The Chesapeake Experience:

Lessons Learned Challenges Ahead

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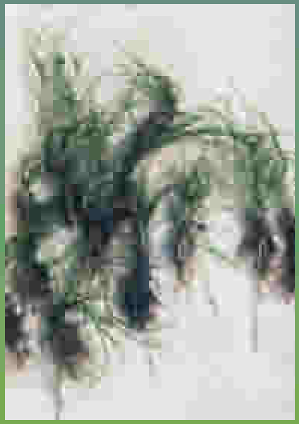
College of William and Mary

www.vims.edu/bio/sav

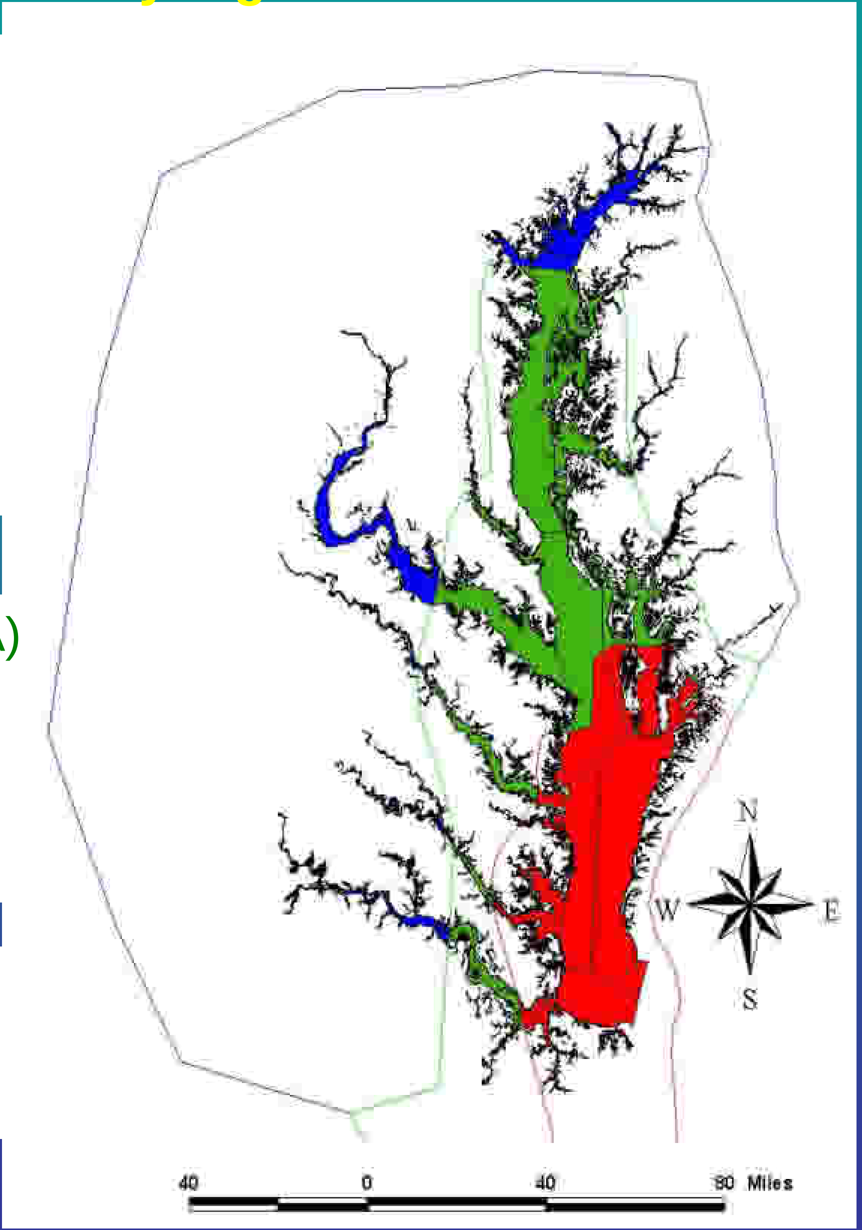


SAV communities are widely distributed in Chesapeake Bay and determined by salinity regime

FRESHWATER/LOW SALINITY (BLUE AREA)
Vallisneria americana (wild celery)
Elodea canadensis (common elodea)
Najas spp. (Naiads)
Hydrilla verticillata (hydrilla)
Myriophyllum spicatum (milfoil)
Heteroanthera dubia (water stargrass)
Ceratophyllum demersum (coontail)

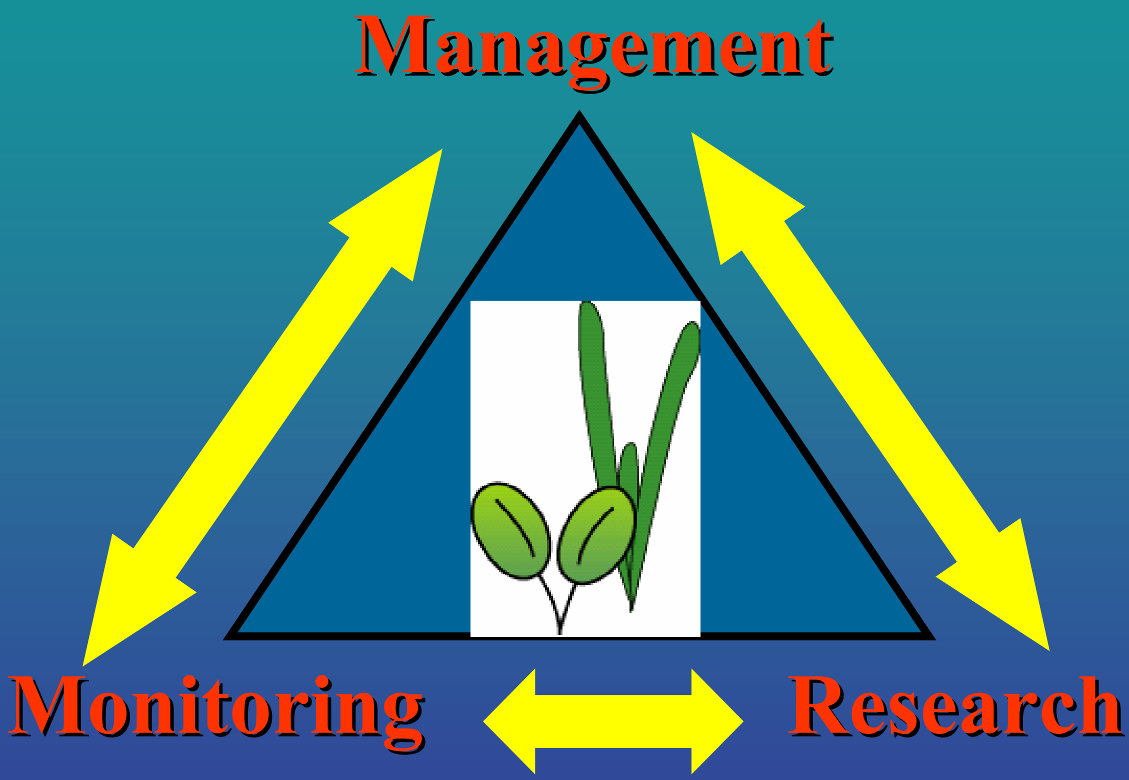
MID-SALINITY (MESOHALINE)(GREEN AREA)
Ruppia maritima (widgeongrass)
Zostera marina (eelgrass)
Potomageton perfoliatus (redhead grass)
Stukenia pectinata (sago pondweed)

HIGH-SALINITY (POLYHALINE) (RED AREA)
Zostera marina (eelgrass)
Ruppia maritima (widgeongrass)



