Eelgrass Restoration in Shinnecock Bay, NY, & Considerations for Assisted Gene Flow Research Efforts

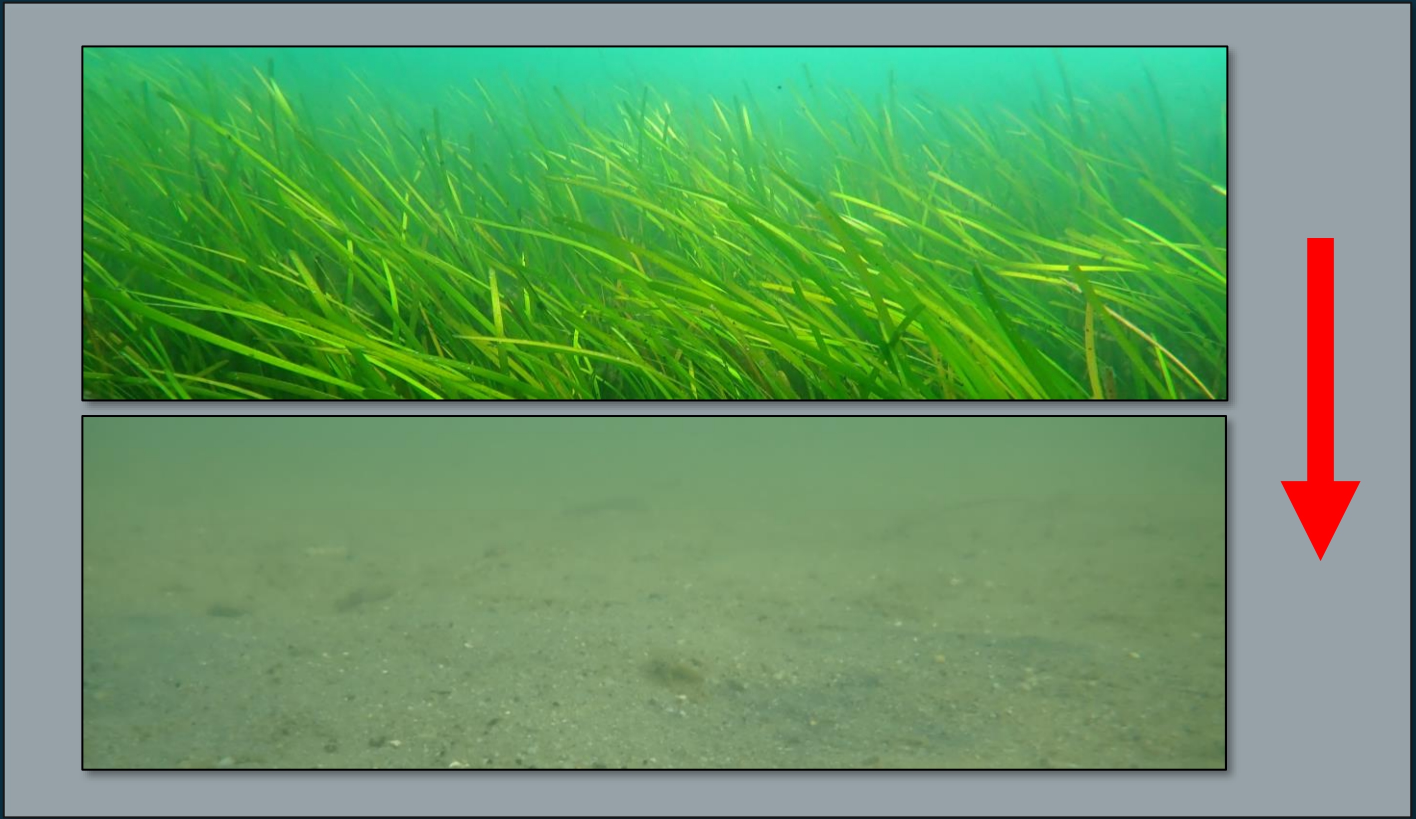
