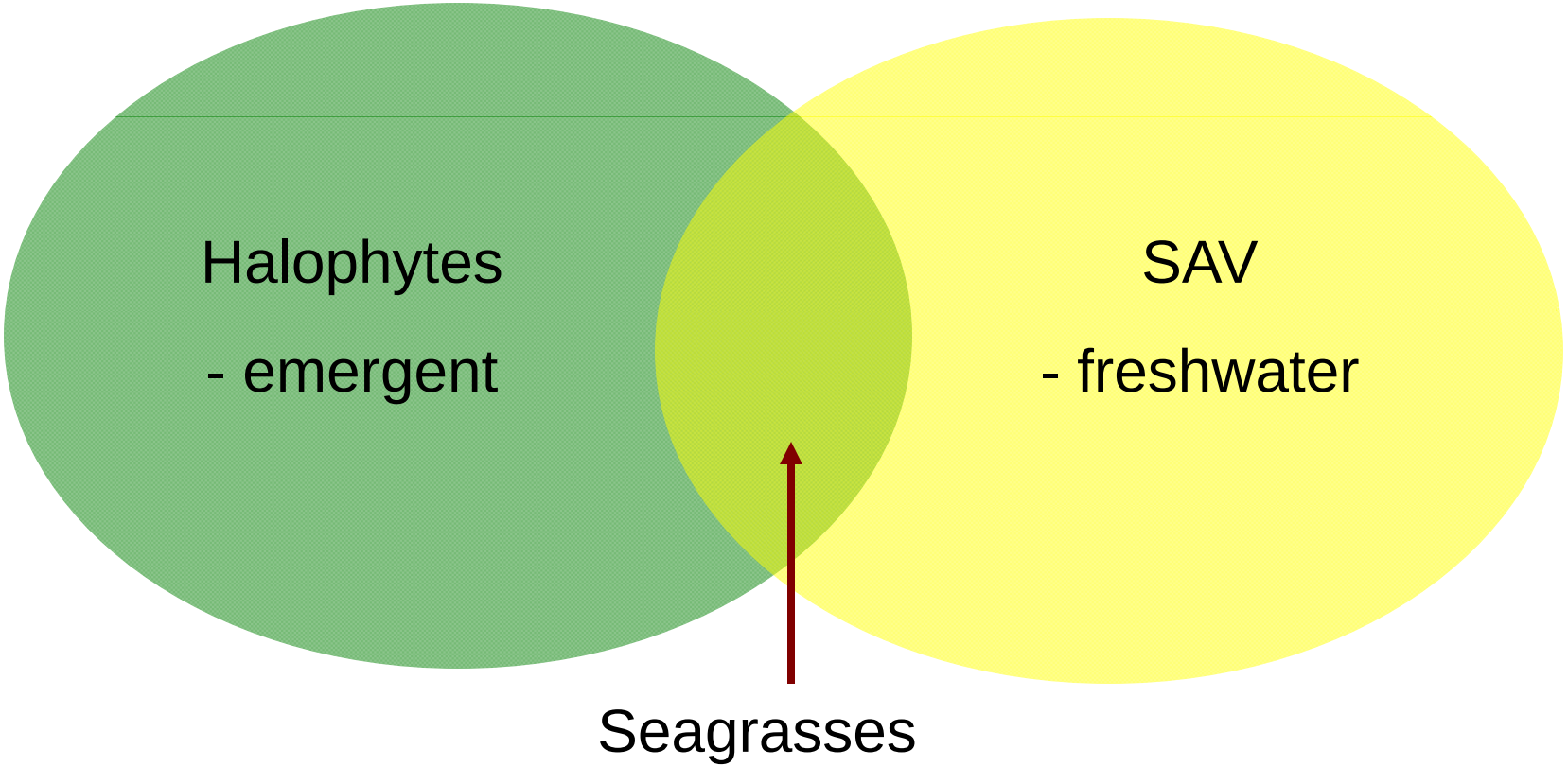
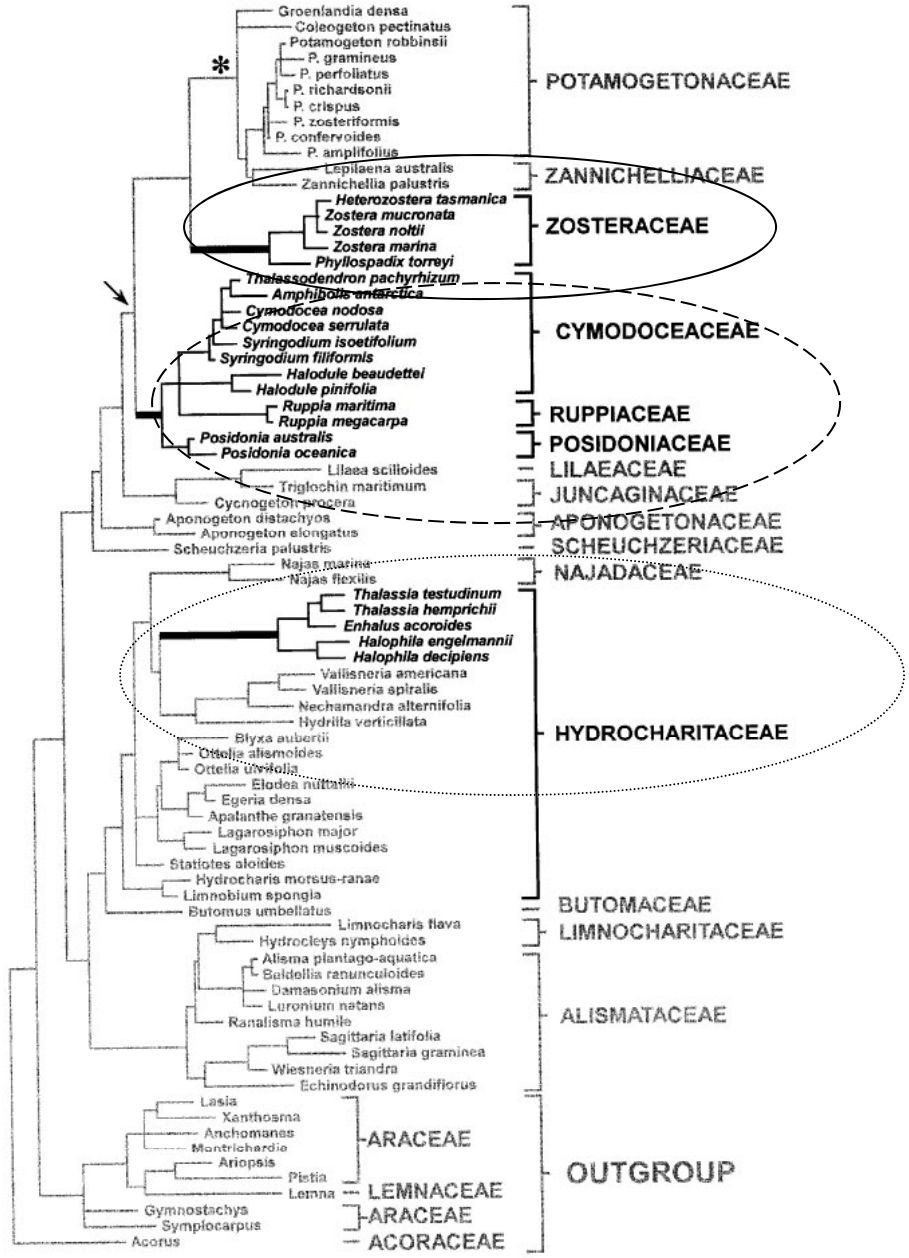
From where did seagrasses originate?