THE BENEFITS AND CHALLENGES

OF INTEGRATING



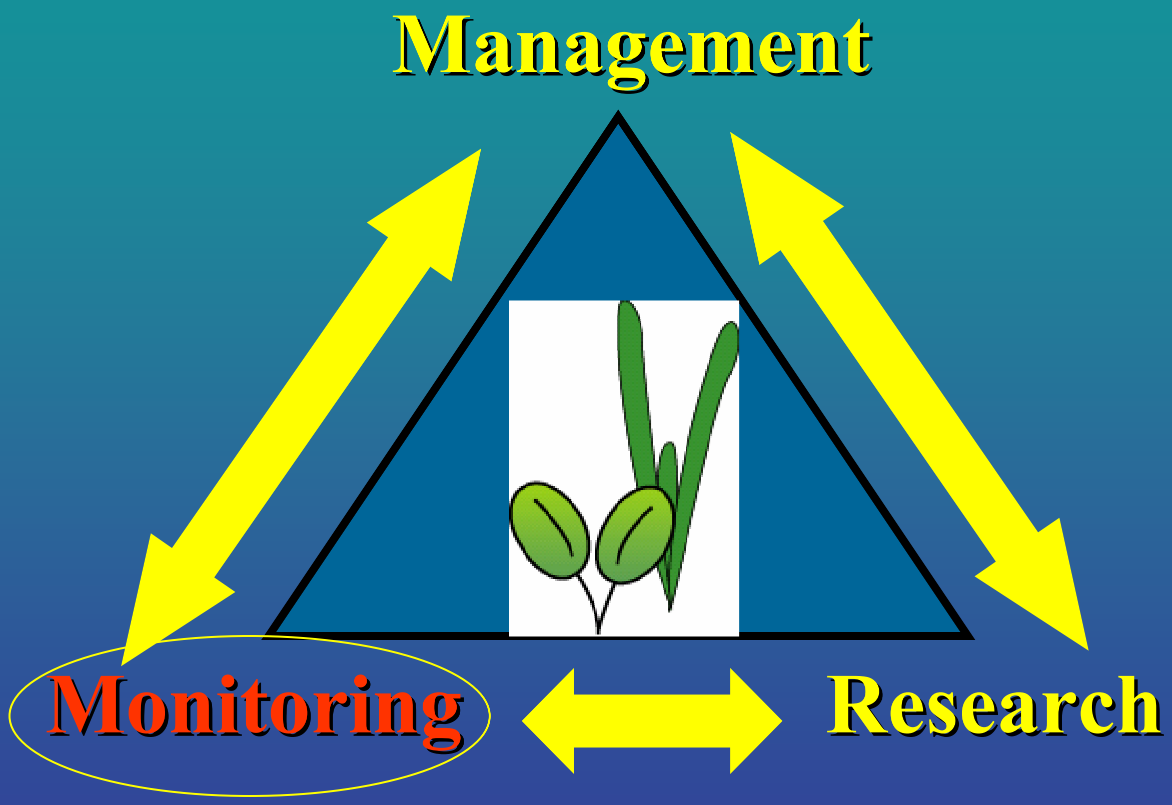
FOR

SUBMERGED AQUATIC VEGETATION

CONSERVATION AND RESTORATION

THE BENEFITS AND CHALLENGES

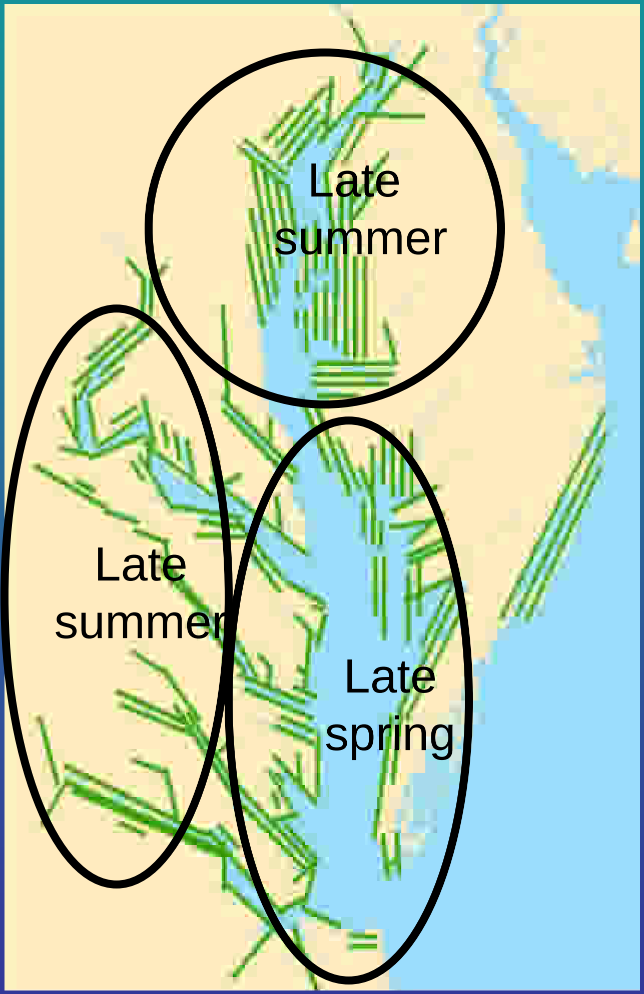
OF INTEGRATING



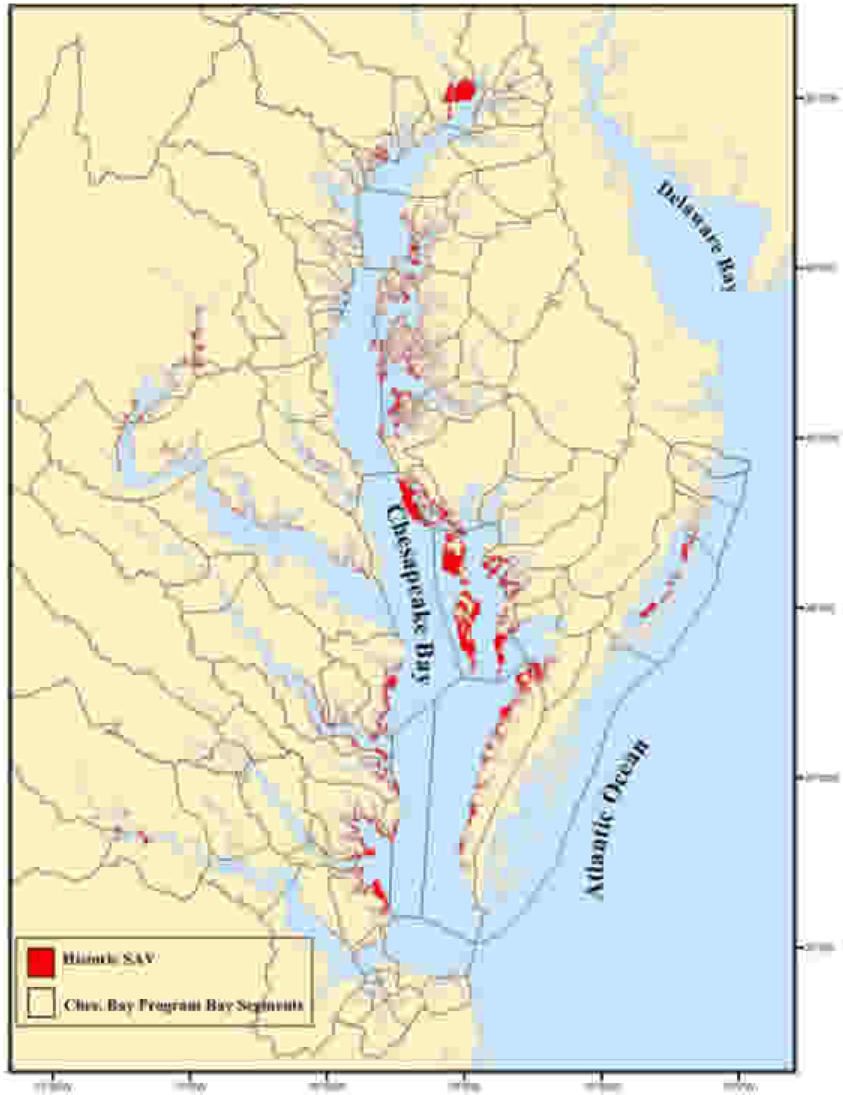
FOR

SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION

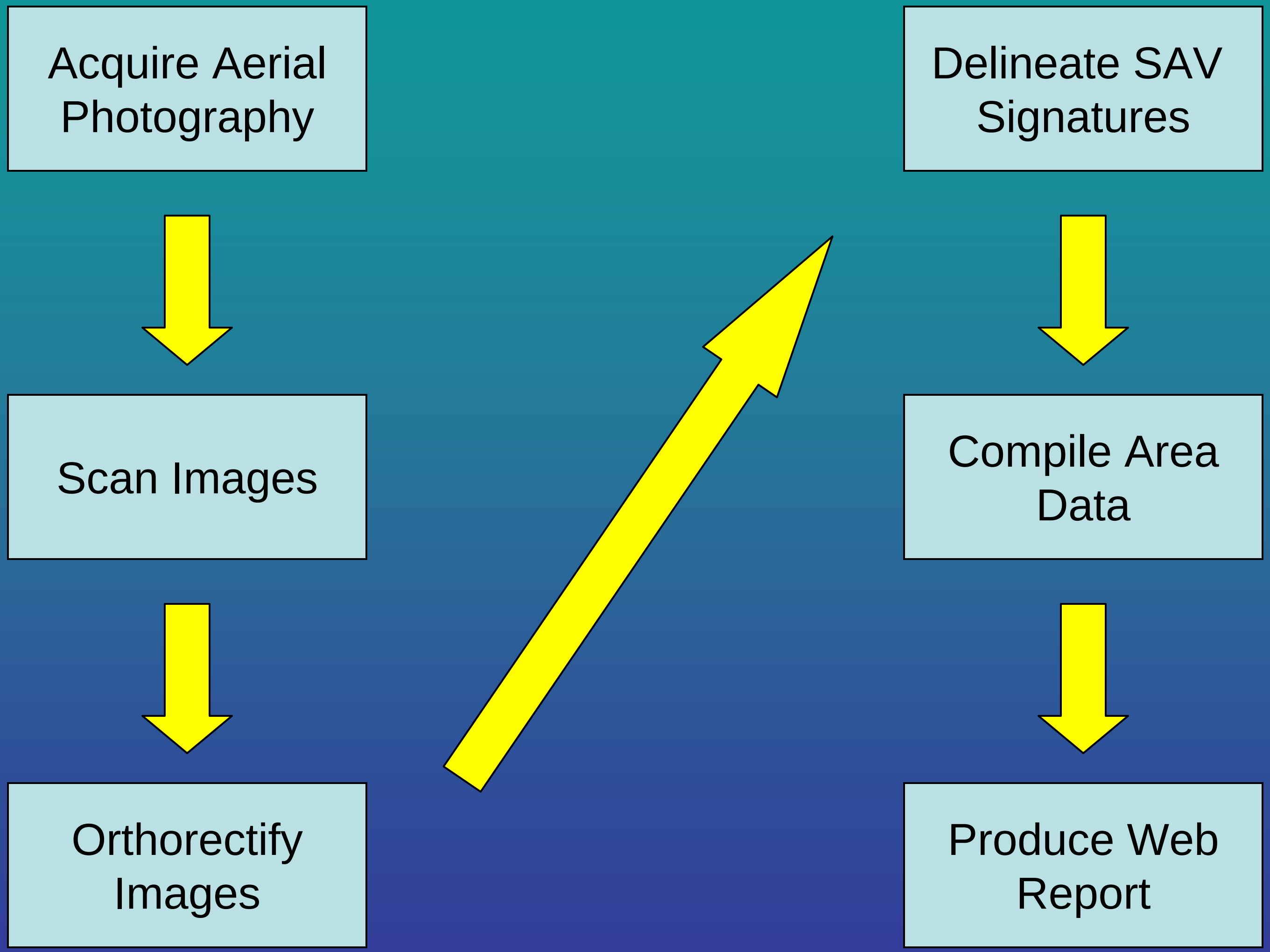
Annual Aerial SAV Monitoring Project

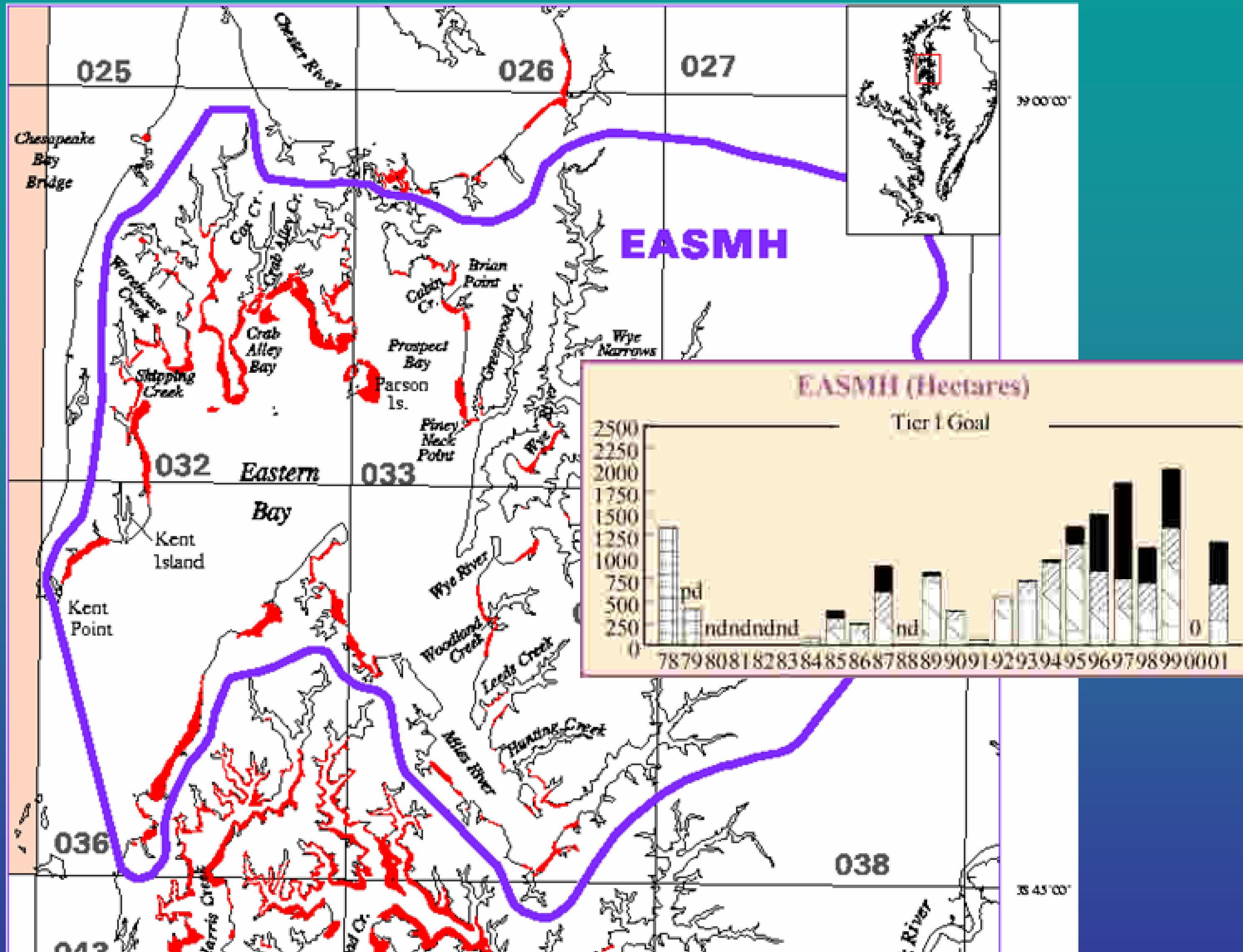


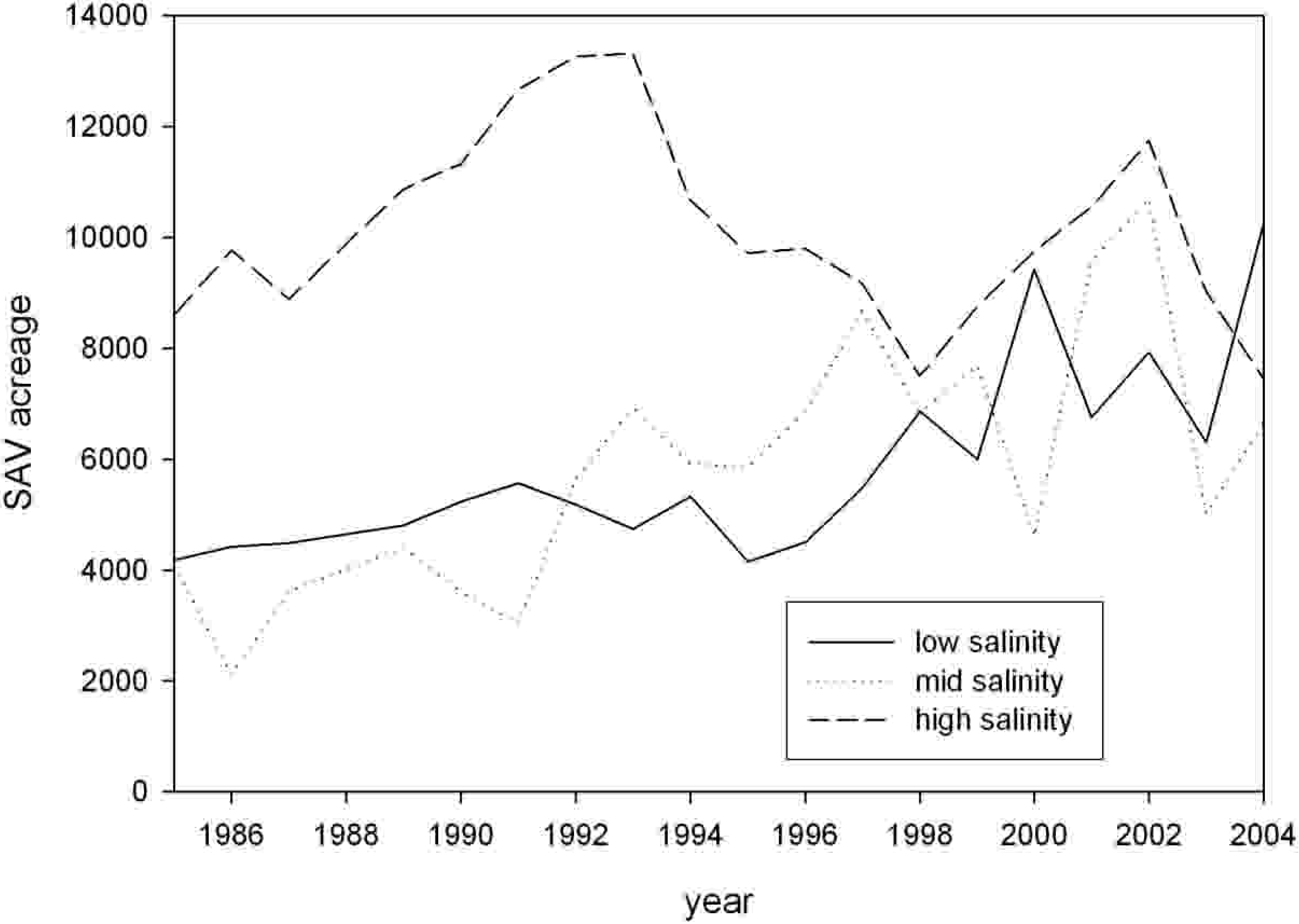
- 173 Flight lines
- 2,033 B/W Aerial photographs
- 2,340 Flight line miles
- Close coordination with contractor & watch the weather and tides


Delaware Bay
Chesapeake Bay
Atlantic Ocean
Historic SAV
Ches. Bay Program Bay Segments

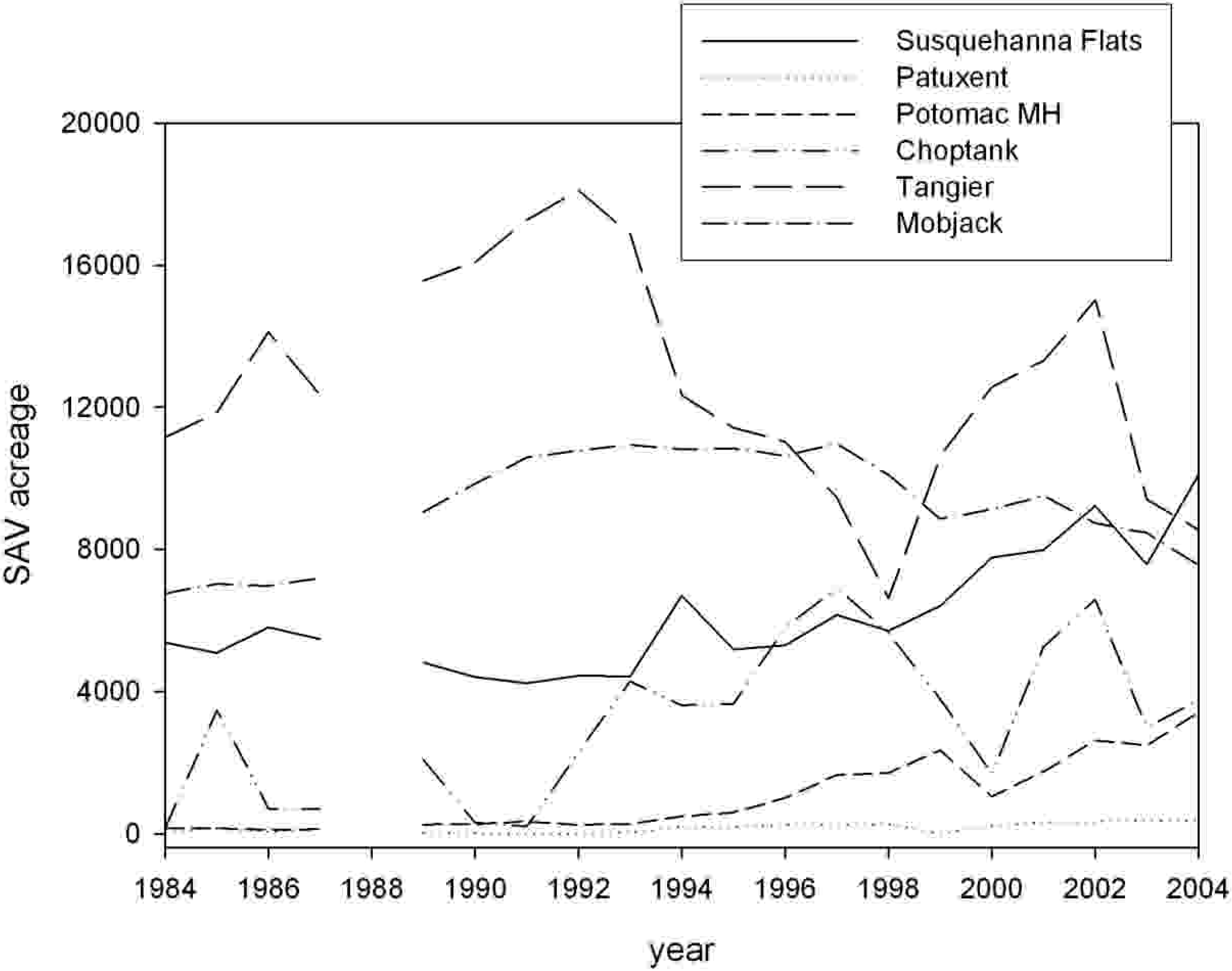
Annual SAV Monitoring Process




025
026
027
032
033
036
038
043
Chesapeake Bay Bridge
Chester River
EASMH
Cox Cr.
Crab Alley Cr.
Warehouse Creek
Crab Alley Bay
Shipping Creek
Brian Point
Cabin Cr.
Greenwood Cr.
Prospect Bay
Parson Is.
Piney Neck Point
Wye Narrows
Wye River
Eastern Bay
Kent Island
Kent Point
Wye River
Woodland Creek
Leeds Creek
Miles River
Hunting Creek
39°00'00"
38°45'00"
EASMH (Hectares)
Tier 1 Goal
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
pd
nd nd nd nd nd
nd
0
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01



