The Seagrasses

Dr. Kim Peyton
(w/ some modifications by Dr. Bruland)
University of Hawai‘i Mānoa
Department of Botany
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

- 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
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:
Coastal wetlands (mangroves) - seagrass meadow - 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**
- **Posidonia**
- **Halophila**
- **Enhalus**
- **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

- Fruits with hooked barbs
- Macroalgae
- Roots sticky

(Turner 1983)

Bird dispersed Zostera & Ruppia fruits
Large seeds
Seed bank

Vegetative fragments
Seagrass as a food source: Grazers

Smaragdia spp.

Dugongs & Manatees

Waterfowl

Green Turtles
Seagrass as a food source: suspension & deposit feeders

- Few direct grazers
- Sequestered nutrients
- Litter
- 10 tons leaves acre\(^{-1}\) year\(^{-1}\)
- 50 million invertebrate infauna acre\(^{-1}\)
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\(^{-1}\)
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

- *Gracilaria salicornia*
- *Halophila decipiens*
- *Halophila hawaiiana*
- *Avrainvillea amadelpha*
- *Gracilaria sp. Florida*
- *Ruppia maritima*
Maunalua Bay - East Honolulu

Urbanized watershed
Water depth 1.3 m
Methods - Removal Experiment

*Halophila hawaiiana & Avrainvillea amadelpha*

- Established 25 0.25 m² 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

Mean Percent Cover

- Seagrass (Treatment)
- Seagrass (Invasive Control)
- Invasive alga (Treatment)
- Invasive alga (Invasive Control)
- Seagrass (Seagrass Control)
- Invasive alga (Seagrass Control)

Legend:
- June 2004
- October 2004
- January 2005
- June 2005
- October 2005
- January 2006
- June 2006
- October 2006
- June 2007
- October 2007
A line in the sand - in which direction is the invasion moving?

June 2004
Ruppia maritima
Bristle-Thighed Curlew flipping mats of *Ruppia* on Molokai
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
Experimental Results

2 experiments:
• Each at 2 sites
• Both tilapia genera

1) Exclosure experiment

n = 6
4 Levels

2) Cage experiment
Results: Cage Expt.

Control

Day 0

Day 6

Large Tilapia

Day 0

Day 6

Small Tilapia

Day 0

Day 6
Results: Cage Experiment

Large tilapia consume *Ruppia*

- Tilapia Large
- Tilapia Small
- Top Minnow Large
- Top Minnow Small
- No Fish Control

% Change Wet Weight (g)

Treatments

- 0
- 10
- 20
- 30
- 40
- 50
- 60

-20 -10 0 10 20 30 40 50 60

-40 -30 -20 -10 0 10 20 30 40 50 60
Waikiki Site Descriptions: Dredged Areas

1 = Impact Site
- Discontinuous meadows of 57 m² & 21 m²
- 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 m² 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 m²
  continuous *H. decipiens* meadow
• 3-3.5 m water depth
• No *G. salicornia*
• Honu feeding area

Impact Site
• Discontinuous meadow of *H. decipiens* 57 m² & 21 m²
• 2-2.5 m water depth
• *G. salicornia* present 3-3.5 m water depth
Seagrass results, so far

n=10; n.s.

n=10; p<0.00001