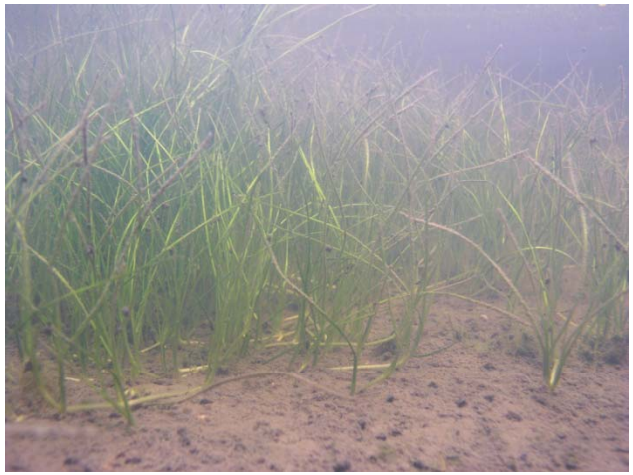




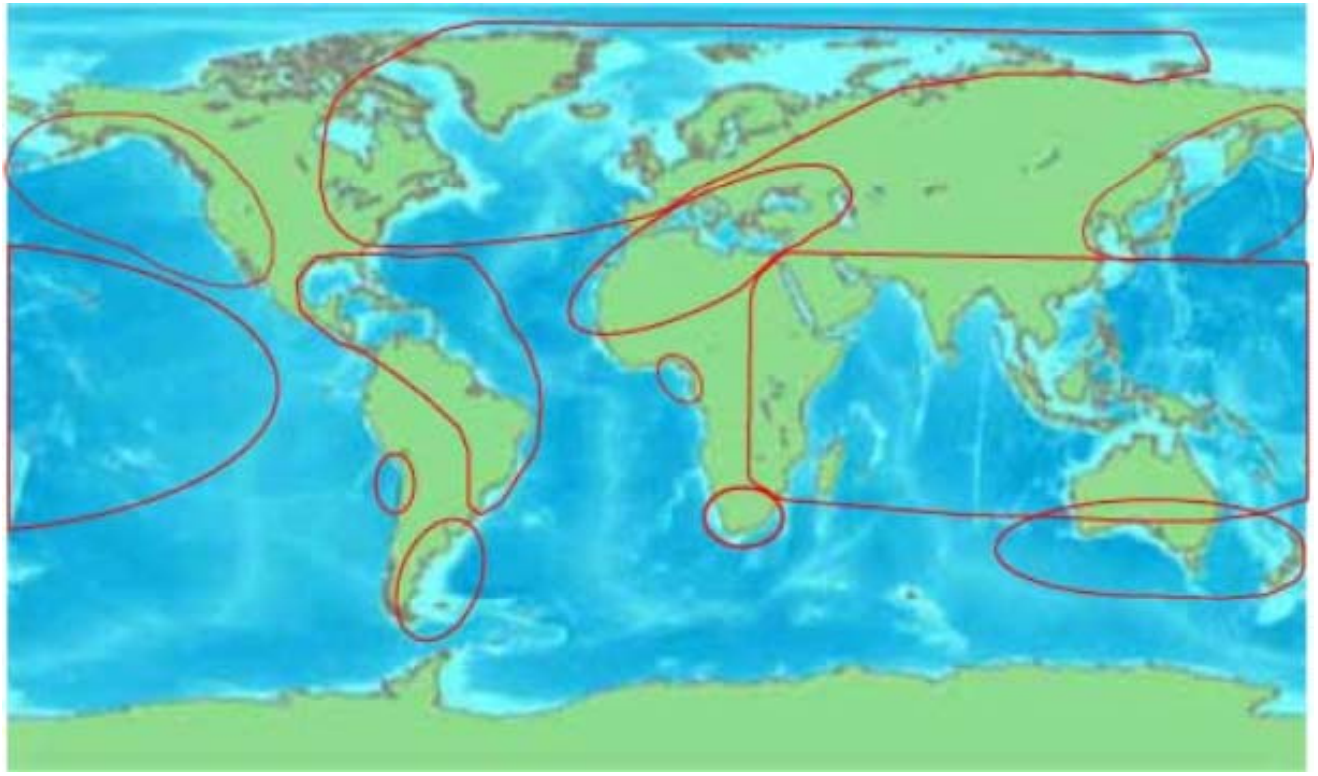
rbcL marker

(Les et al. 1998)

- 3 lineages
- 5 families
- 12 genera
- SAV ancestry



Seagrass Distribution



Temperate - Boreal Regions

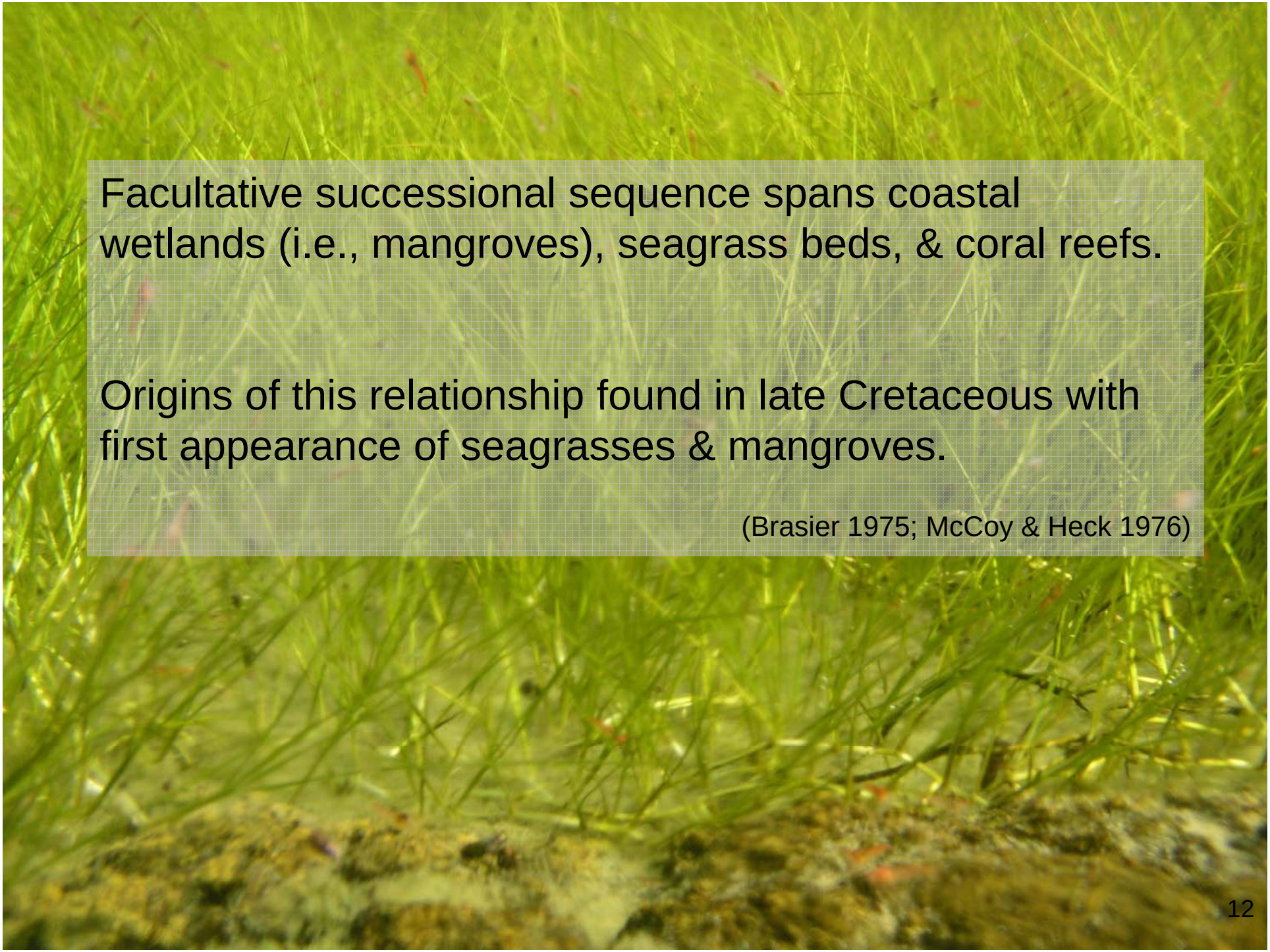
- 4 genera
- ~ 28 species

Tropical - Subtropical Region

- 7 genera
- ~ 30+ species

Eurythermal

- *Ruppia*
- ~ 2-10 spp.