14000
12000
10000
8000
6000
4000
2000
0
SAV acreage
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
year
low salinity
mid salinity
high salinity

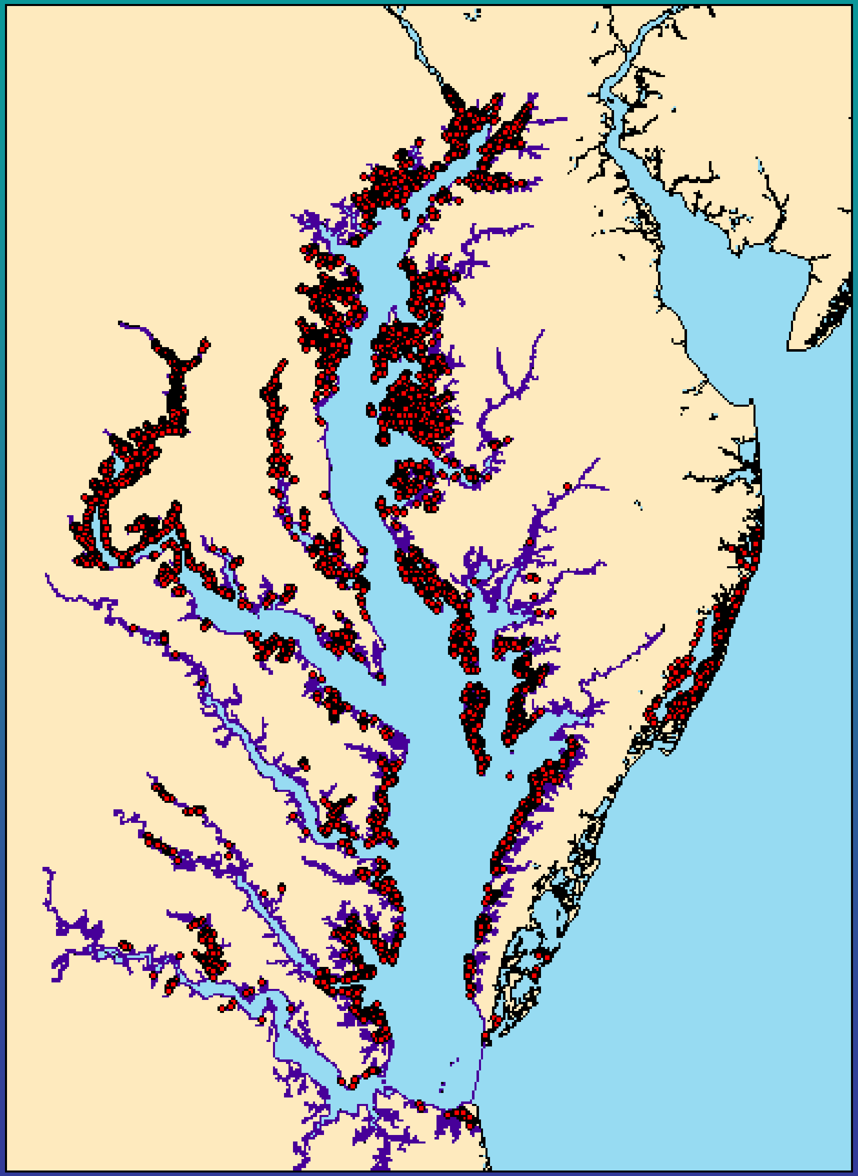

Susquehanna Flats
Patuxent
Potomac MH
Choptank
Tangier
Mobjack
20000
16000
12000
8000
4000
0
SAV acreage
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
year

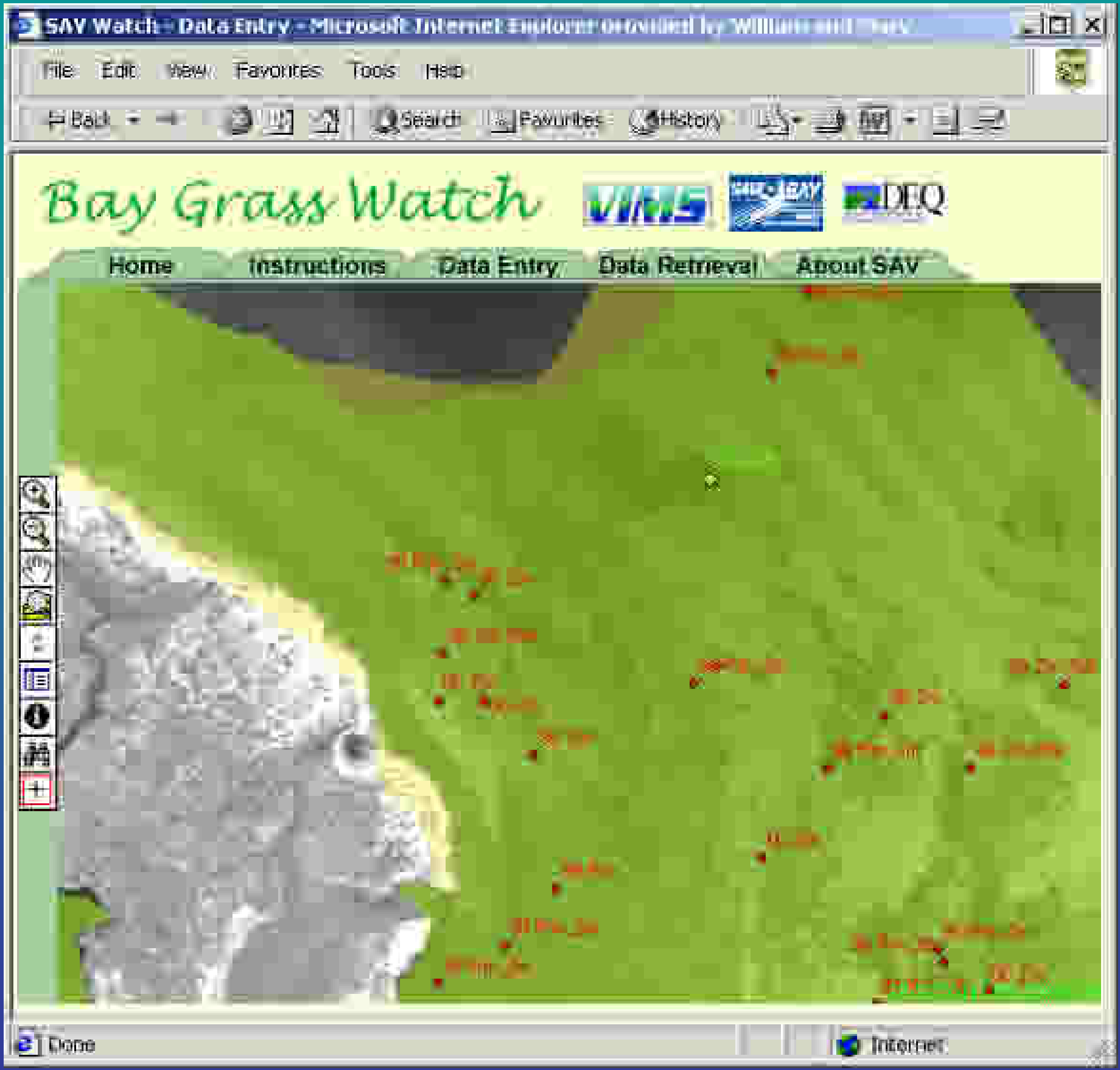
SAV Species Observations

~1000 observations per year
Over 17,000 observations

Participants:

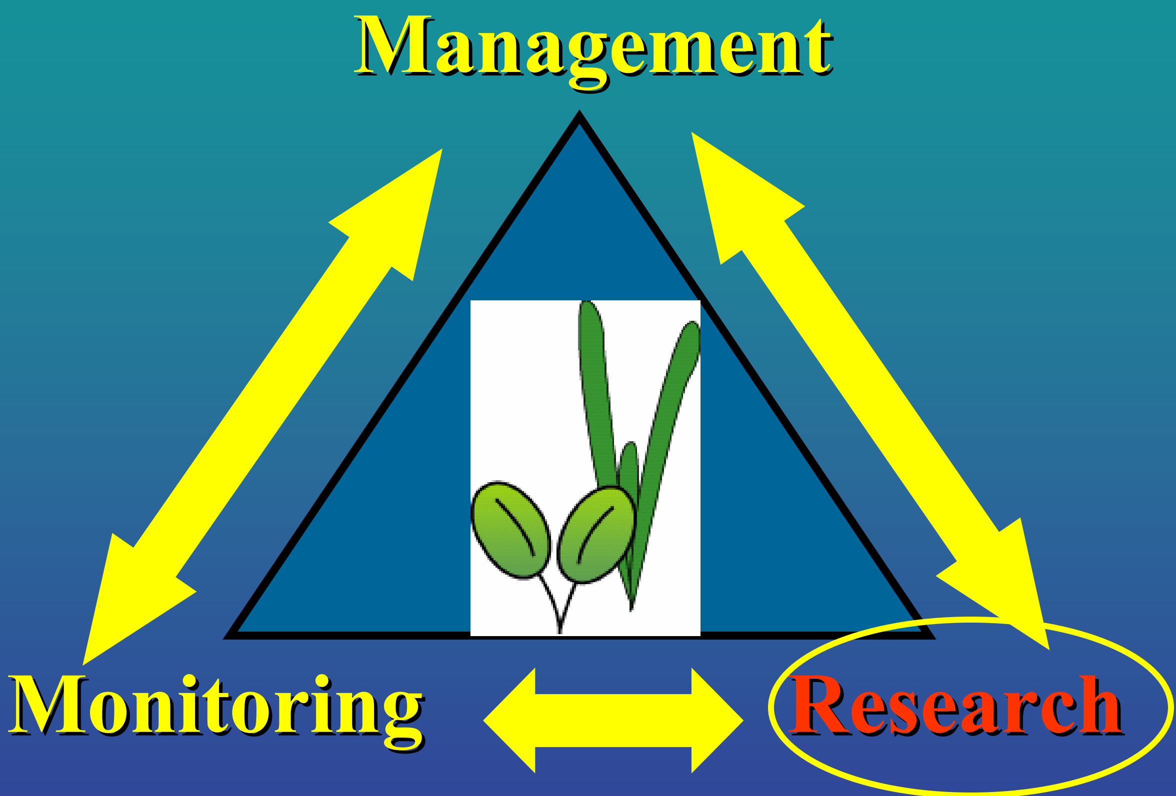
- Research programs
- Bay managers
- Charter boat captains
- “SAV Hunt”





SAV Watch - Data Entry - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Bay Grass Watch
VIMS
DEQ
Home
Instructions
Data Entry
Data Retrieval
About SAV
Done
Internet

THE BENEFITS AND CHALLENGES OF INTEGRATING

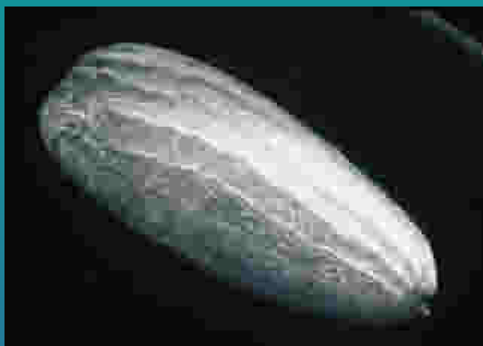


FOR SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION

SAV Habitat Requirements

Salinity	Kd	TSS mg/l	Chl µg/l	DIN mg/l	DIP mg/l	PLW	PLL
Tidal Fresh (<0.5 ppt)	< 2	< 15	< 15	---	< 0.02	> 13%	> 9%
Oligohaline (0.5-5 ppt)	< 2	< 15	< 15	---	< 0.02	> 13 %	> 9%
Mesohaline (5-18 ppt)	< 1.5	< 15	< 15	< 0.15	< 0.01	> 22%	> 15%
Polyhaline (>18 ppt)	< 1.5	< 15	< 15	< 0.15	< 0.02	> 22%	> 15%

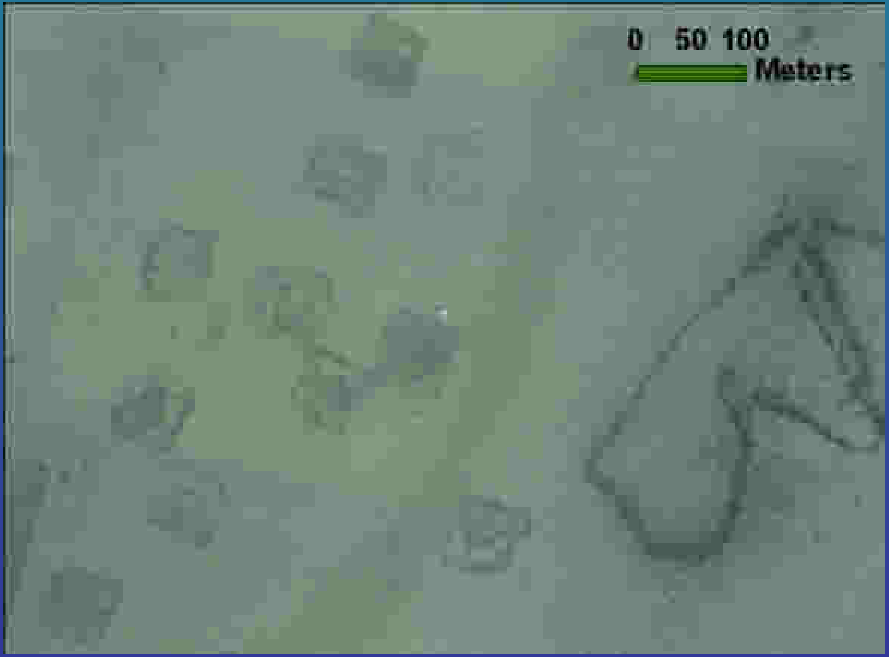
EMERGING ISSUES IN SEED ECOLOGY



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)

