THE BENEFITS AND CHALLENGES OF INTEGRATING

FOR

SUBMERGED AQUATIC VEGETATION

CONSERVATION AND RESTORATION
Aquatic grass communities are important in Chesapeake Bay

- Food for waterfowl
- Increase water clarity
- Habitat for blue crabs

Good water clarity vs. Poor water clarity

- Aquatic grass present
- Aquatic grass absent
SAV as bioindicators:
- Widespread distributions
- Responsive to perturbations (high light requirements)
- Integrative of environmental conditions
- Important ecological role

SAV = canary in Chesapeake Bay
Aquatic grass communities - widely distributed in Chesapeake Bay

Zostera marina
'eelgrass'

Ruppia maritima
'widgeon grass'

Sources: VIMS & Maryland DNR
Aquatic grass communities are determined by salinity regime.
Chesapeake Bay: Bay wide seagrass loss

- 1933
- 1963
- 1965
- 1980
- 1984-2003

Note: Hatched area of bar includes estimated additional acreage. No survey in 1988.
Restoration of aquatic grass communities of Chesapeake Bay: How should we proceed?

Robert Orth(1), Peter Bergstrom(2), Walter Boynton(3), Tim Carruthers(3), William Dennison(3), Katia Englehardt(3), Dave Goshorn(4), Lee Karrh(4), Evamaria Koch(3), Scott Marion(1), Ken Moore(1), Laura Murray(3), Mike Naylor(4), Nancy Rybicki(5) and Dave Wilcox(1)
THE BENEFITS AND CHALLENGES OF INTEGRATING MANAGEMENT, MONITORING, AND RESEARCH FOR SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION
Models are a powerful, but seductive tool for management

But monitoring...
Annual aquatic grass monitoring using aerial photography

- Annual monitoring project (1978, 1984-present)
- 173 flight lines (2,340 mi)
- 2,033 B/W aerial photographs
- Scale 1:24,000
- Funding: EPA, NOAA, VA DEQ and CRM, MD DNR, ACE

Breton Bay
SAV Species Observations

~1000 observations per year
Over 17,000 observations

Participants:
- Research programs
- Bay managers
- Charter boat captains
- "SAV Hunt"
Photographs are converted to maps by VIMS and ground truthed

- Diamonds show ground truth sites, where species are recorded
- Density is also estimated from photographs
Aquatic grass abundance is inversely related to freshwater flows.

- **1993-1998**: mainly wet
- **1999-2002**: dry
- **2003**: wet

Mean inflow to Chesapeake Bay:
- **1984-1992**: normal or dry
- **1985-2005**:
  - **Q25** (25th percentile): 90,000 ft³ s⁻¹
  - **Q75** (75th percentile): 65,000 ft³ s⁻¹

Historical distribution:
- **75,000 ha**: conservative
- **16,000 - 36,000 ha**: Aquatic grass area (ha)

Graph showing inflow and aquatic grass abundance over time.
River flow affects nitrogen loads (and thus SAV area)

Drought

Sediment load also went up with flow, but was higher in 1996 than 2003

Source: USGS, CBP
Sediment load also responds to flow

Source: MD DNR, CBP
Why do changes in flow change N loads so much?
A: Point source nitrogen is going down...
... but it's only 20% of the total inputs

Source: USGS, CBP
Diffuse N sources are more affected by rainfall, and do not appear to be declining.

Tom Horton estimated that the manure produced by livestock in Lancaster County, PA, alone could meet the fertilizer needs for the whole watershed, but it would be too expensive to ship it.

Thus, we need to reduce diffuse N sources to improve aquatic grasses.

Source: USGS, CBP
Aquatic grass communities are determined by salinity regime.

Chesapeake Bay Communities

Names color coded to map

Freshwater

Potamogeton

Ruppia

Zostera

Eastern Neck Narrows

2002

2004

2004
Havre de Grace

1989

2000

2004
THE BENEFITS AND CHALLENGES OF INTEGRATING MANAGEMENT, MONITORING, AND RESEARCH FOR SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION
Importance of seeds in establishing new beds versus maintaining existing beds (basic research)

Optimal time for use in restoration efforts with seed (spring, summer, fall) (applied research)
Seeds on the sediment surface do not move far from where they settle.

Dark bands are patches of seedlings from seeds broadcast onto bare sand substrate.