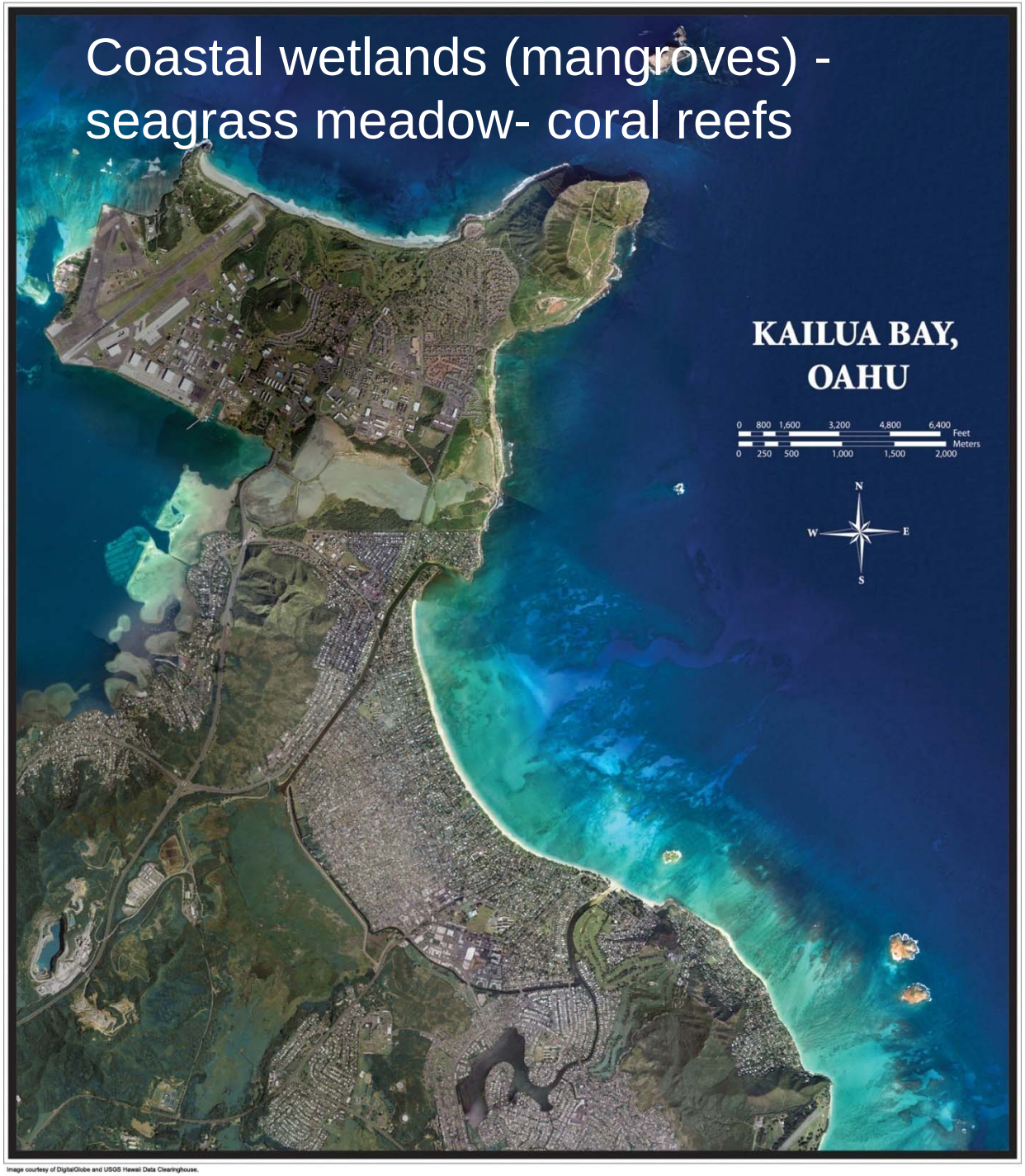


Facultative successional sequence spans coastal wetlands (i.e., mangroves), seagrass beds, & coral reefs.

Origins of this relationship found in late Cretaceous with first appearance of seagrasses & mangroves.

(Brasier 1975; McCoy & Heck 1976)

Tropical wetlands (mangroves) - seagrass meadows - coral reefs:



Shared evolution & distribution:

- seagrasses
- coral reef fishes
- decapods
- mollusks
- manatees

(McCoy & Heck 1976; Brasier 1975; Domning et al. 1982)

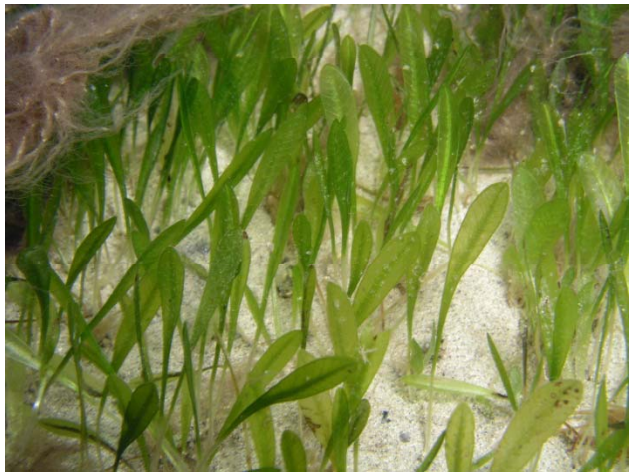
Seagrass Diversity

Halodule

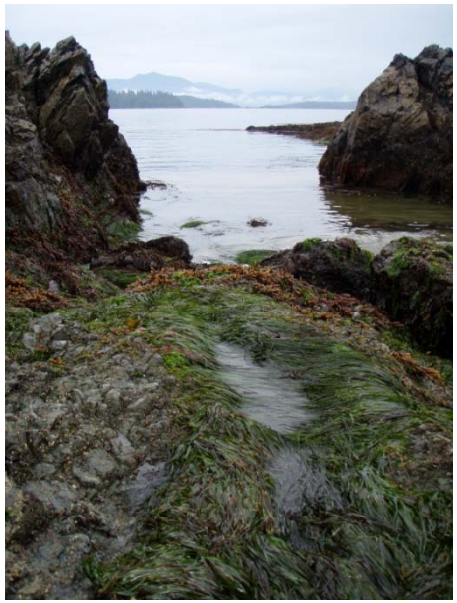
Zostera

Enhalus

Posidonia



Halophila



Phyllospadix

Habitats: Soft Sediment

Leaves ↓ flow

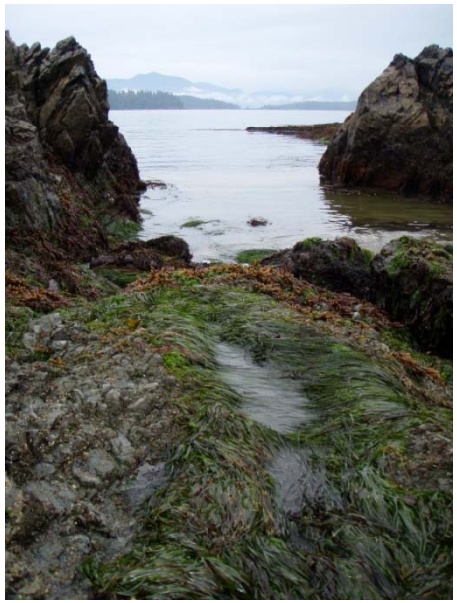
Particulate matter drops out

Rhizomes –

Roots -

Habitat

Habitats - Hard Bottom



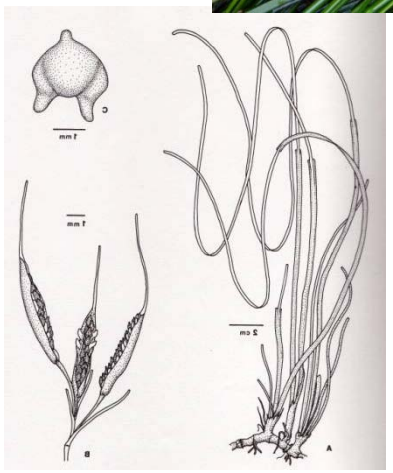
Rocky Inner Tidal

Phyllospadix

Late successional species

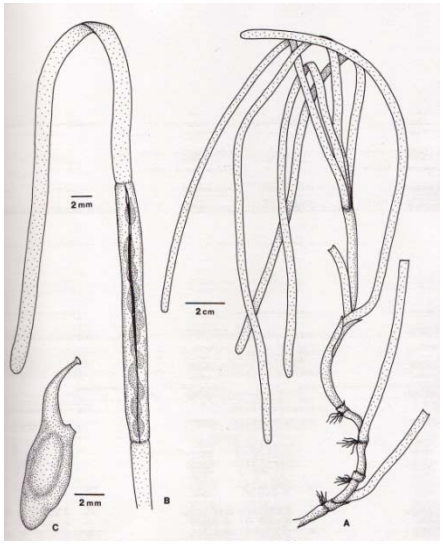
Seagrass Fruits & Seeds

Phyllospadix



- Fruits with hooked barbs
- Macroalgae
- Roots sticky

(Turner 1983)



Vegetative fragments

Bird dispersed *Zostera* & *Ruppia* fruits

Large seeds

Seed bank

Seagrass as a food source: Grazers

Dugongs & Manatees

Waterfowl

Green Turtles

Smaragdia spp.