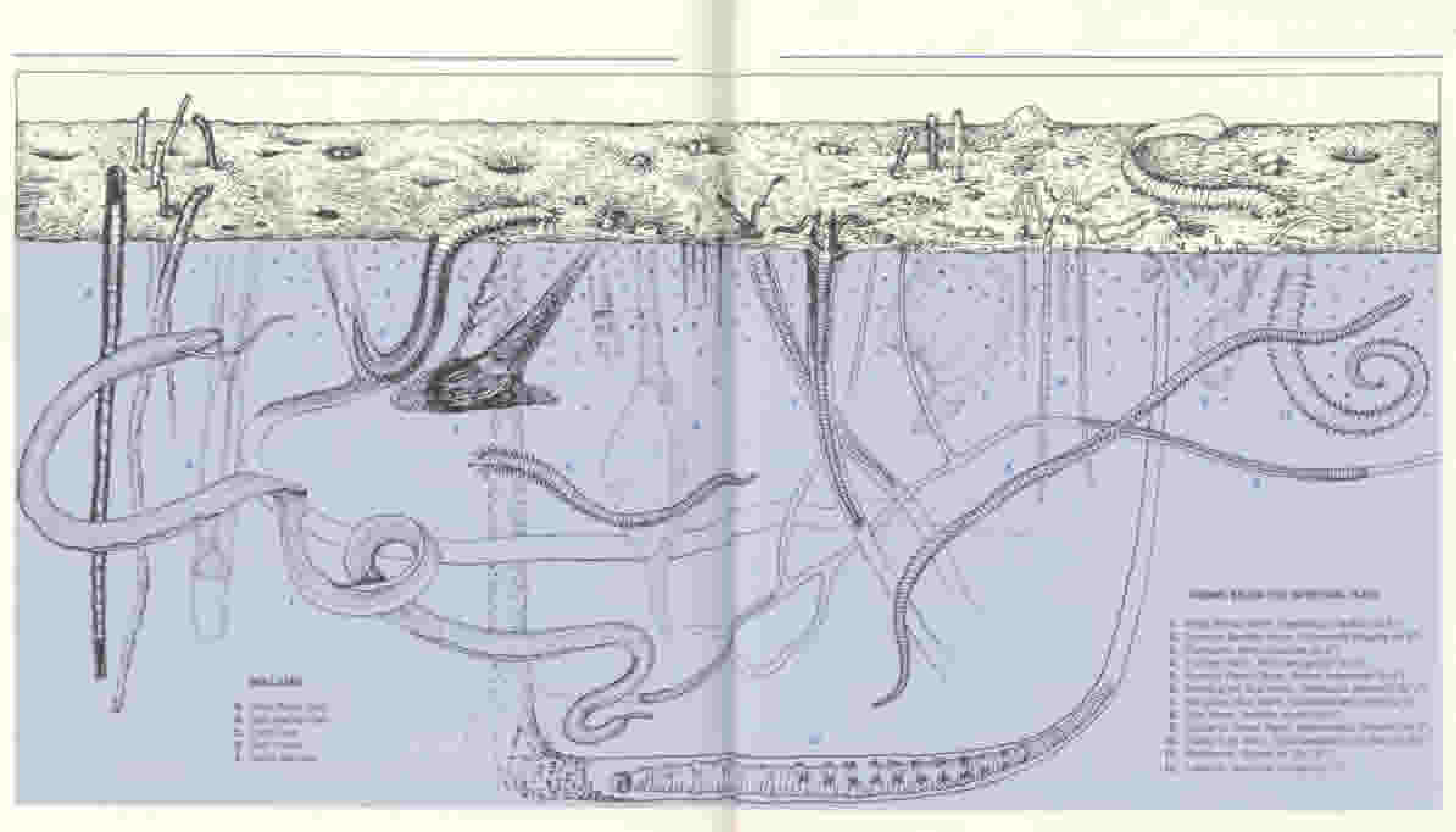
Dark bands are patches of seedlings From seeds broadcast onto bare sand substrate



Seeds on the sediment surface do not move far from where they settle

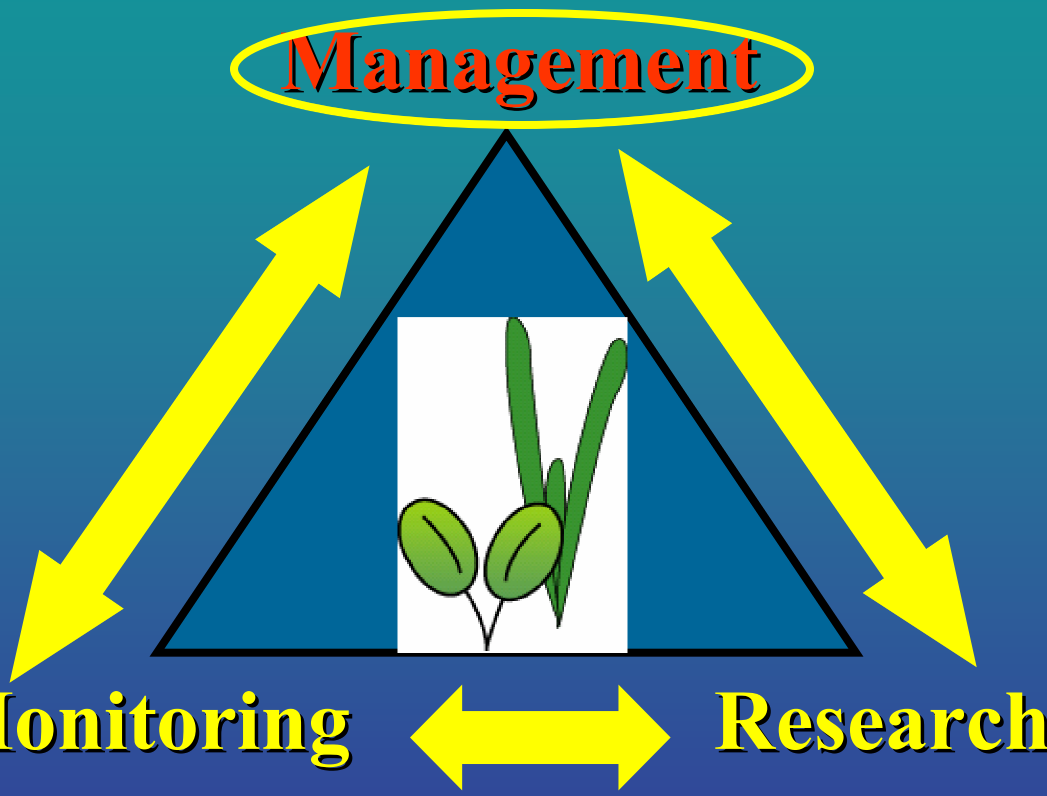
Orth, Moore and Luckenbach (1994) Ecology 75:1927-1939

Seeds retained where they settle because of topographic complexities of sediment surface due to bioturbation or physical discontinuities (e.g., sand ripples)



Luckenbach and Orth (1999) Aquatic Botany 62:235-247

THE BENEFITS AND CHALLENGES OF INTEGRATING



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

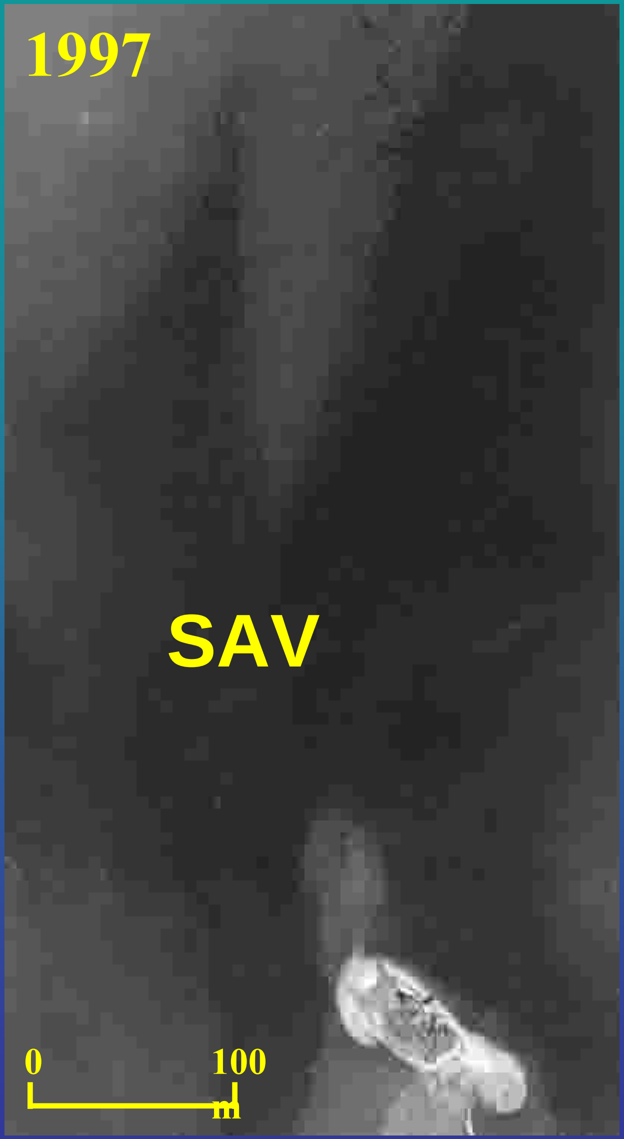
- 1997 Blue Crab Fisheries Management Plan – link fisheries management to both water and habitat (seagrass) quality
- 2000 Bay Agreement – develop specific plans to protect and restore seagrass
- 2002 Bay Agreement – new goal for restoring seagrass set at 186,000 acres
- 2003 – Strategy for the protection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

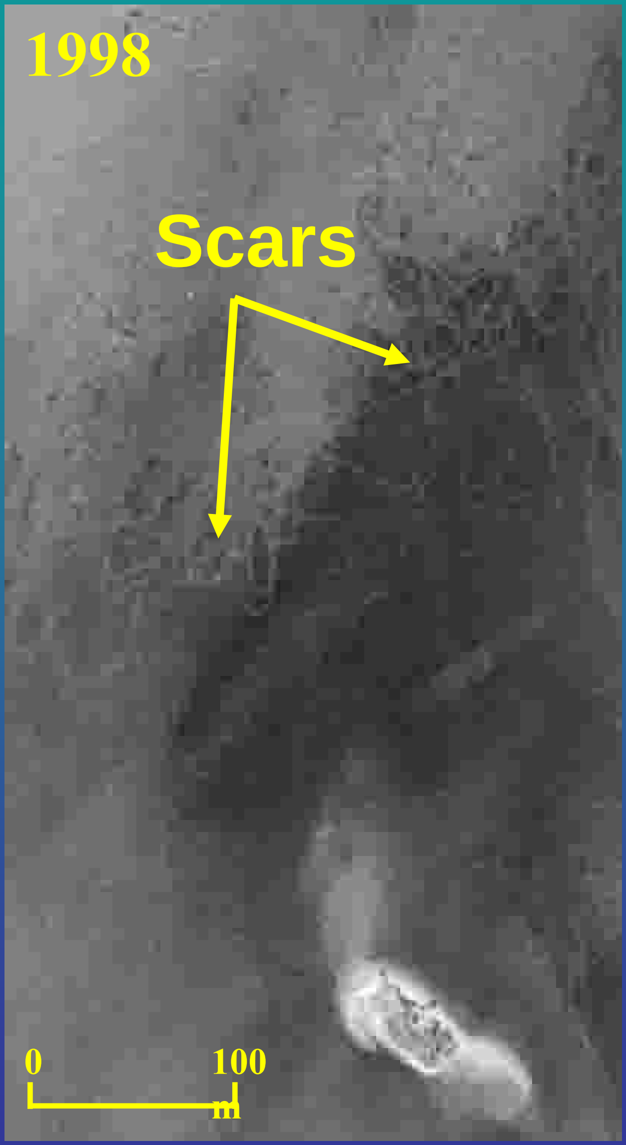

CHINCOTEAGUE BAY
SAV SANCTUARY

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.

Hydraulic Dredge Scars in Maryland

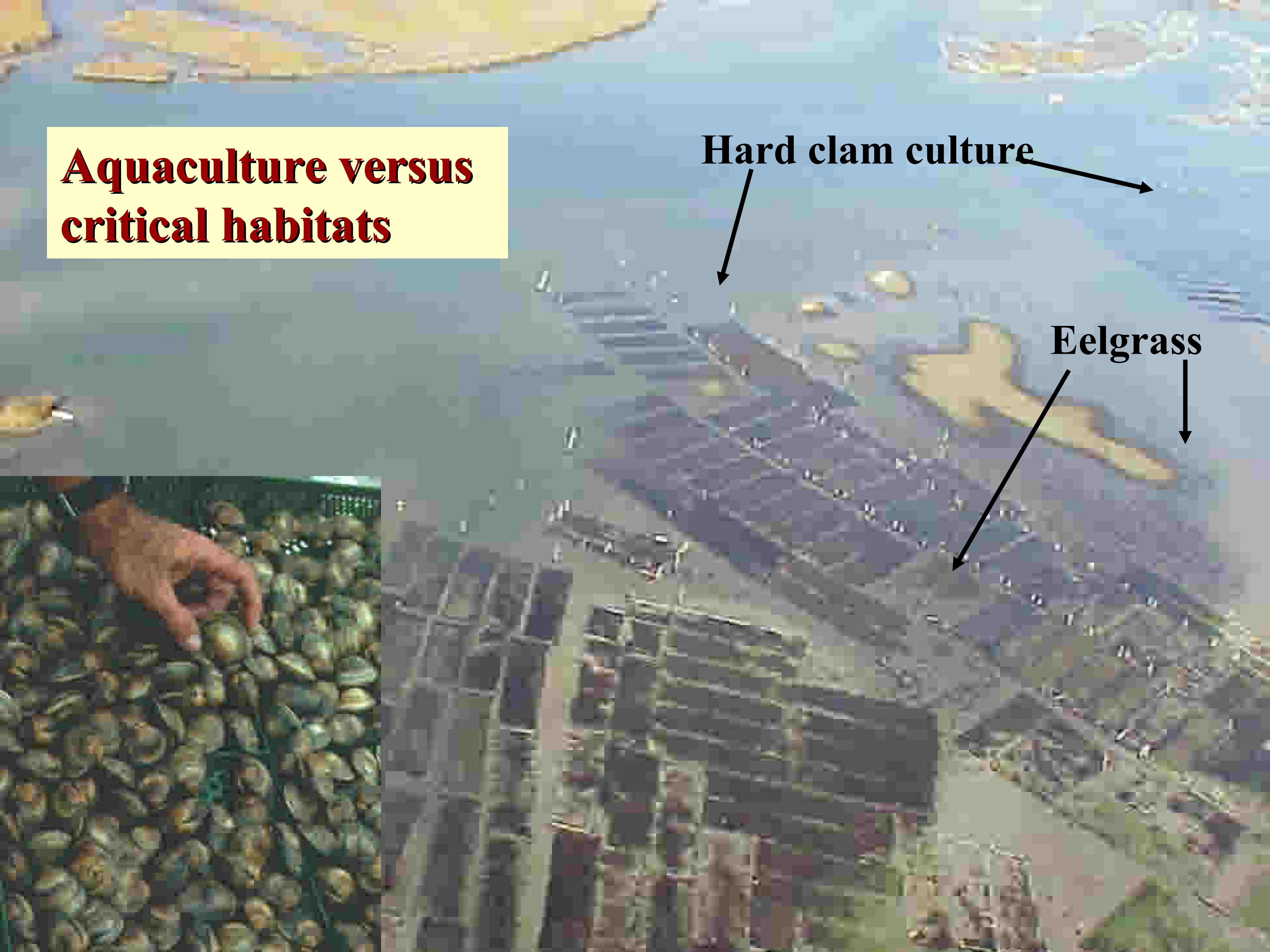




MARYLAND REGULATIONS

- 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



- **VMRC 4 VAC 20335-10 (Jan. 1998) – On-bottom shellfish aquaculture activities requiring structures are now prohibited from being placed on '*existing*' SAV**

CHESAPEAKE BAY POLICIES FOR SEAGRASS RESTORATION AND CONSERVATION

- 1997 Blue Crab Fisheries Management Plan – link fisheries management to both water and habitat (seagrass) quality
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‘Strategy to Accelerate Protection and Restoration of SAV in Chesapeake Bay’

By Dec. 2008, plant at least 1000 acres at multiple sites!!