Stephen Heck

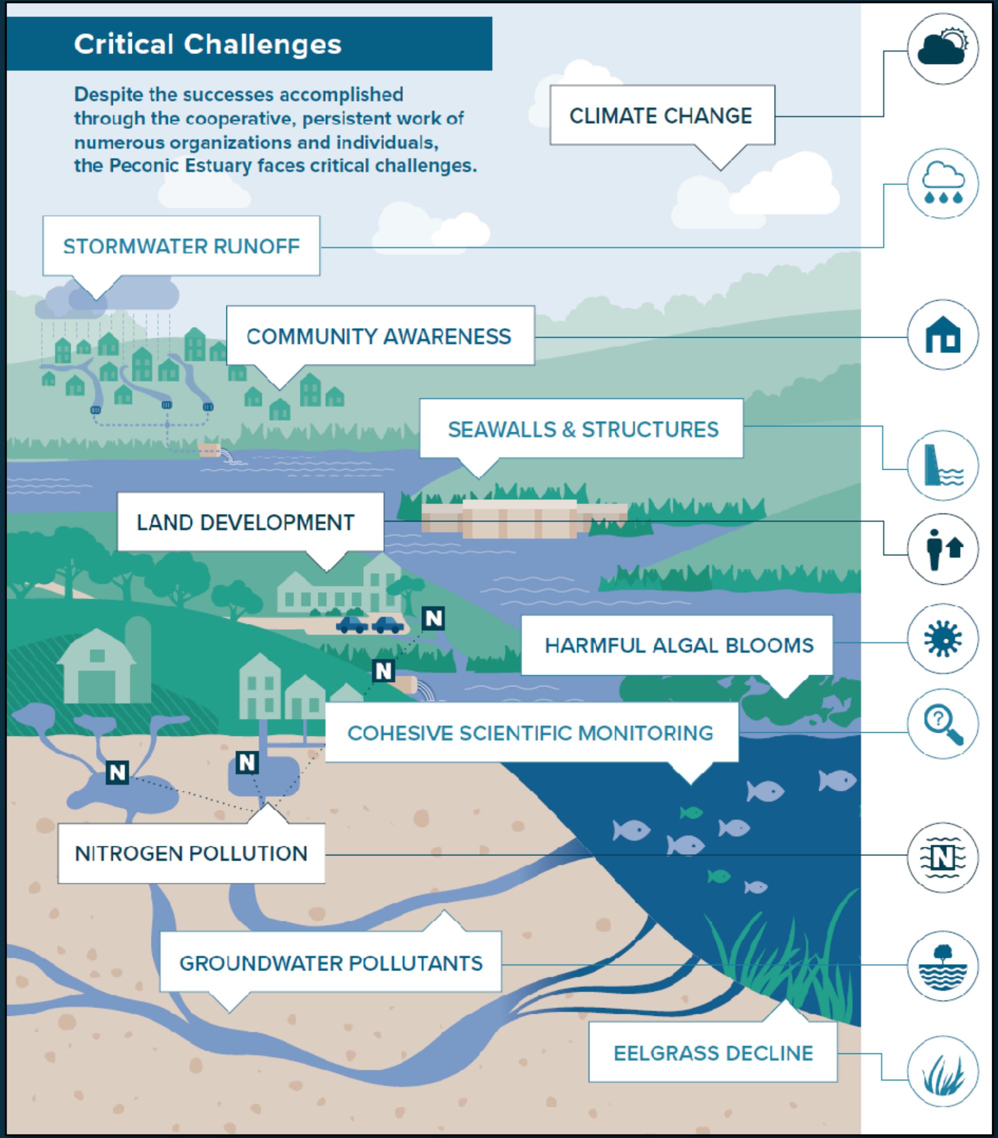
Long Island Sound Eelgrass Collaborative Workshop | June 12th, 2024