Seagrass as a food source: suspension & deposit feeders

Estimated Annual Production & Blade Elongation Rate: Florida

(Virnstein 1982)

Halodule beaudettei 182 - 730 g C m^{-2} y^{-1}

~3.1 mm d^{-1}

Syringodium filiforme 292 - 1095 g C m^{-2} y^{-1}

~8.5 mm d^{-1}

Thalassia testudinum 329 - 5840 g C m^{-2} y^{-1}

~2-5 mm d^{-1}

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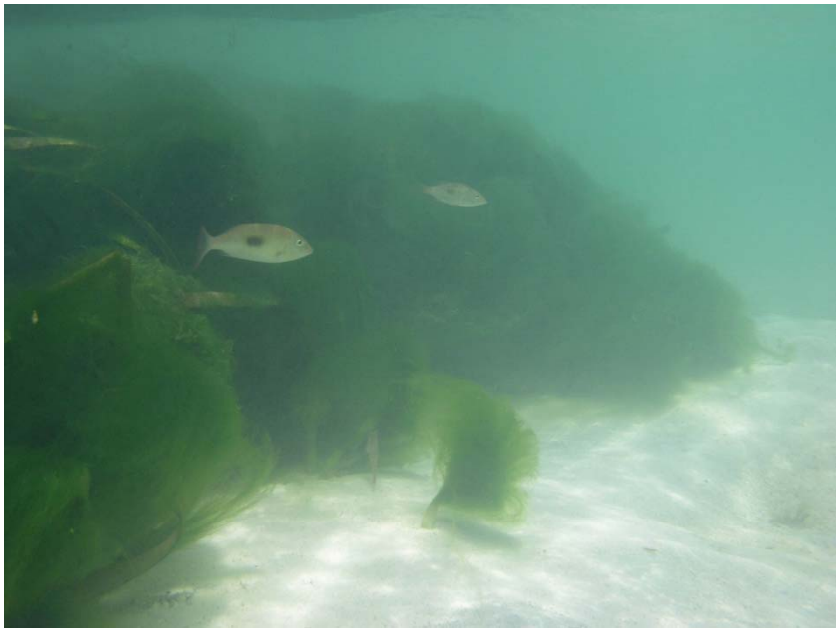
Anthropogenic Stressors

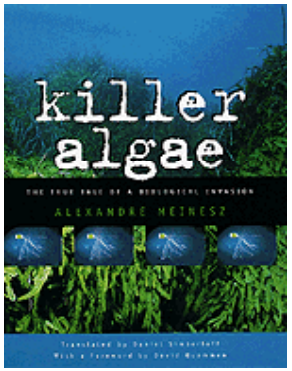


Sewage discharge

Non-point pollution

Algal epiphytes

Invasive spp.



Invasive Species

Caulerpa taxifolia - cultured strain

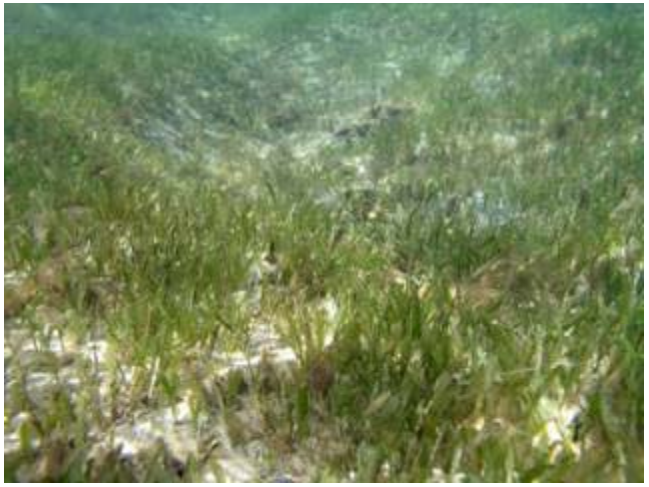
Mediterranean Sea; California; Australia

Posidonia oceanica - endemic seagrass

Seagrasses of Hawai‘i

Halophila decipiens

Halophila hawaiiana



Ruppia maritima

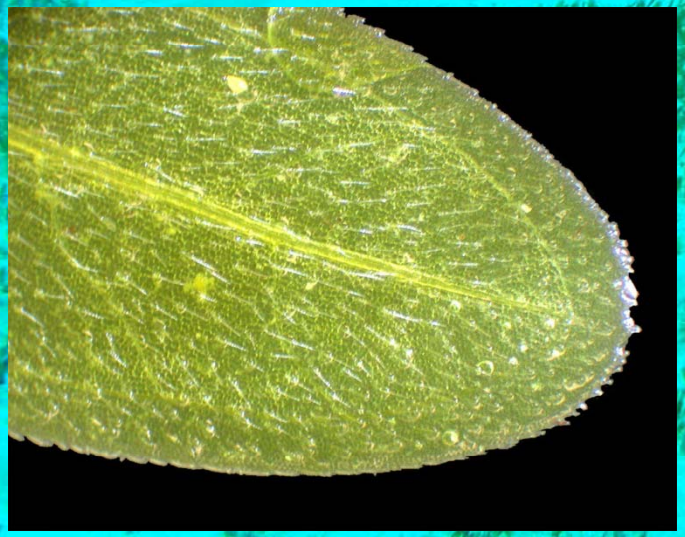
Hawaiian flora reflects isolation

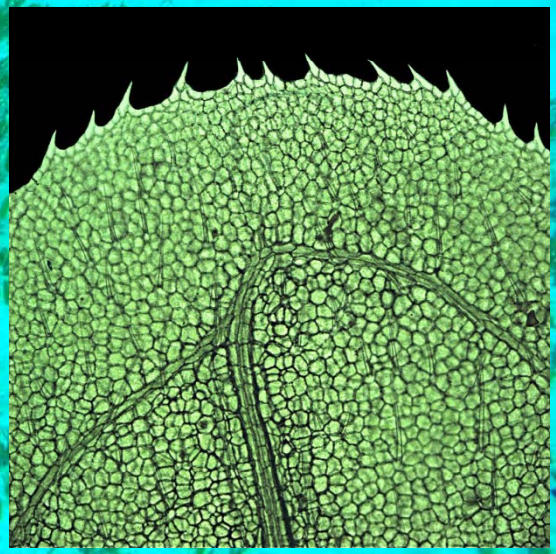
Halophila hawaiiana
Limu enenue

- Endemic species
- 2-3 cm canopy height
- Builds perennial mounds (den Hartog 1970)