VIMS SAV
RESTORATION PROGRAM
OBJECTIVES

- Application of basic biology and ecology to restoration activities and for their conservation EMPHASIS ON SEED ECOLOGY
- Methods for optimal use of seeds
- transplants to assess water quality, habitat requirements, and propagule availability
- explore relationships between plant abundance, bed size, and density, on fish and invertebrates
- Undertake large scale restoration activities

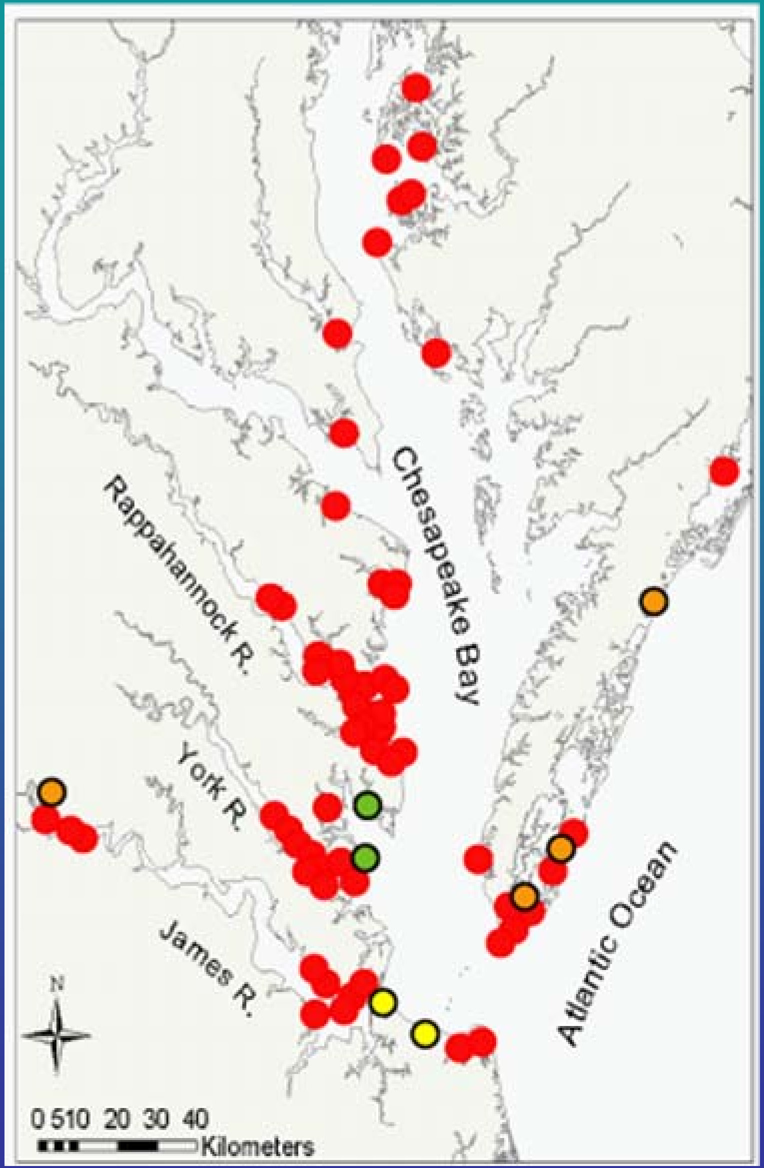
A variety of techniques are used for restoration of aquatic grass

Adult shoot transplants

Seed dispersal

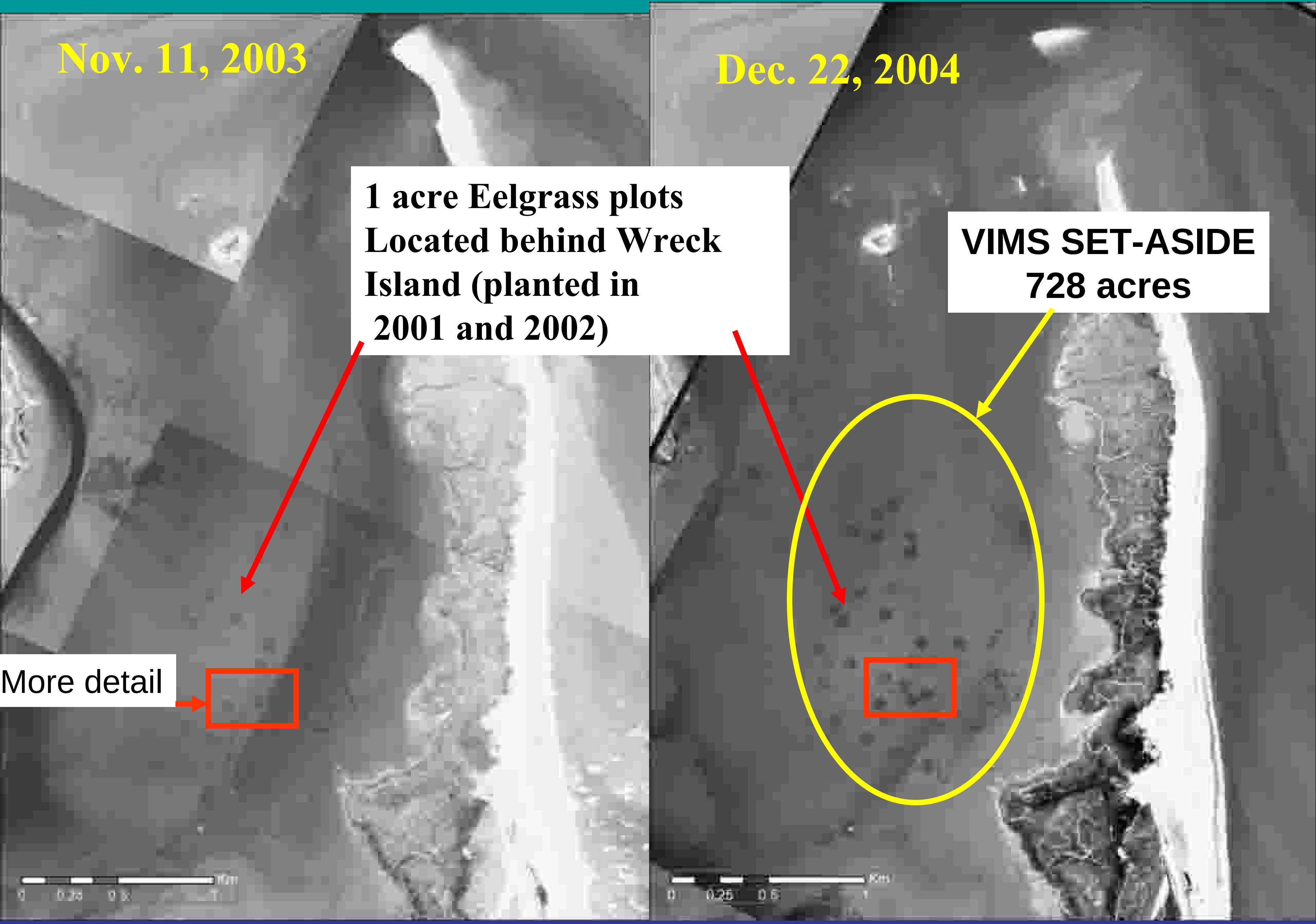
- All are labor intensive; tedious; have potential donor bed impacts; and only plant small areas

However, less than 10% of transplant sites (adult or seed) have long term survival



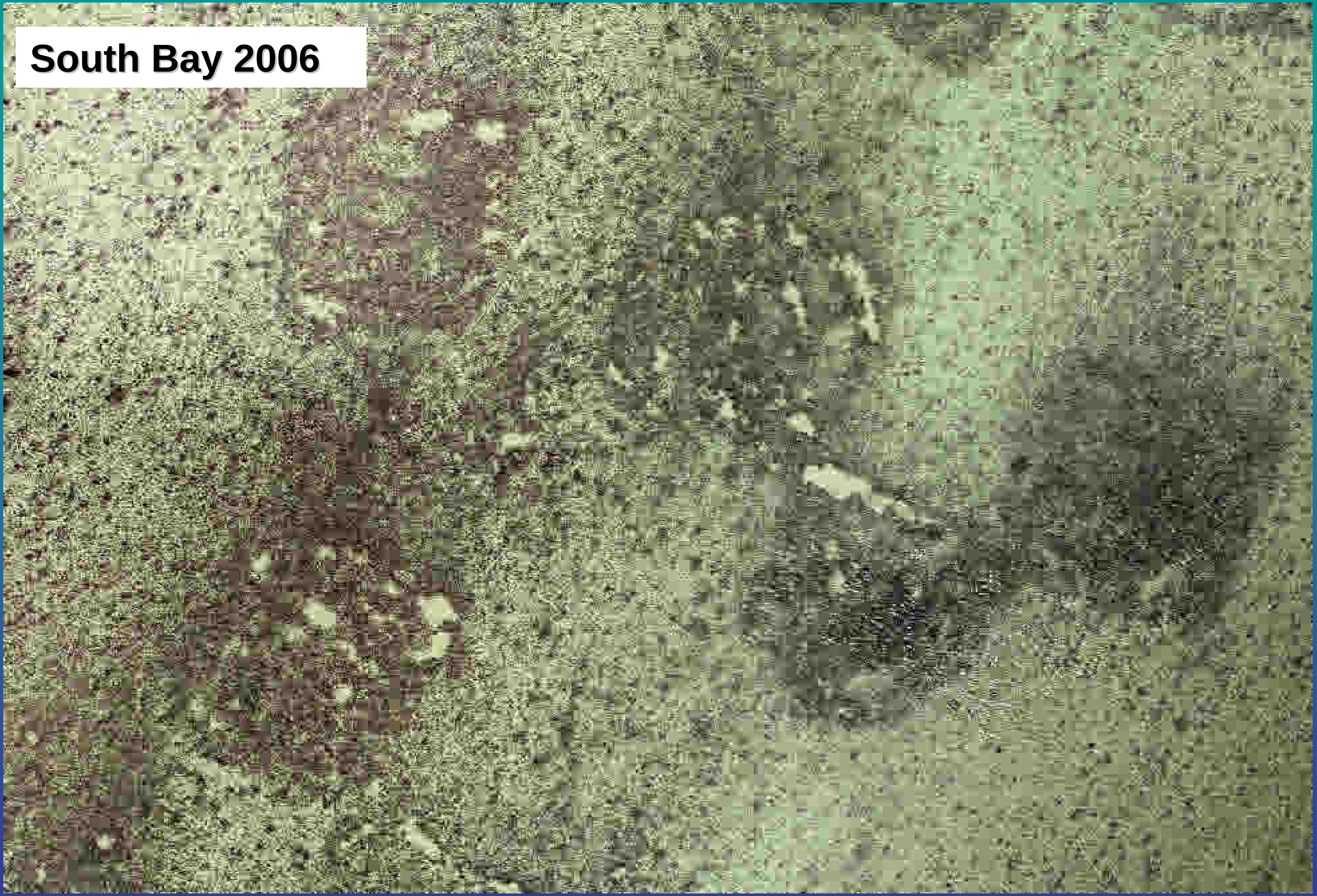
VIMS Transplant Sites 1979-2004

- Transplants died
- Survival 1-5 years
- Survival 5-10 years
- Survival >10 years