Peterson
Marine Community Ecology Lab

Stony Brook University

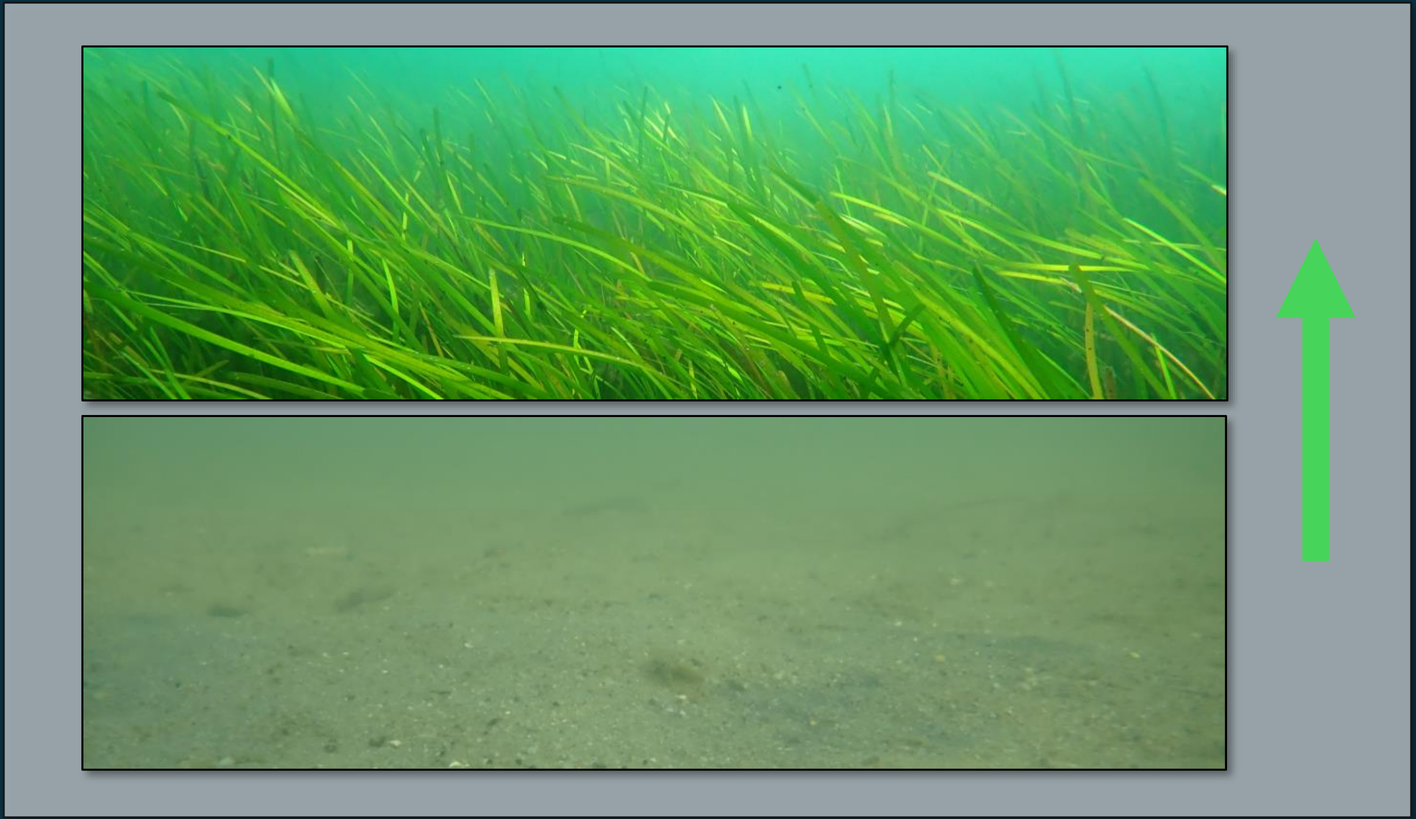
Improved understanding of eelgrass decline