Seeds retained where they settle because of topographic complexities of sediment surface due to bioturbation or physical discontinuities (e.g., sand ripples)
*Diopatra* influences reproductive shoot dispersal by entraining them in tube caps.
**Posidonia australis**

'Heaps' of fruits!

15-20 mm
Parker Point, Rottnest Island, Western Australia, 1996
IN THE BEGINNING!!

Seedlings abundant in bare sand and *Halophila*, none in dense seagrass

*Posidonia* seedling
METHODS (Phase I)

- Tethered seeds
- 10 in sand and grass
- 24 hour test period
- Scored as completely or partially eaten
- Trials 3-8 days depending on location in Nov. & Dec. 2001
For a seed
STAY OUT OF THE GRASS
THE BENEFITS AND CHALLENGES OF INTEGRATING MANAGEMENT FOR SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION
CHESAPEAKE BAY POLICIES FOR SEAGRASS RESTORATION AND CONSERVATION

- 1989 Management Policy - achieve net gain in seagrass distribution
- 1992 Bay Agreement - use seagrass as initial measure of progress in restoring living resources and water quality
- 1993 Bay Agreement - restore seagrass to historic levels and an interim goal of 114,000 acres
CHESAPEAKE BAY POLICIES FOR SEAGRASS RESTORATION AND CONSERVATION

- 1997 Blue Crab Fisheries Management Plan - link fisheries management to both water and habitat (seagrass) quality
- 2000 Bay Agreement - develop specific plans to protect and restore seagrass
- 2002 Bay Agreement - new goal for restoring seagrass set at 186,000 acres
- 2003 - Strategy for the protection and restoration of SAV
CHINCOTEAGUE BAY SAV SANCTUARY

VMRC Reg 4VAC 20-1010-10 (1997 - no markers); amended by Reg 4VAC 20-70-120 (Dec. 1, 2001 - with marked boundaries) following meetings with staff, scientists, and watermen preventing clam and crab dredging in SAV protected area
NR4-1006.1 - No clam dredging in areas delineated with SAV from a composite of 3 consecutive years of aerial photography (takes into account natural inter-annual variability)
Aquaculture versus critical habitats
'Strategy to Accelerate Protection and Restoration of SAV in Chesapeake Bay'

By Dec. 2008, plant at least 1000 acres at multiple sites!!
Restoration of aquatic grass communities of Chesapeake Bay: How should we proceed?

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A variety of techniques are used for restoration of aquatic grass. All are labor intensive; tedious; have potential donor bed impacts; and only plant small areas.
Long term survival of eelgrass planted in the York River at VIMS

1984

1985

1987

1988

1990-2004
However, less than 10% of transplant sites (adult or seed) have long term survival.
How is nature doing relative to our efforts?

Humans

Nature
Nature is doing pretty well in some areas (natural recovery)

Middle Potomac River

MD Coastal Bays
Natural recovery of freshwater community in the middle Potomac; 1982-2003

- Initial recruitment of exotic *Hydrilla*
- Native species slowly increased from propagules upriver - *Hydrilla* remains
- During this period, nitrogen in the middle Potomac declined (next slide)

Source: VIMS
Middle Potomac had improving water quality (nitrogen) during this natural recovery.

49% reduction in TN discharge from Blue Plains WWTP; 1985-2003

Sources: MD DNR, MWCOG
Natural recovery of *Zostera* community in MD Coastal Bays; 1986-2003

- Aquatic grass died in 1930s; wasting disease
- 600 acres per year returned without planting (1986-2003)

Source: State of Maryland Coastal Bays 2004
MD Coastal Bays had good water quality where this natural recovery occurred

- Areas of regrowth in Chincoteague had good water quality 2001-2003
- Among MD Coastal Bays, grass cover highly related to water quality (see below)

Source: State of Maryland Coastal Bays 2004

<table>
<thead>
<tr>
<th>Bay</th>
<th>Sinepuxent</th>
<th>Chincoteague</th>
<th>Assawoman</th>
<th>Isle of Wight</th>
<th>Newport</th>
<th>St Martin</th>
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<tbody>
<tr>
<td>Water quality</td>
<td>Green</td>
<td>Green</td>
<td>Pink</td>
<td>Yellow</td>
<td>Pink</td>
<td>Pink</td>
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<tr>
<td>Aquatic grass area (% of Bay)</td>
<td>36</td>
<td>32</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>&lt;1</td>
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Conclusions

- Aquatic grass communities widespread in Chesapeake Bay; variable and greatly reduced from historical distribution.