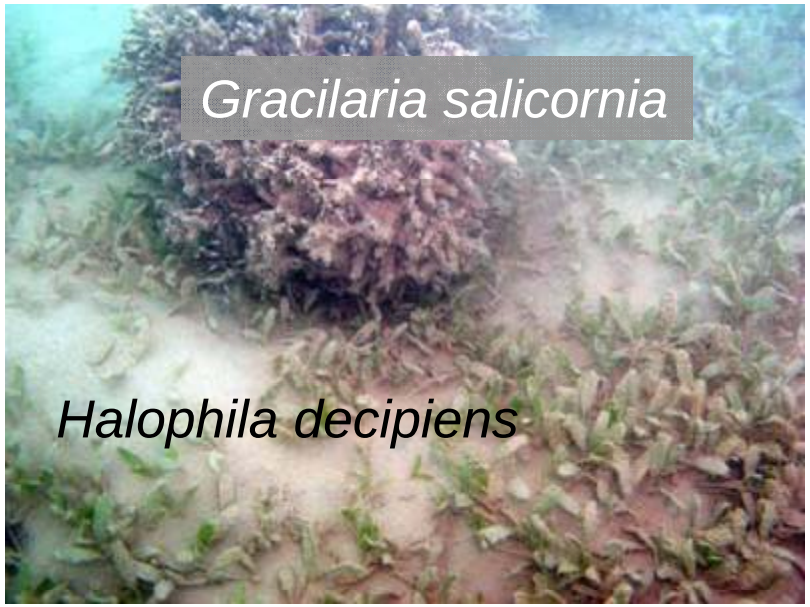
Depth Distribution: 1-90 ft

Halophila decipiens

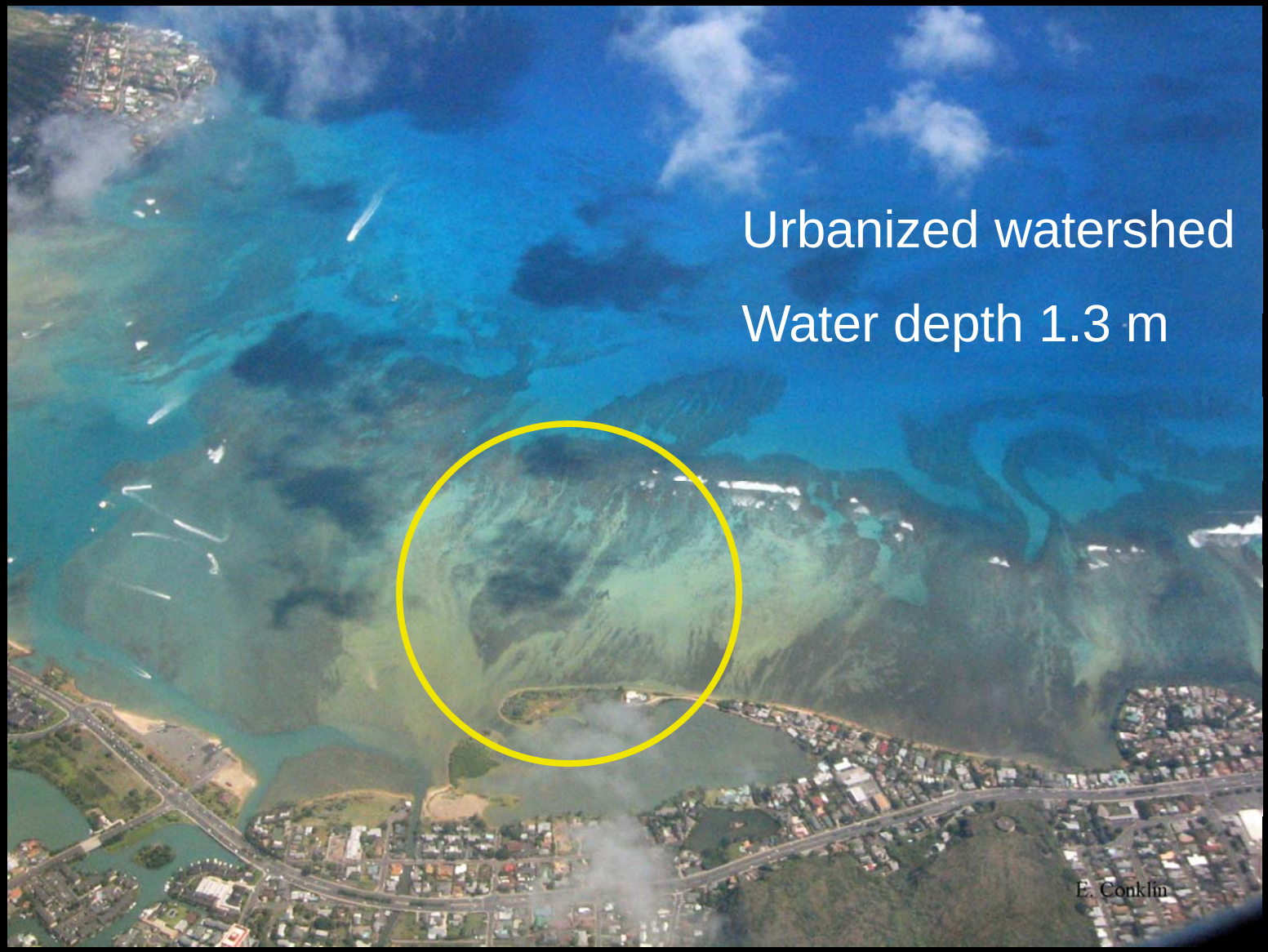




Invasive species & seagrasses of Hawai‘i: Displacement & Smothering

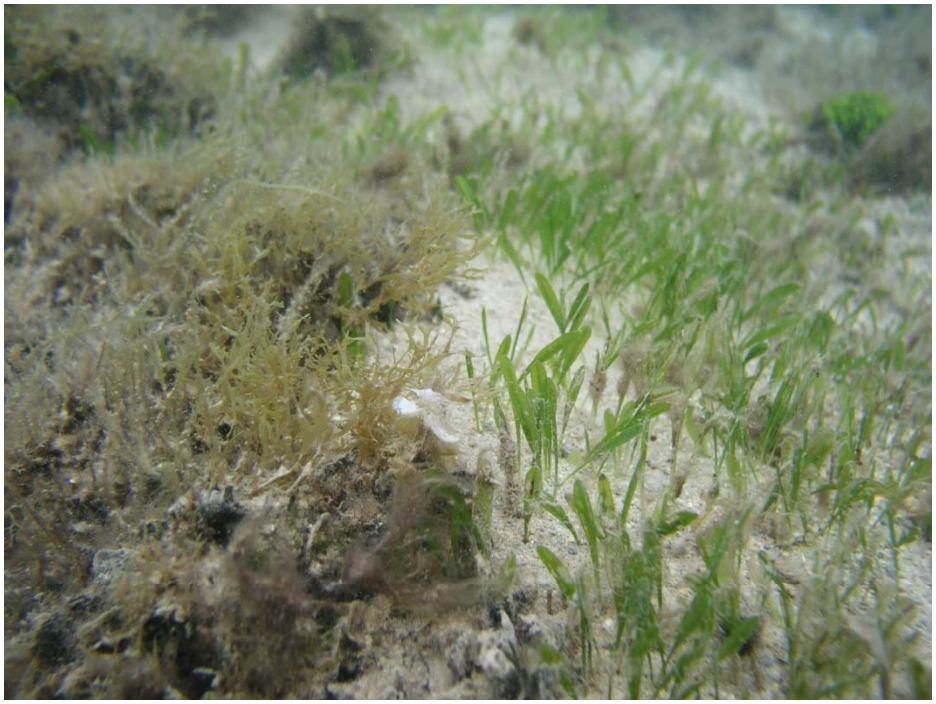


Maunalua Bay - East Honolulu

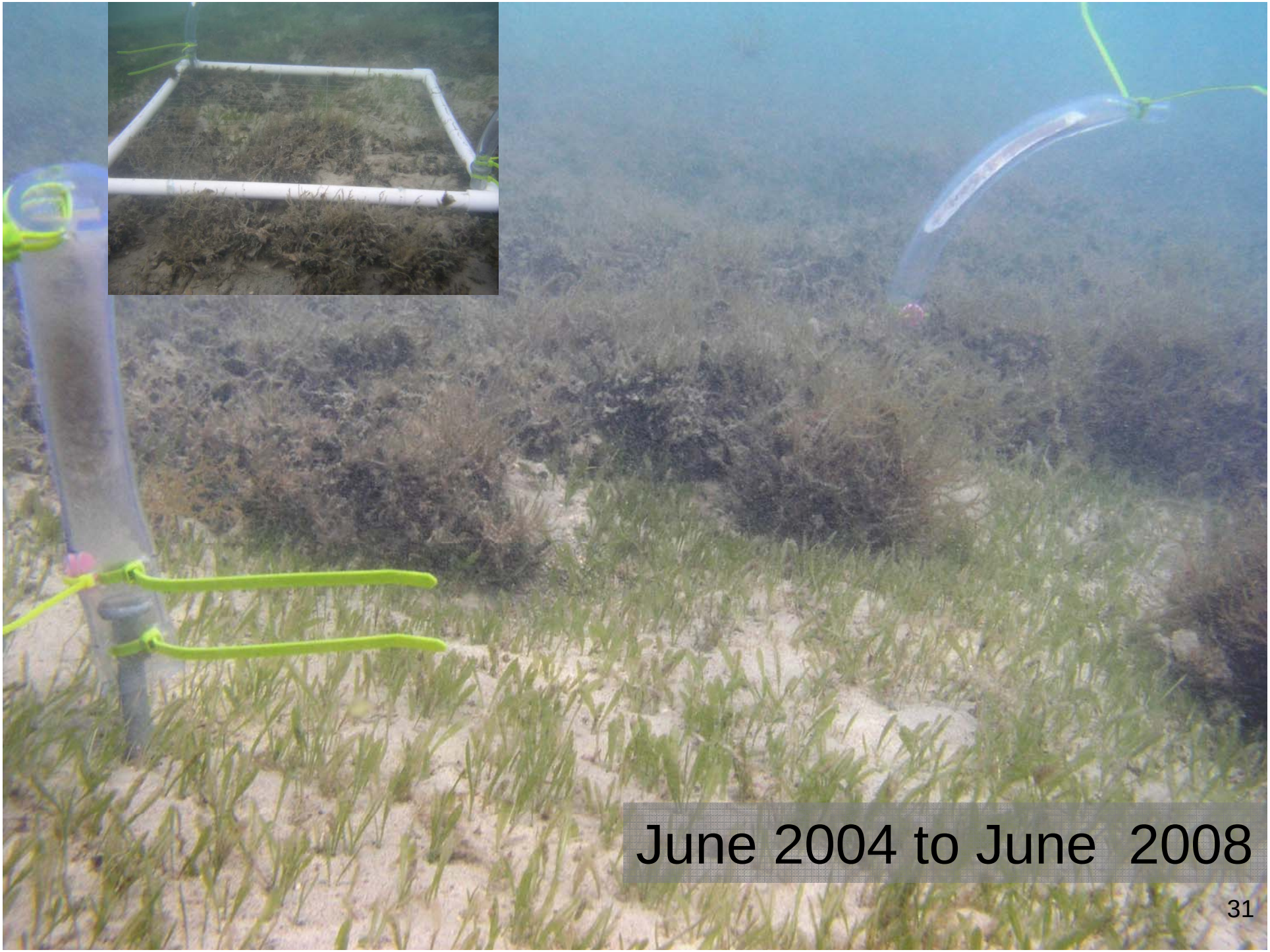


Methods - Removal Experiment

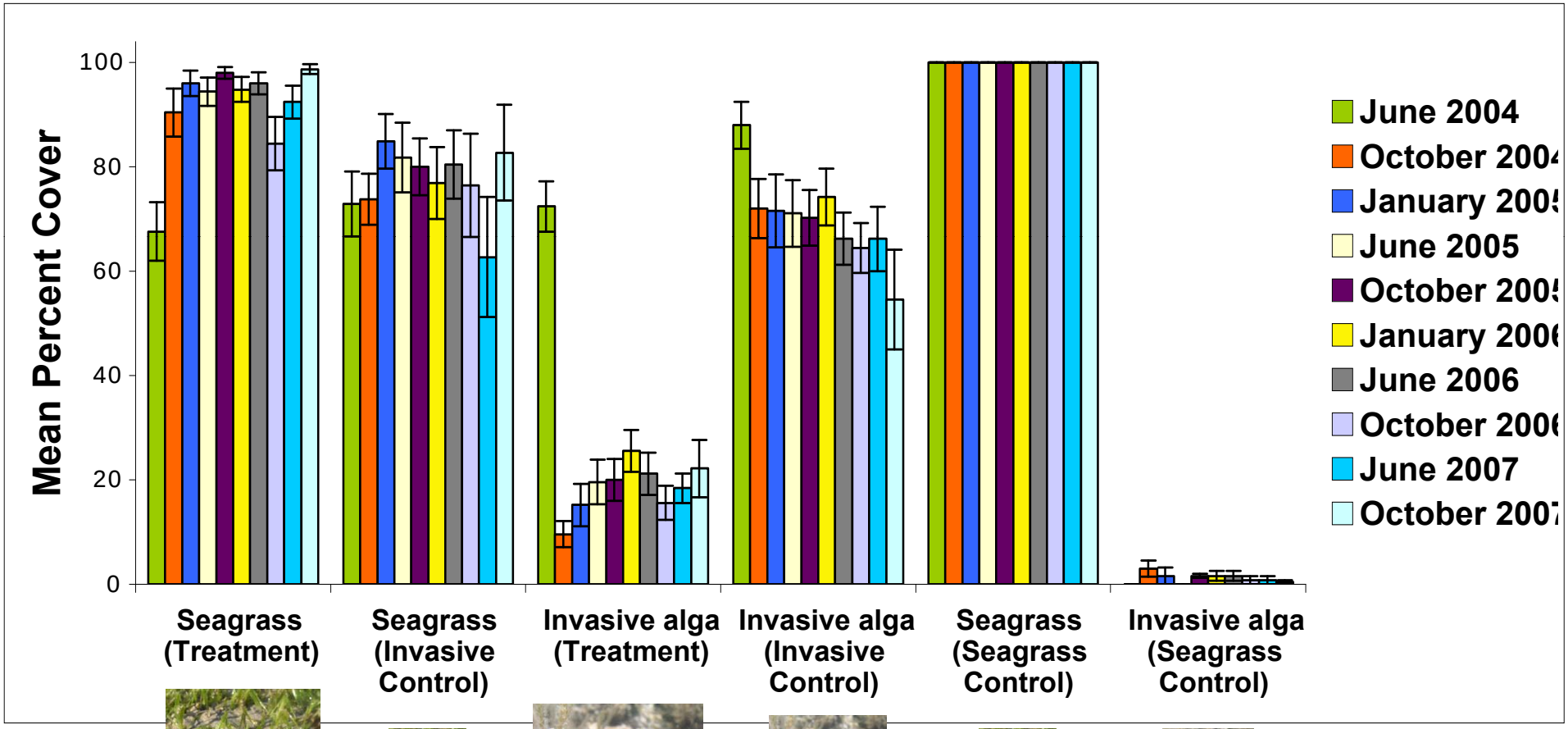