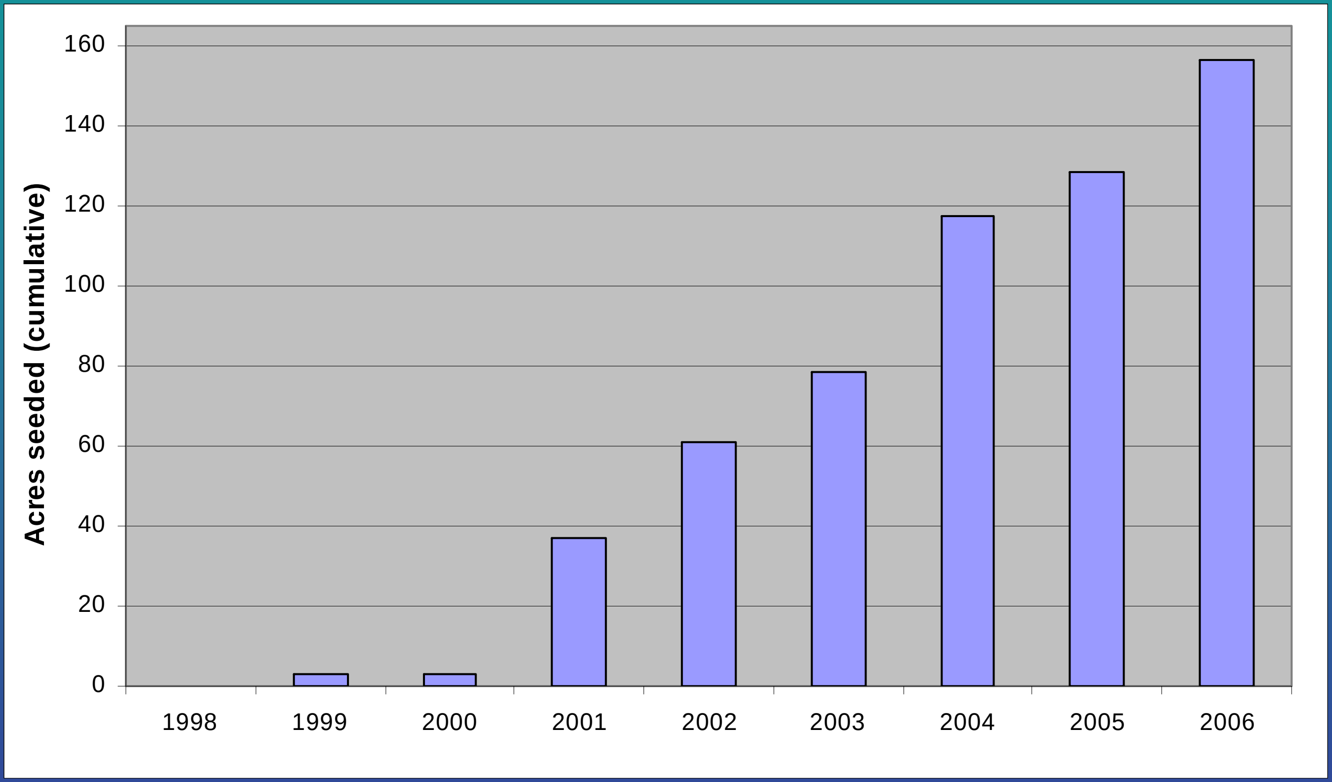


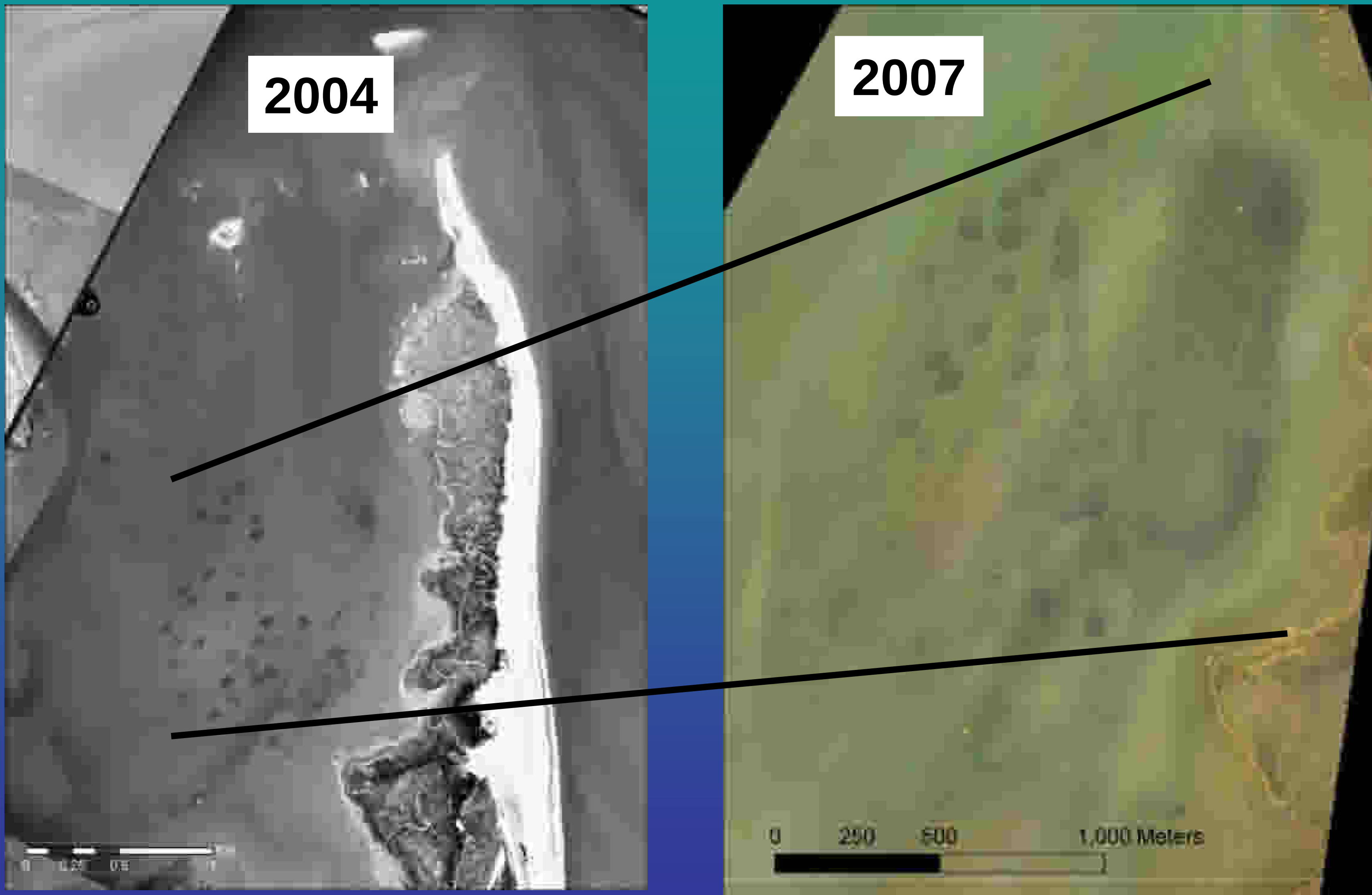
Nov. 11, 2003
Dec. 22, 2004
1 acre Eelgrass plots Located behind Wreck Island (planted in 2001 and 2002)
VIMS SET-ASIDE 728 acres
More detail


South Bay 2004


South Bay 2006

VIMS SAV restoration effort – VA coastal bays

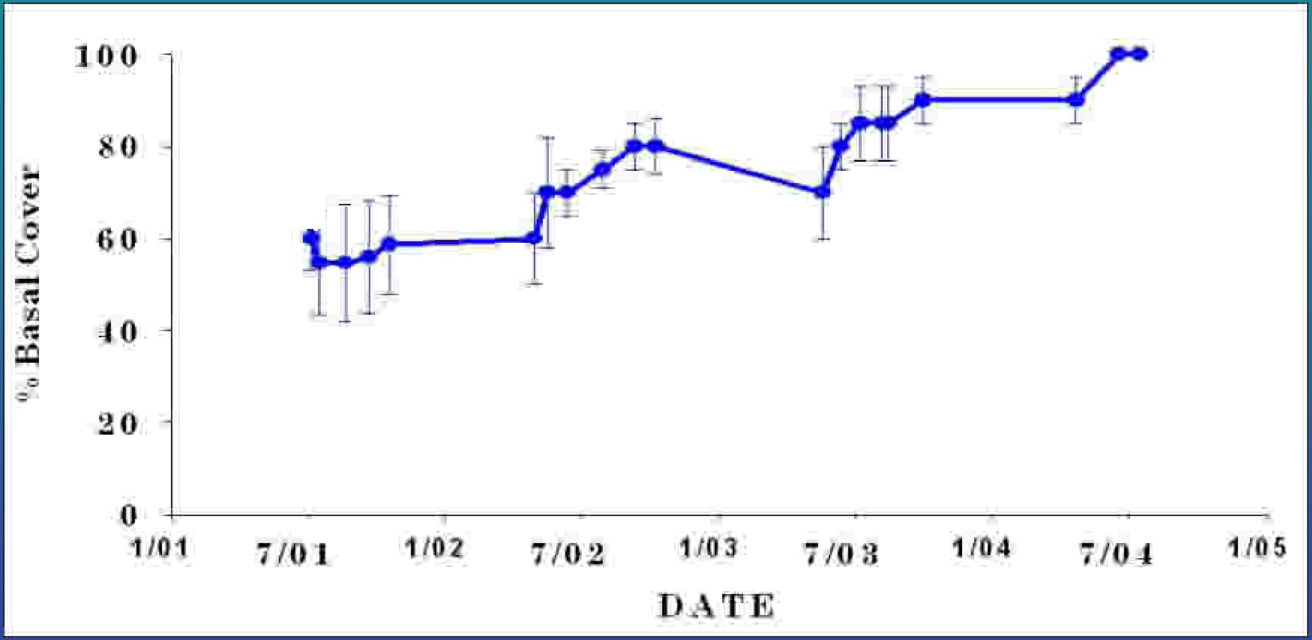



2004
2007
0 250 500 1,000 Meters

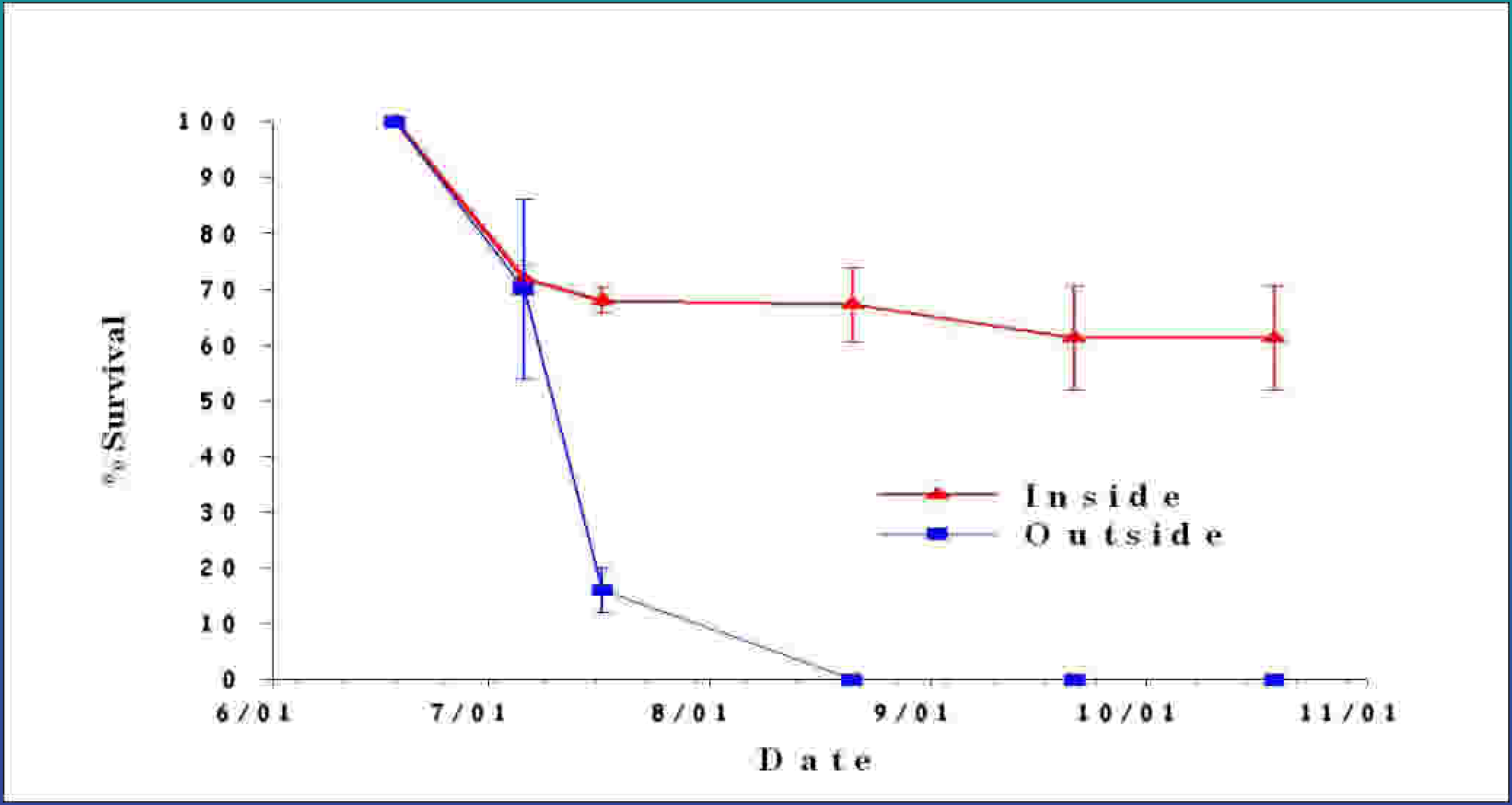
The freshwater SAV *V. americana* can be found in habitats with high turbidity and variable salinities.

Replicated plots of *V. americana* transplants and seeds have been planted within plastic mesh exclosures in five locations on the Upper James River.

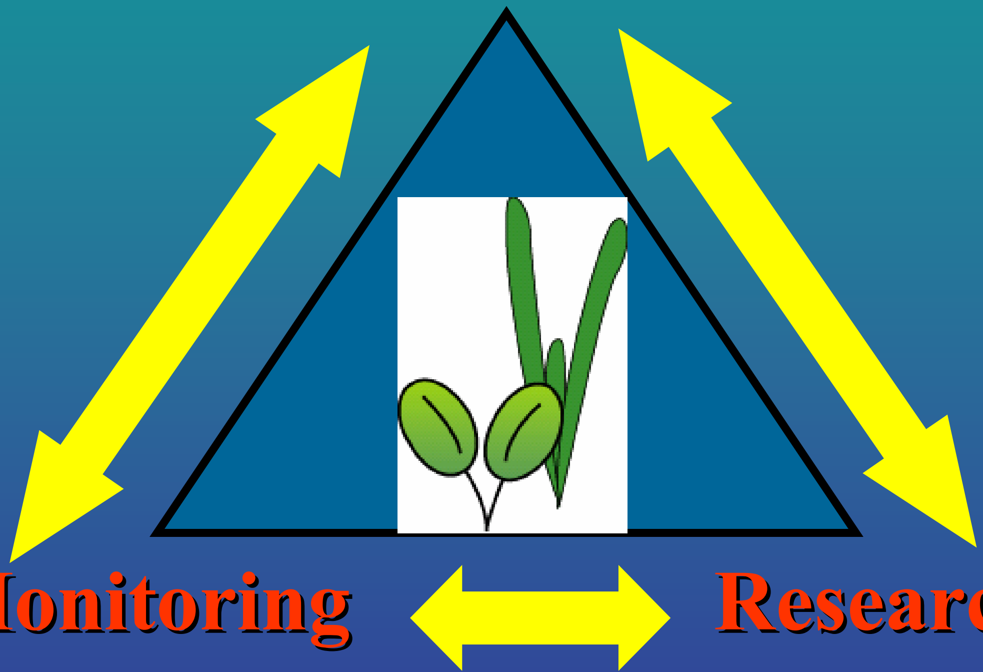
Bare-rooted shoots of *V. americana* typically take 3-4 years after transplantation to completely revegetate within an exclosure



Loss of plants from herbivory outside of protective exclosures, limits seagrass restoration of unvegetated areas in many tidal, freshwater areas.