- Seed and shoot transplanting can work, but <10% long term success.

- Natural recovery has occurred where there is good water quality.

- Where good water quality occurs, targeted local restoration efforts are valuable.
1 acre eelgrass plots located behind Wreck Island (PLANTED WITH SEEDS IN 2001 AND 2002)

Scale - 1:24,000
seeds
'Dots' are small eelgrass patches from seeds produced by plants in the 'B' and not observed in 2003 photo.
~100% SAV cover derived from small test plots

200 m
Seagrass Planted in the Seaside Coastal Bays

Seagrass Area (acres)

- 1997: 10 acres
- 1998: 20 acres
- 1999: 30 acres
- 2000: 40 acres
- 2001: 50 acres
- 2002: 60 acres
- 2003: 70 acres
- 2004: 80 acres
Restoration of aquatic grass communities of Chesapeake Bay:
How should we proceed?

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Recommendations

- Need better understanding of the four aquatic grass communities, their variability and recovery

- Due to limited long term survival, restoration projects must include long term monitoring, and improved site and technique targeting

- Continue annual aquatic grass mapping to quantify natural recovery events

- Returning aquatic grasses to Chesapeake Bay will require improved water quality
SAV recovery in tidal freshwater region of the Patuxent River
Management

Monitoring

Research

75,000 ha: conservative historical distribution

1984 - 2003
16,000 - 36,000 ha

Healthy Chesapeake Waterways

Graph
Acknowledgments

- Chesapeake Bay Program for making aquatic grasses a priority since 1976

- Funding agencies for aerial survey: EPA, NOAA, VA DEQ and CRM, MD DNR, USACE

- Funding agencies for aquatic grass restoration: NOAA (NMFS, VA & MD CZM and Sea Grant), KCF, VMRC, DoD (USACE, Legacy, USAEC, APG), EPA, NFWF, CBT, CBF, NAIB, MPA, USGS, MD DNR, VIMS Hopewell WWTP
EELGRASS
## SAV Habitat Requirements

<table>
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<tr>
<th>Salinity</th>
<th>Kd</th>
<th>TSS mg/l</th>
<th>Chl μg/l</th>
<th>DIN mg/l</th>
<th>DIP mg/l</th>
<th>PLW</th>
<th>PLL</th>
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<tr>
<td>Tidal Fresh (&lt;0.5 ppt)</td>
<td>&lt; 2</td>
<td>&lt; 15</td>
<td>&lt; 15</td>
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<td>&lt; 0.02</td>
<td>&gt; 13%</td>
<td>&gt; 9%</td>
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<td>Oligohaline (0.5-5 ppt)</td>
<td>&lt; 2</td>
<td>&lt; 15</td>
<td>&lt; 15</td>
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<td>&lt; 0.02</td>
<td>&gt; 13%</td>
<td>&gt; 9%</td>
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<td>Mesohaline (5-18 ppt)</td>
<td>&lt; 1.5</td>
<td>&lt; 15</td>
<td>&lt; 15</td>
<td>&lt; 0.15</td>
<td>&lt; 0.01</td>
<td>&gt; 22%</td>
<td>&gt; 15%</td>
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<td>Polyhaline (&gt;18 ppt)</td>
<td>&lt; 1.5</td>
<td>&lt; 15</td>
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<td>&lt; 0.15</td>
<td>&lt; 0.02</td>
<td>&gt; 22%</td>
<td>&gt; 15%</td>
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PROPELLER SCARRING
Poquoson Flats region

A

480 ACRES

B

536 ACRES

C

261 ACRES

Boat Scars Present

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Browns Bay Boat Scars

Scar length (m)


[Graph showing the number of boat scars at Browns Bay from 1989 to 2003, with scar length in meters on the y-axis and years on the x-axis.]
20 locations in scars created in 2000 in Poquoson Flats and Browns Bay.

Susquehanna R. at Conowingo Dam

- TN
- NO₃

mg N L⁻¹

calendar year


- wet years
- fertilizers, human/animal waste
- watershed management?

forests (Clark et al. 2000)

data source: USGS