Halophila hawaiiana & Avrainvillea amadelpha



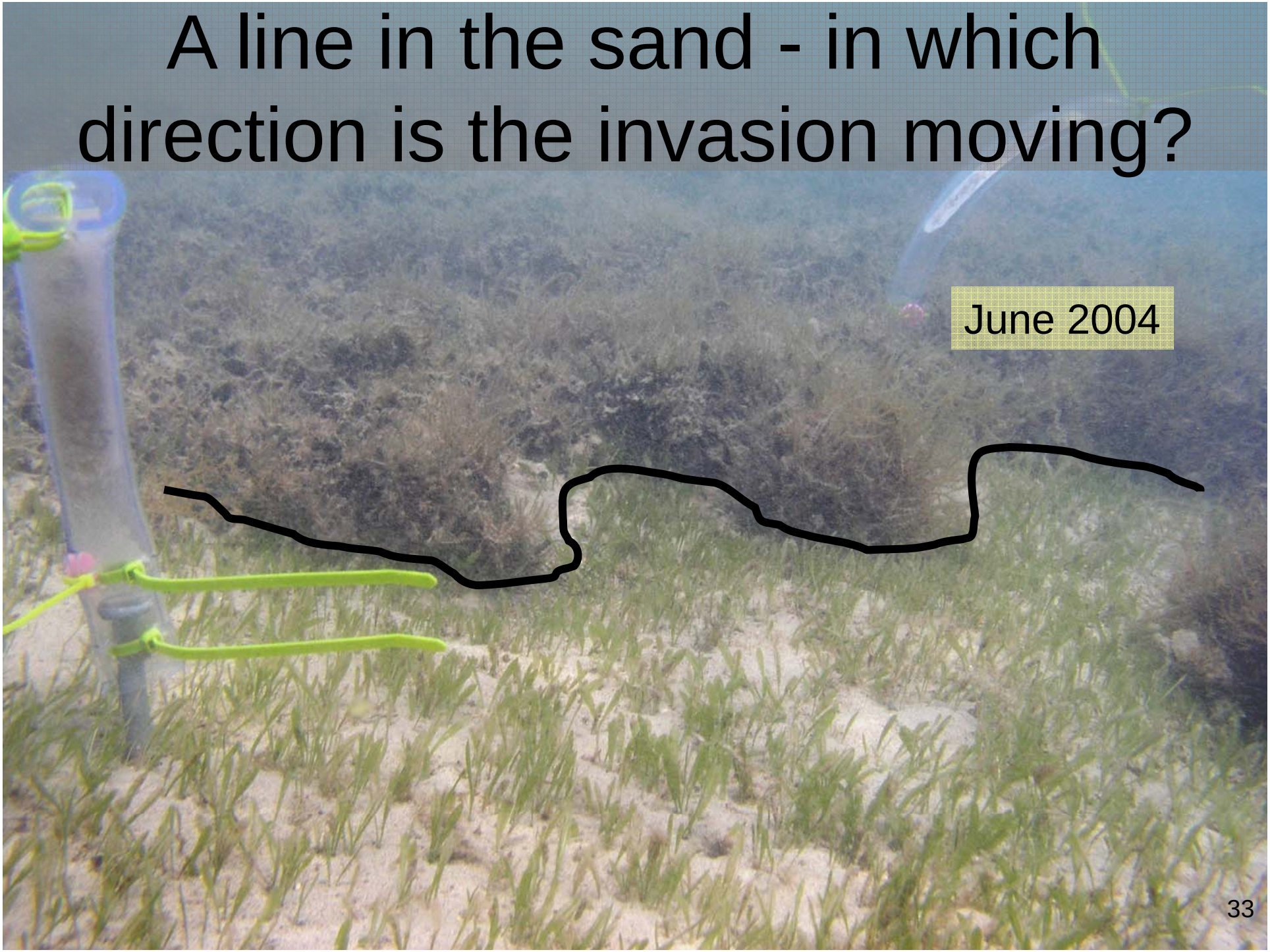
- Established 25 0.25 m^2 fixed plots with 10 treatments, 10 controls with alga & 5 controls without alga
- Treatments - *Avrainvillea* is removed
- Quantified % cover and blade pair densities (Morris *et al.* 2000)
- Monitored over 120 days
- June 2004 to October 2007 +