THE BENEFITS AND CHALLENGES OF INTEGRATING



FOR

SUBMERGED AQUATIC VEGETATION CONSERVATION AND RESTORATION

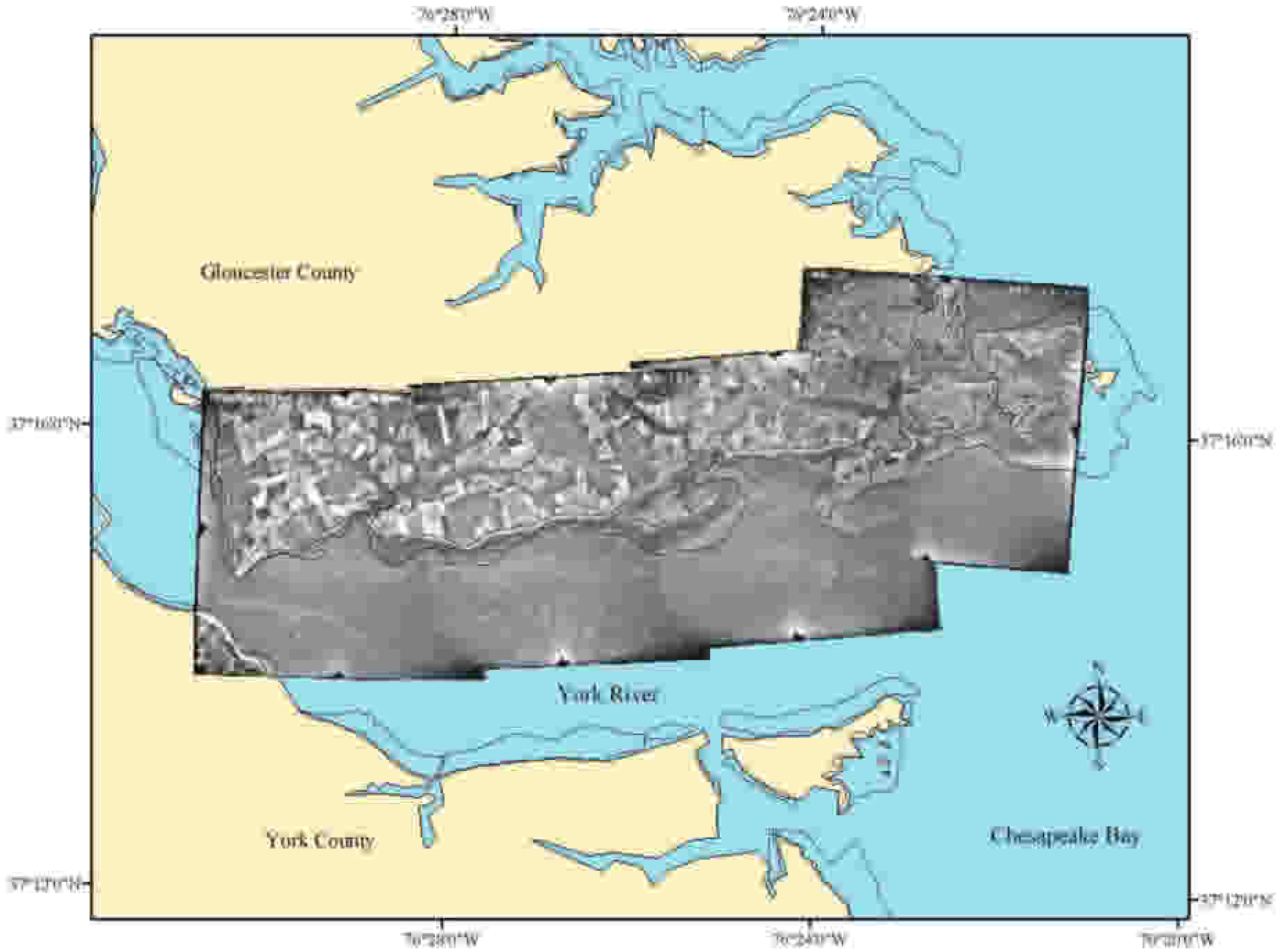
Steps Used to Set and Measure Water Clarity Standards Using SAV

- Determine historical SAV distributions and depth limits
- Relate these depth limits to water clarity conditions
- Set criteria for water clarity targets based on historical depth limits
- Evaluate existing turbidity using spatially intensive underway monitoring "DATAFLOW"
- Measure standards attainment using:
  - Average SAV mapping acreage including all SAV (unclipped)
  - CFD of water clarity standard exceedences through space and time
  - water clarity attainment acres within 2m littoral zone using both secchi depth (Kd) and 22% light to bottom criteria

Chesapeake Bay and Coastal Bays Historical Land Use

- **Pre-1630** — Forested Watershed; < 1% land cleared
- **1630-1720** — Initial European settlement; <20% land cleared
- **1720-1880** — Developing Agriculture; 20-40% land clearance
- **1880-1930s** — Intensive Agriculture 60-80% land clearance, mechanization, deep plowing, fertilization, disease
- **1940s-1950s** — Farm abandonment, re-forestation, 40% land clearance
- **1950s-Present** — Urban Growth, storms (Tropical Storm Agnes 1972)

Mosaiced Photographs of Lower York River, Virginia



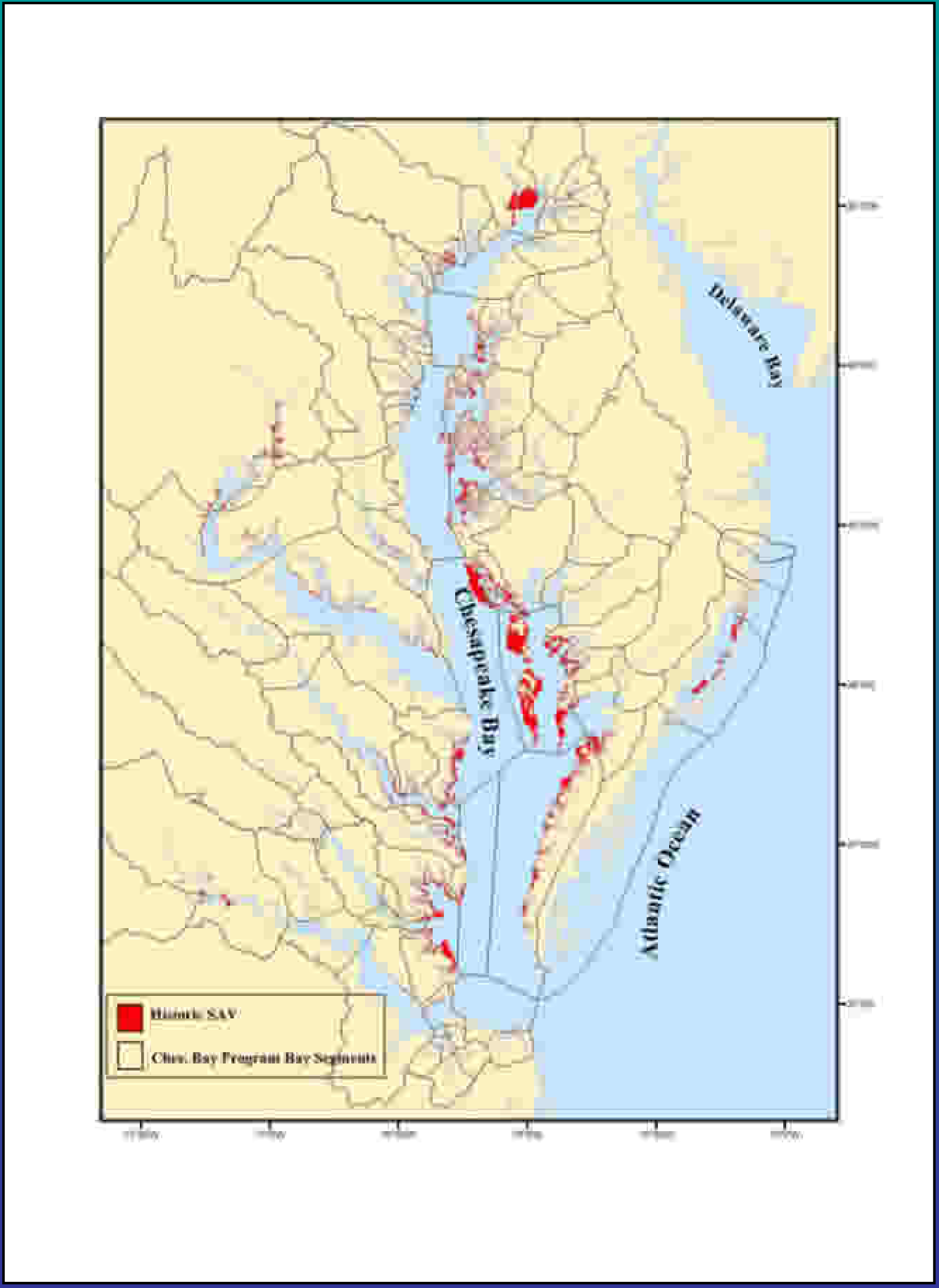
Historical SAVs distributions were determined for each Chesapeake Bay and Coastal Bay Management Segment.

% Historical Today

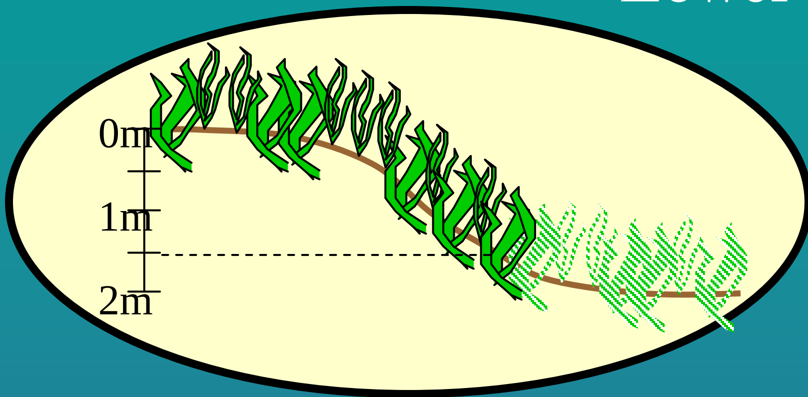
Upper Zone - 25%

Middle Zone - 33%

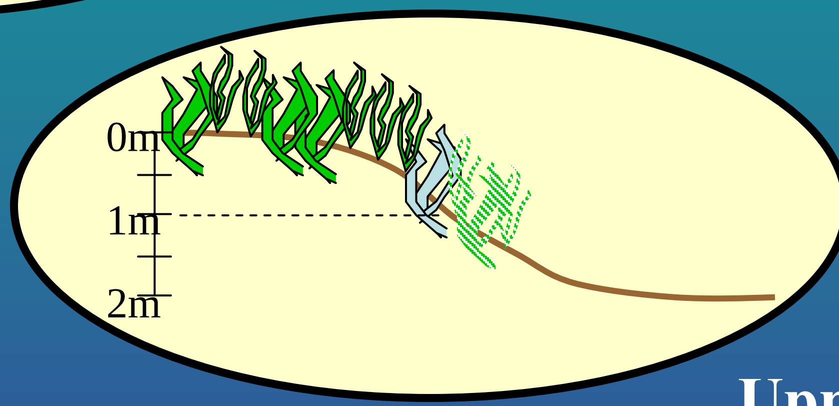
Lower Zone - 45%



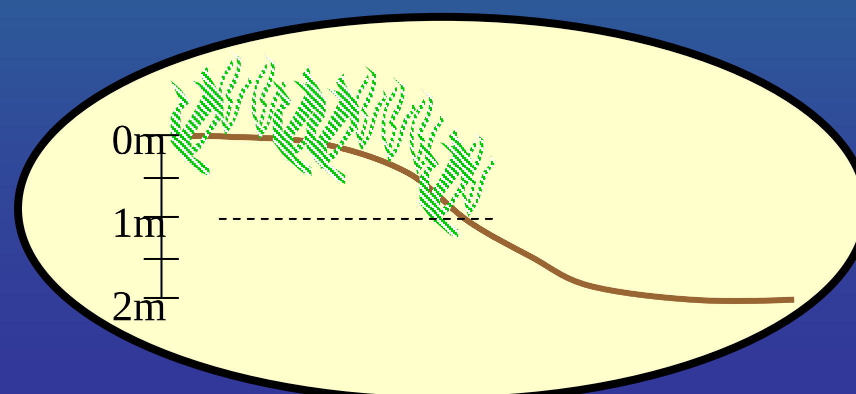
Lower York Estuary



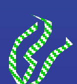
Middle York Estuary



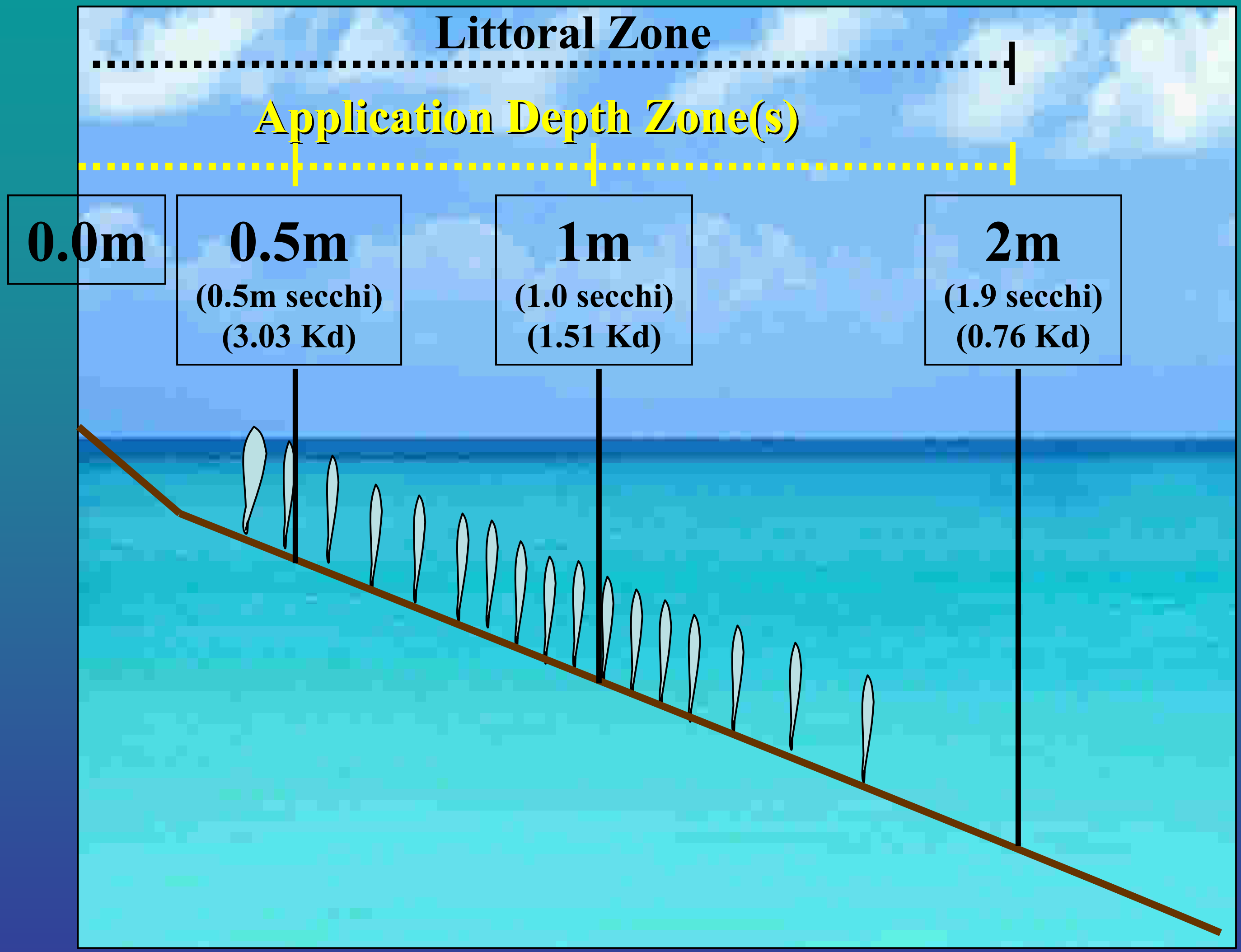
Upper York Estuary



Current Depth Distribution



Historical Depth Distribution



Water Clarity Criteria 22% of Surface Light to Bottom (PLW)

Three Approaches to Meeting Water Clarity Requirements for SAV Designated Use of Shallow Water Areas in Each Bay Segment