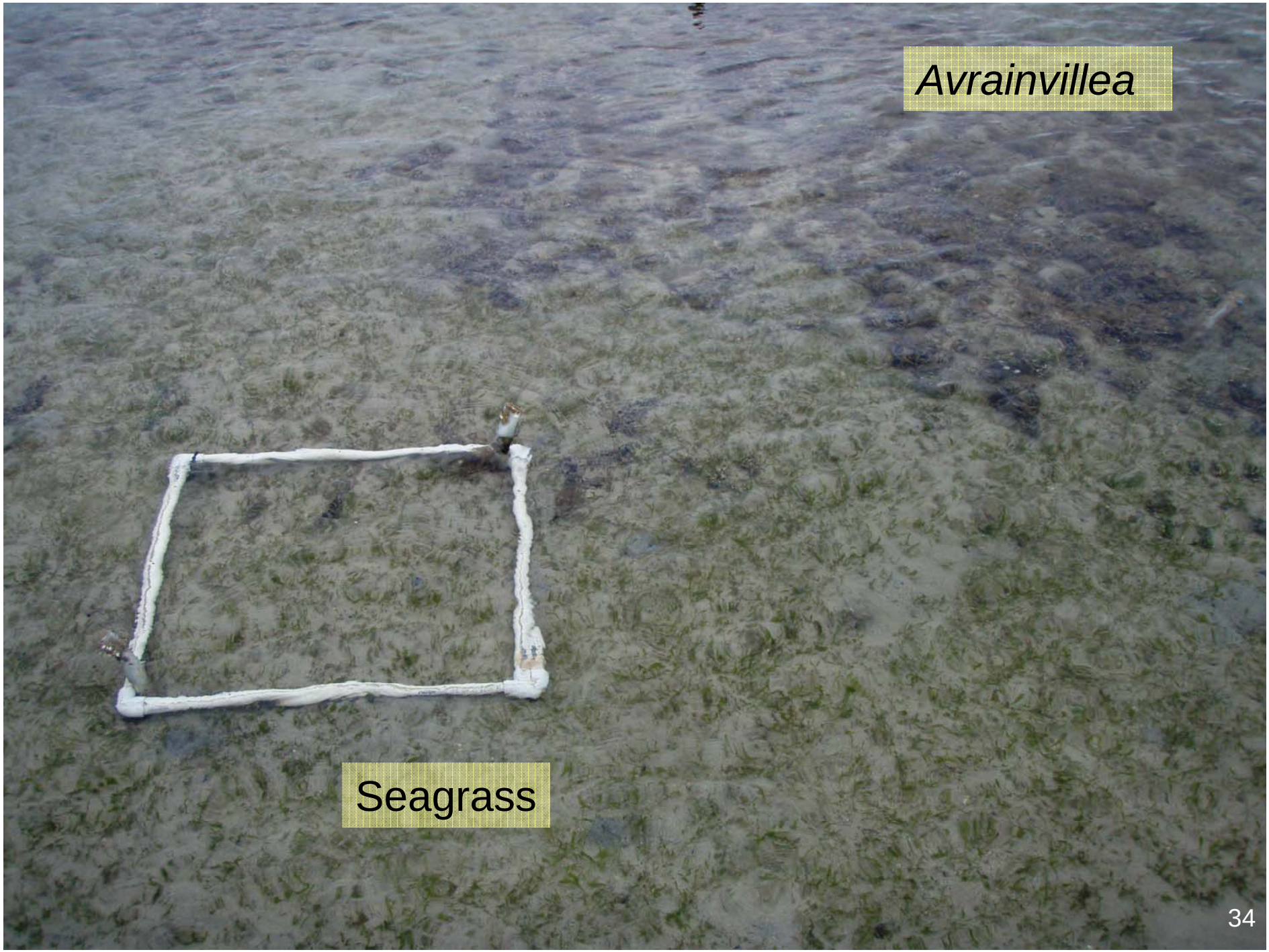

June 2004 to June 2008

Invasive Removal Results



A line in the sand - in which direction is the invasion moving?

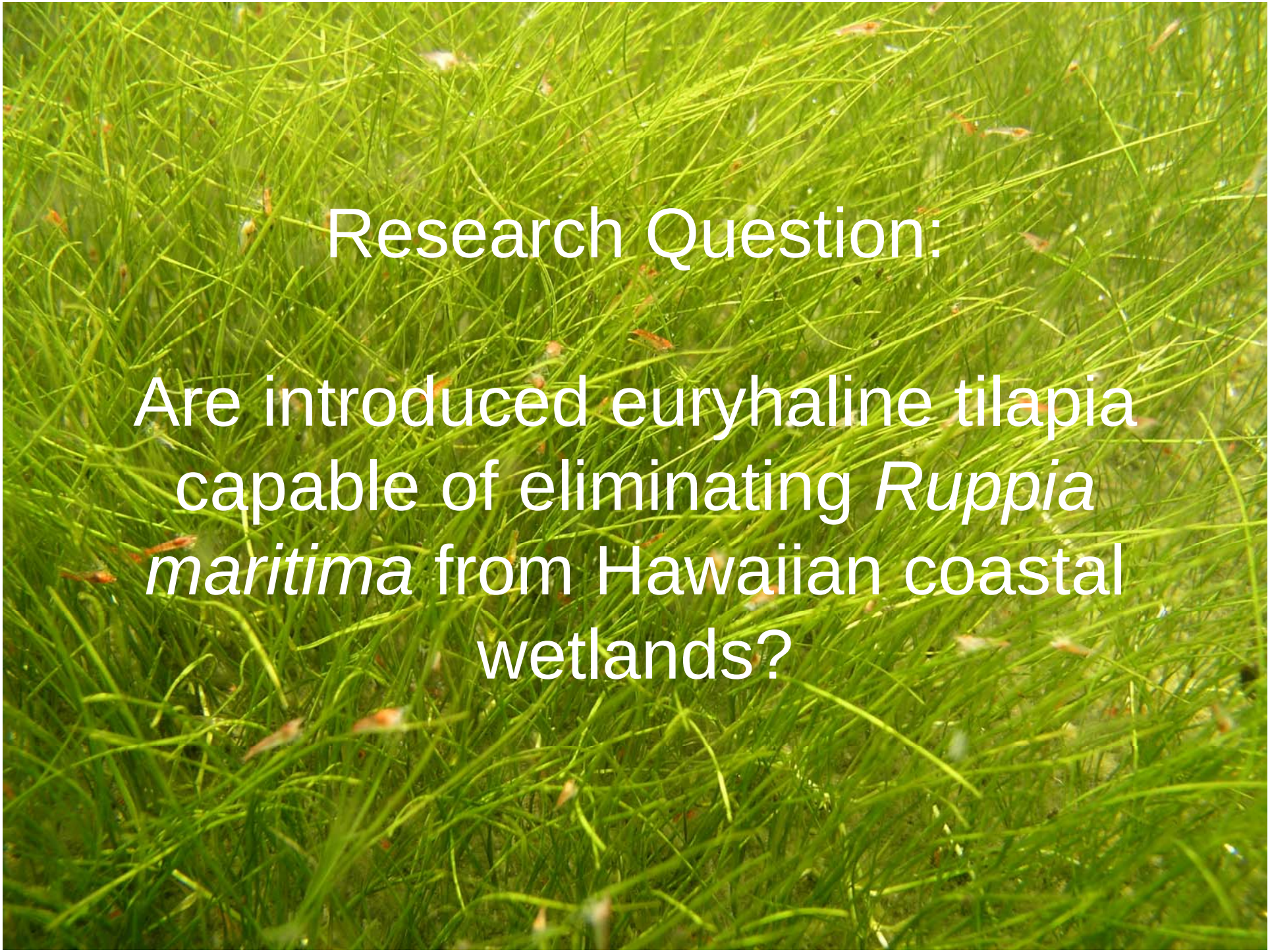



Avrainvillea
Seagrass

Ruppia maritima

Bristle-Thighed Curlew flipping mats of *Ruppia* on Molokai

A. Dibben-Young


Research Question:
Are introduced euryhaline tilapia capable of eliminating *Ruppia maritima* from Hawaiian coastal wetlands?

Observational Results: *Ruppia* distribution across 41 Sites in Hawai‘i

30% sites

56% sites

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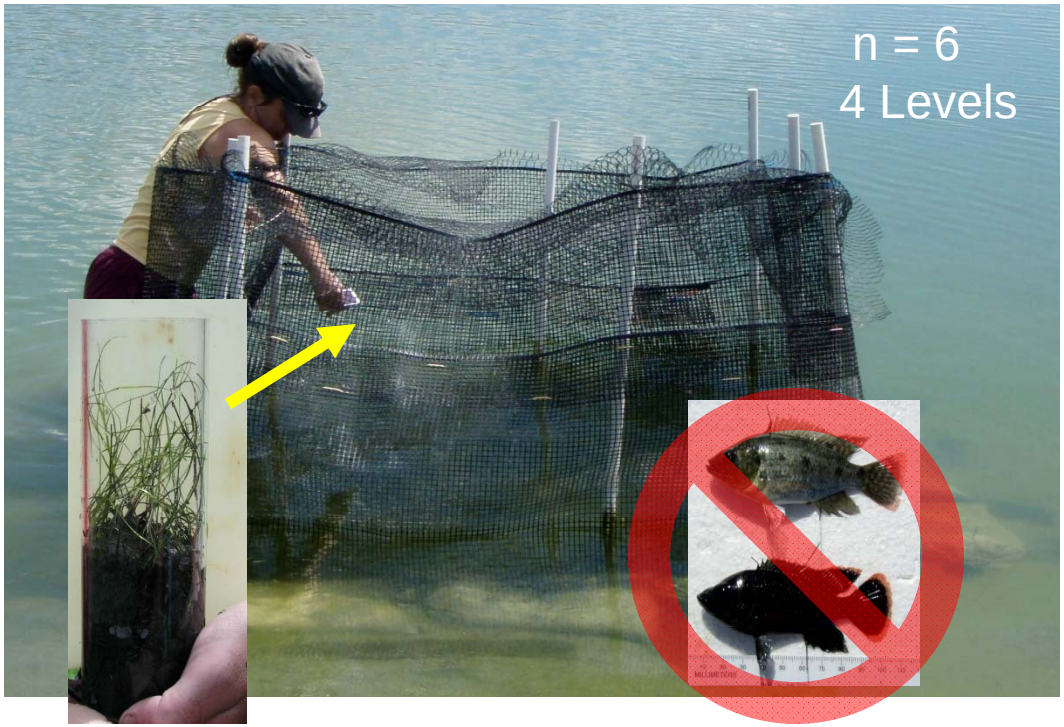
Experimental Results

2 experiments:

- Each at 2 sites
- Both tilapia genera

1) Exclosure experiment



2) Cage experiment

Results: Cage Expt.

Control

Day 0

Day 6

Large Tilapia

Day 0

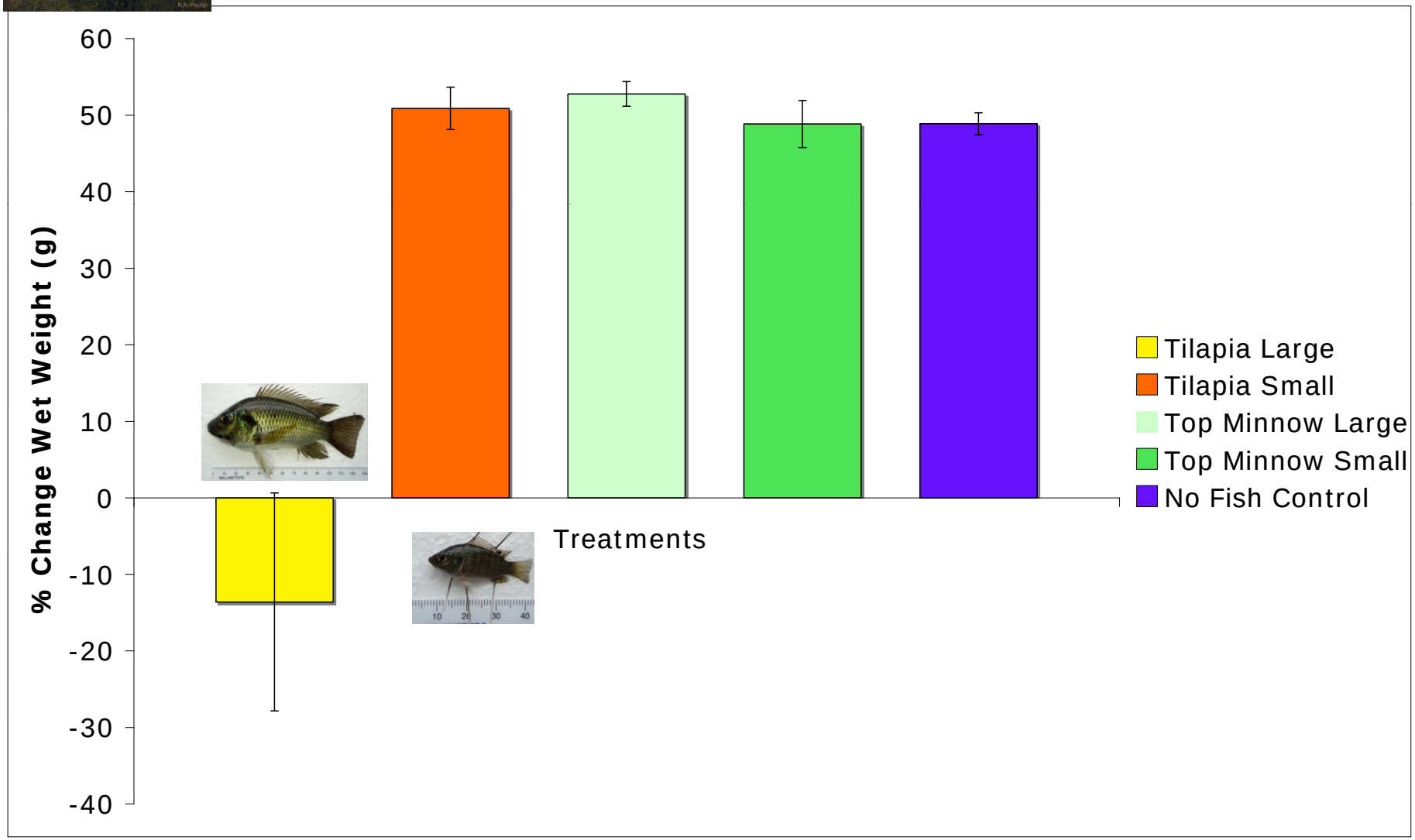
Day 6

Small Tilapia

Day 0

Day 6

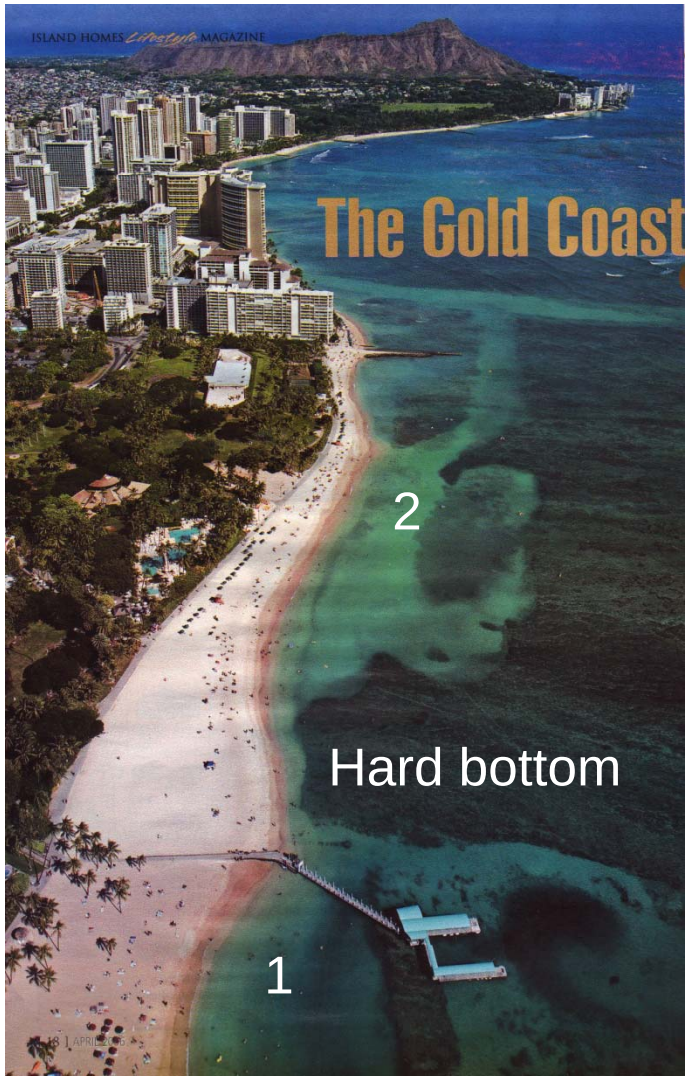
Large tilapia consume *Ruppia*



Waikiki Site Descriptions: Dredged Areas

1 = Impact Site

- Discontinuous meadows of 57 m^2 & 21 m^2
- Seagrass confined to upper portions of dredged slope in 2-2.5 m water depth
- *G. salicornia* tumbleweeds at 3-3.5 m water depth



2 = Control Site

- >3300 m^2 continuous meadow
- 2.5-3.5 m water depth
- Occasional fragments of *G. salicornia*

Gracilaria salicornia - Negative impacts in a *Halophila decipiens* meadow?

The invasive alga *Gracilaria salicornia*

Results, so far

Control Site

- >3300 m^2 continuous *H. decipiens* meadow
- 3-3.5 m water depth
- No *G. salicornia*
- Honu feeding area

Impact Site

- Discontinuous meadow of *H. decipiens* 57 m^2 & 21 m^2
- 2-2.5 m water depth
- *G. salicornia* present 3-3.5 m water depth

Seagrass results, so far