1. SAV Area
2. Water Clarity Area
3. SAV + Water Clarity Area
4. Water Clarity Cumulative Frequency Distribution

Chesapeake Bay Program Bay Segments

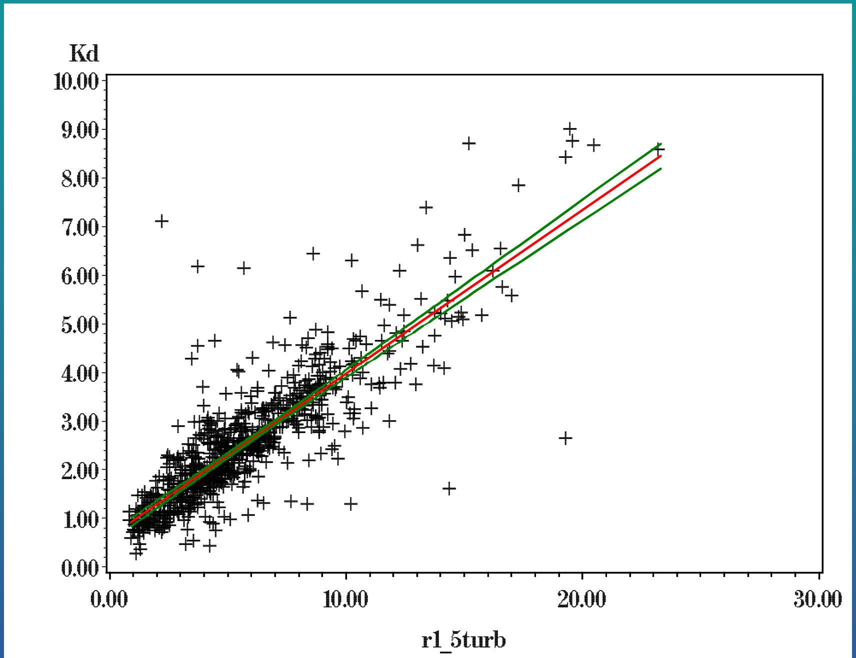
★ Segments monitored

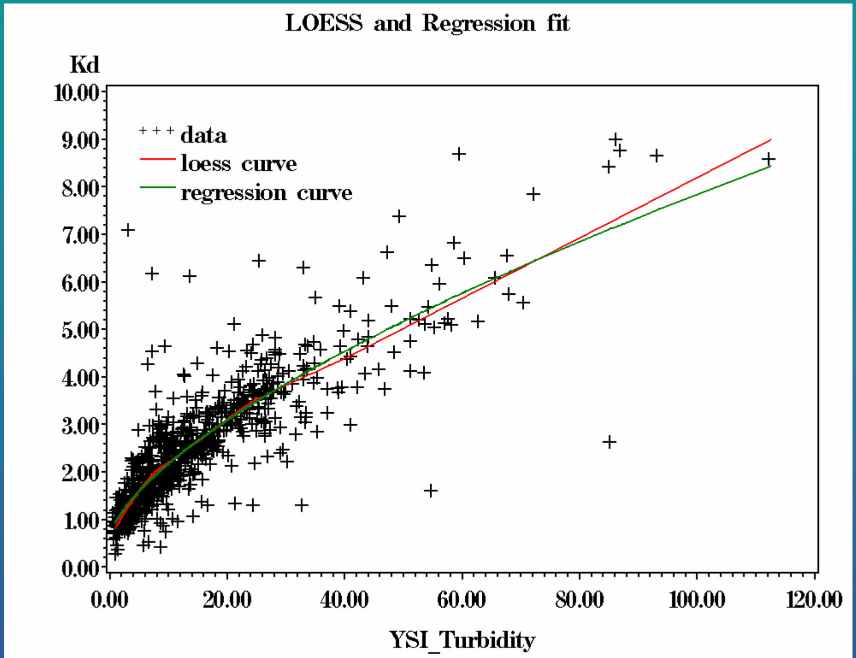
High Frequency Spatial WQ Mapping

- Measurements
  - –Salinity
  - –Specific Conductivity
  - –Temperature
  - –Dissolved Oxygen
  - –pH
  - –Turbidity
  - –Chlorophyll
  - –Depth and GPS

- DATAFLOW
  - –Monthly cruises
  - –Sample every 3-4 seconds while underway
  - –Approximately 50 m sample interval
  - –Shallowest depths of 1 or less

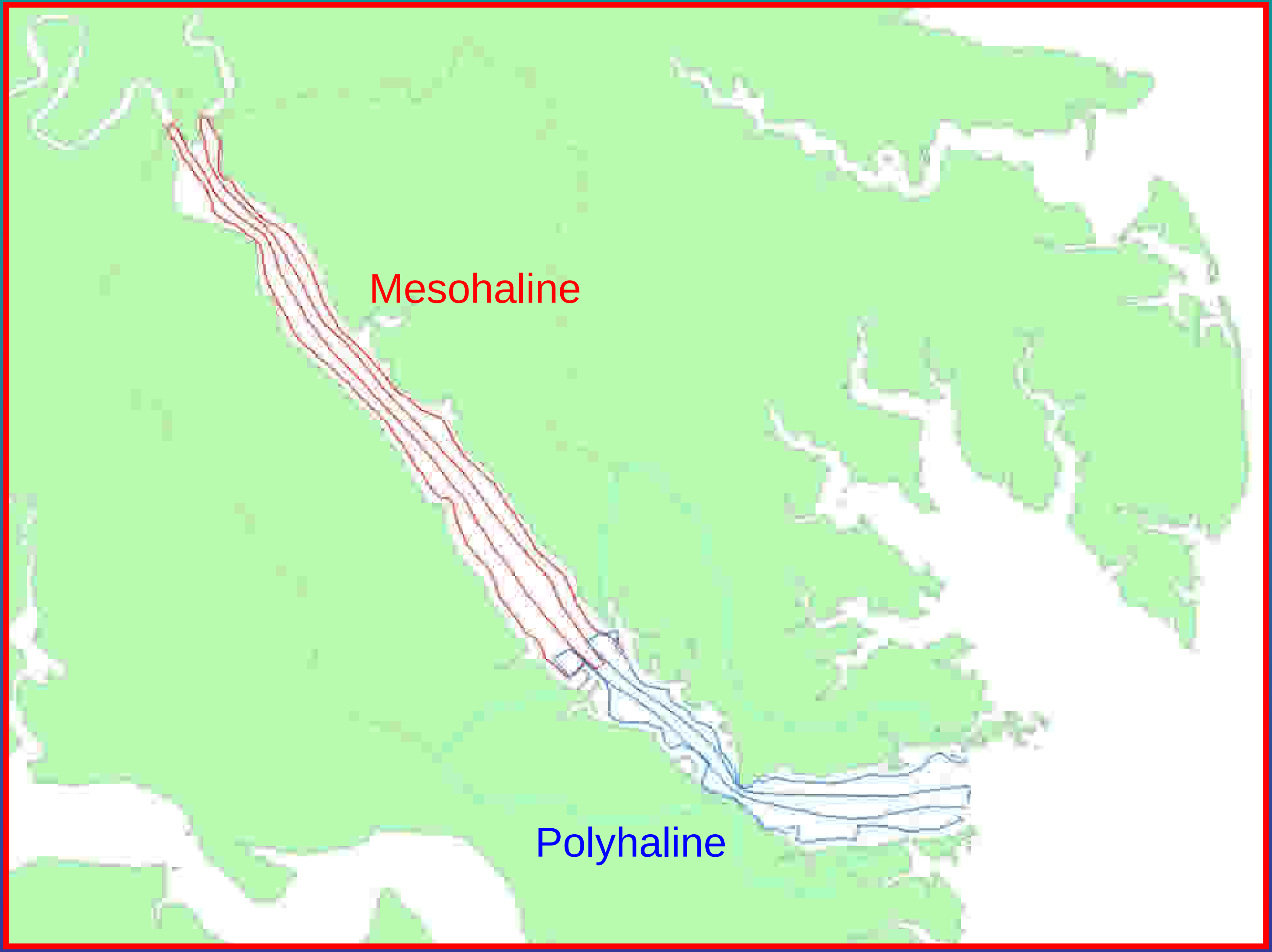
Combined 2003-2005 Virginia Dataflow Calibration Station Data





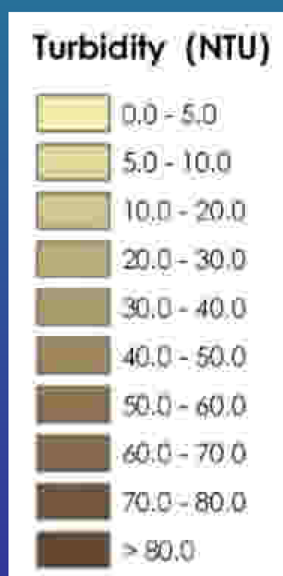
Kd	Loess NTU	Regression NTU
1.0	1.80	1.23
1.25	3.00	2.61
1.5	4.40	4.28
1.75	5.9	6.22
2.0	7.77	8.4
2.5	13.2	13.3
3.0	18.8	18.92
4.0	33.1	31.98
6.0	65.2	64.3

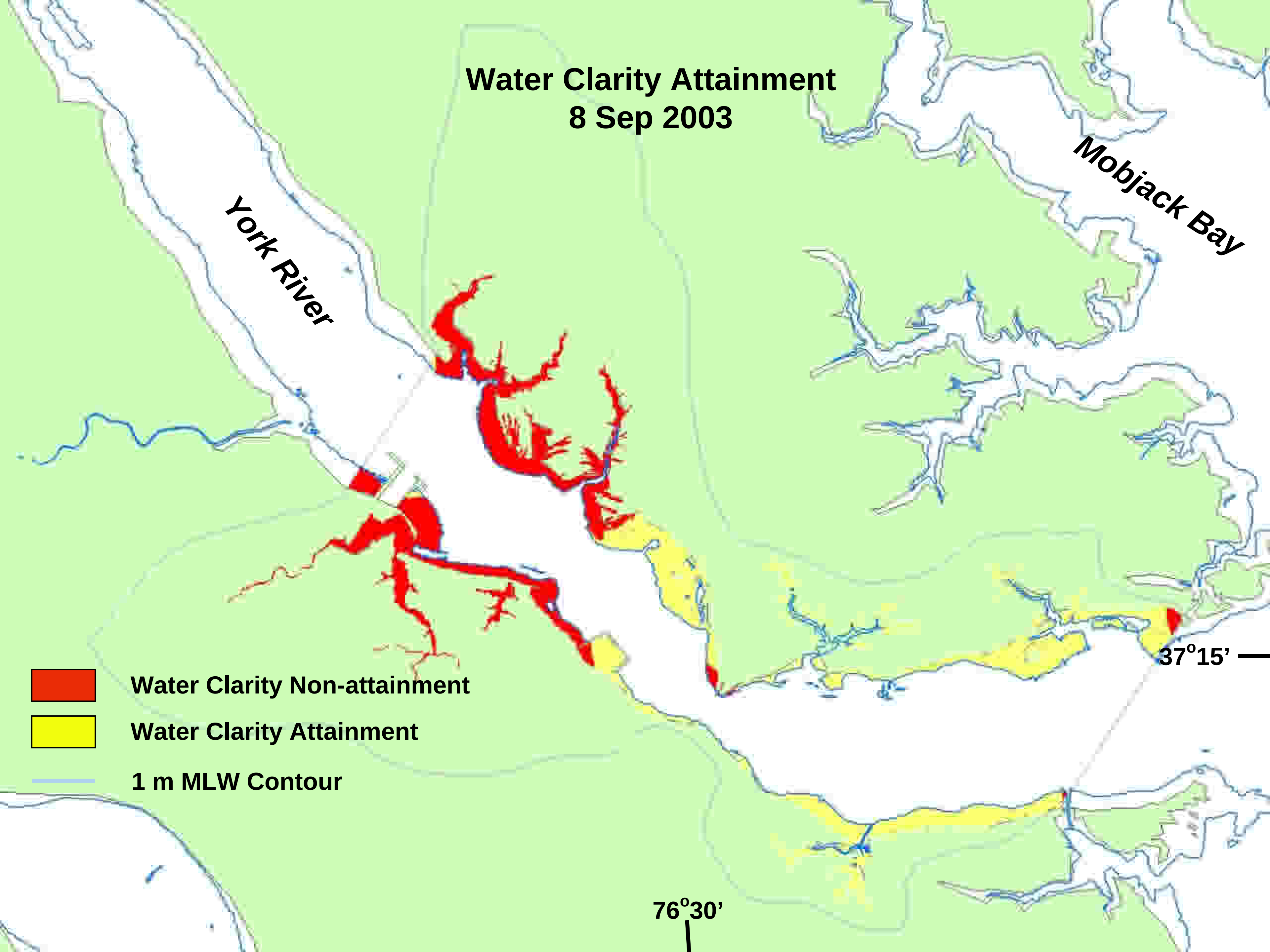
Surface Mapping "DataFlow" Cruise Tracts



York River Turbidity May 2003

Created using:
Geostatistical Analyst extension for ArcMap





Water Clarity Attainment
8 Sep 2003
York River
Mobjack Bay
Water Clarity Non-attainment
Water Clarity Attainment
1 m MLW Contour
37°15'
76°30'

Virginia - Water Clarity Criteria /SAV Attainment

Segment	Year	Historic SAV Goal (Acres)	Current SAV (Acres)	Water Clarity Acres Goal	Current WCA	Current SAV (Acres)	Current WCA	Current WCA + SAV Acres	Current CFD
							PLW (0-2m)	PLW (0-2m)	PLW (0-2m)
YRKPH	2003	2793	851	6982	3833	Not Met	Not Met	Not Met	Not Met
YRKPH	2004	2793	580	6982	4174	Not Met	Not Met	Not Met	Not Met
YRKPH	2005	2793	419	6982	4286	Not Met	Not Met	Not Met	Not Met
YRKMH	2003	239	0	598	2864	Not Met	Not Met	Not Met	Not Met
YRKMH	2004	239	0	598	3034	Not Met	Met	Met	Not Met
YRKMH	2005	239	0	598	3892	Not Met	Met	Met	Not Met
JMSPH	2006	300	141	750	2317	Not Met	Met	Met	Not Met
JMSMH	2006	200	0	500	2726	Not Met	Met	Met	Not Met
JMSOH	2006	15	0	38	0	Not Met	Not Met	Not Met	Not Met
PIAMH	2006	3479	221	8014	2110	Not Met	Not Met	Not Met	Not Met
PIAMH	2005	3479	201	8014	1972	Not Met	Not Met	Not Met	Not Met
PIAMH	2004	3479	73	8014	2462	Not Met	Not Met	Not Met	Not Met

LESSONS LEARNED

- Know your plant biology and ecology! GOOD RESEARCH VITAL!
- Monitoring – absolutely critical and requires persistence and innovation
- WATER QUALITY!!! If it’s clear, they will come (maybe? Recruitment limitation issues)!
- Linking research and monitoring to management has been productive!

CHALLENGES AHEAD

- Water quality issues in the face of increasing population
- Understanding natural vs anthropogenically induced variations in distribution and abundance
- Different ecological state may require significant restoration effort (top-down vs bottom-up issues)
- Global warming (eelgrass declines?)
- Funding and the political will

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

Virginia Institute of Marine Science VIMS

NOAA

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