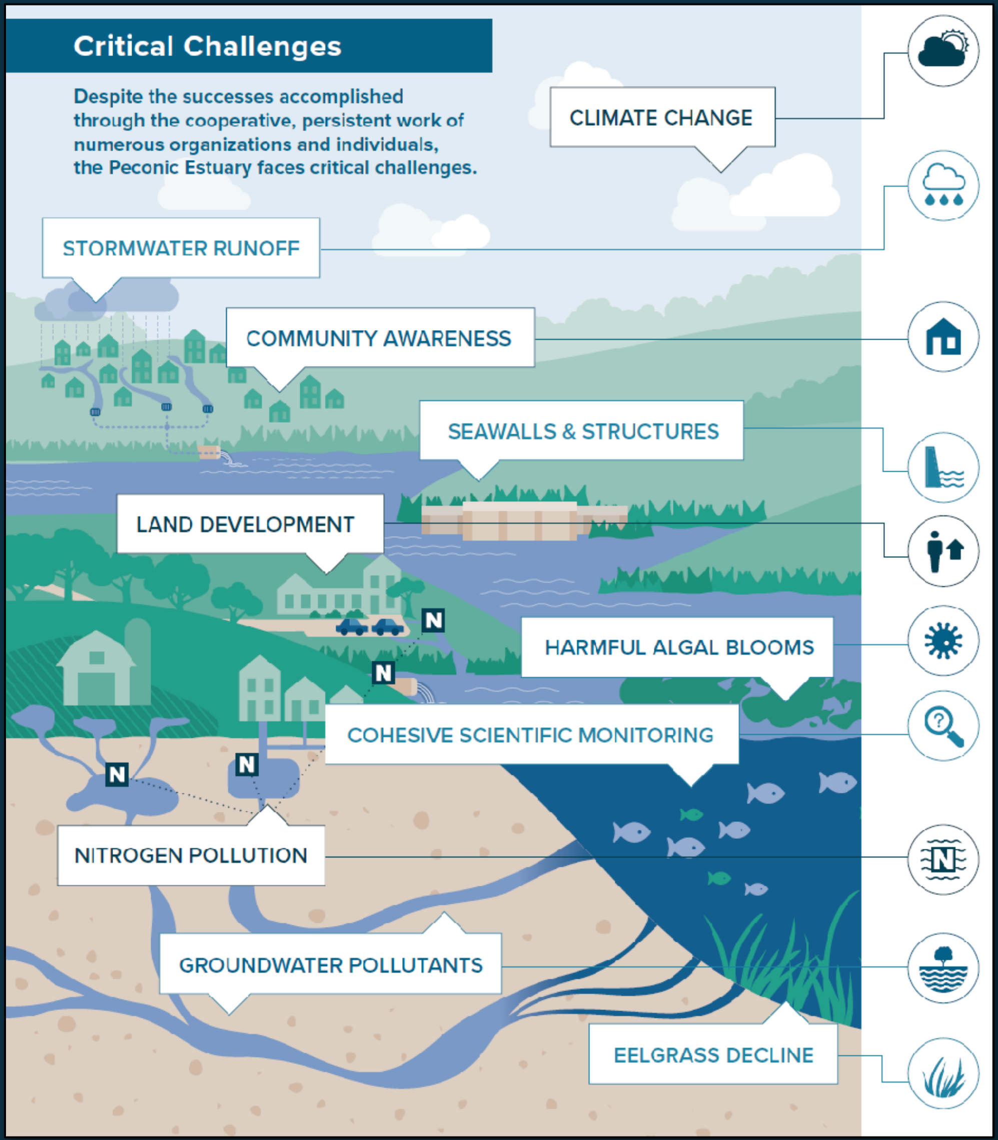




Peconic Estuary Partnership

Improved understanding of eelgrass decline



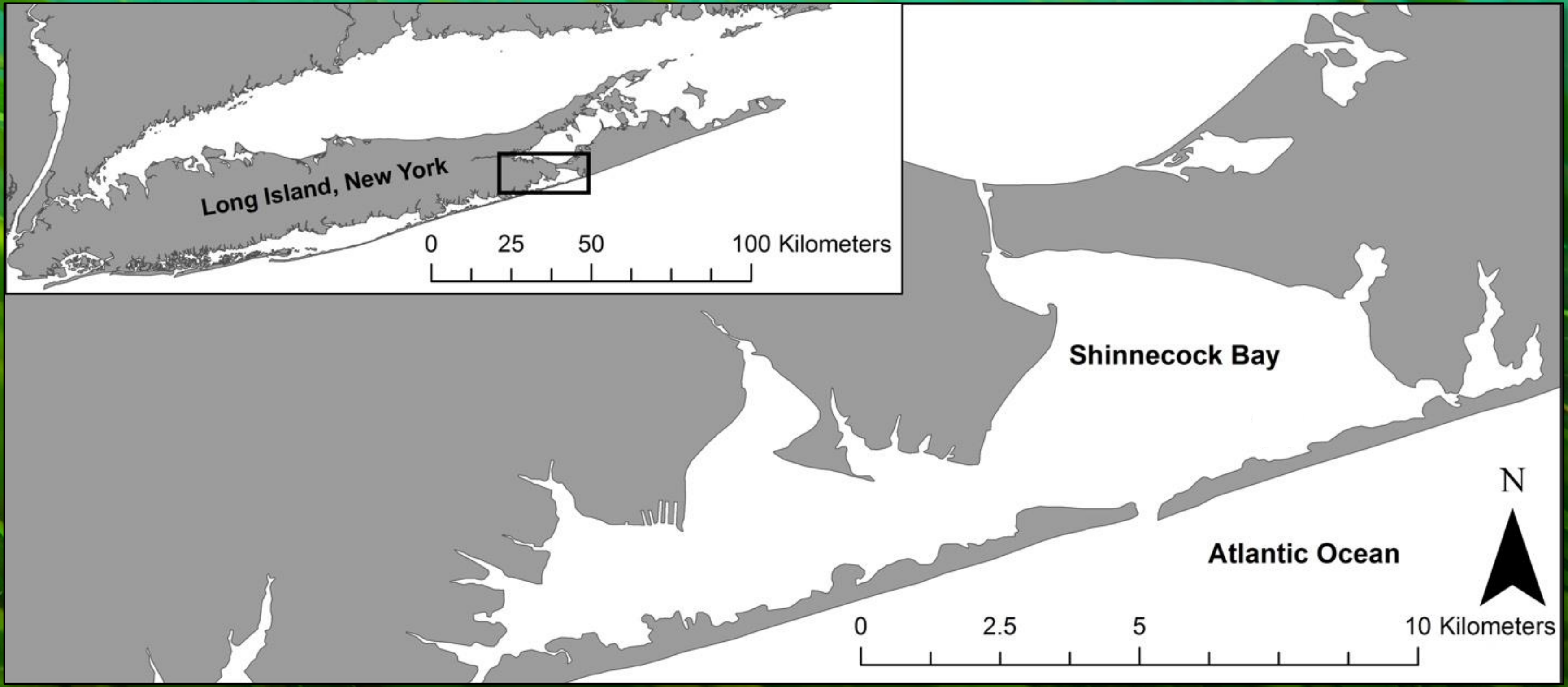


Peconic Estuary Partnership

Shinnecock Bay Restoration Program - Eelgrass

SHINNECOCK BAY
RESTORATION PROGRAM

Peterson
Marine Community Ecology Lab



Most of our eelgrass restoration starts with seed collection

SHINNECOCK BAY
RESTORATION PROGRAM

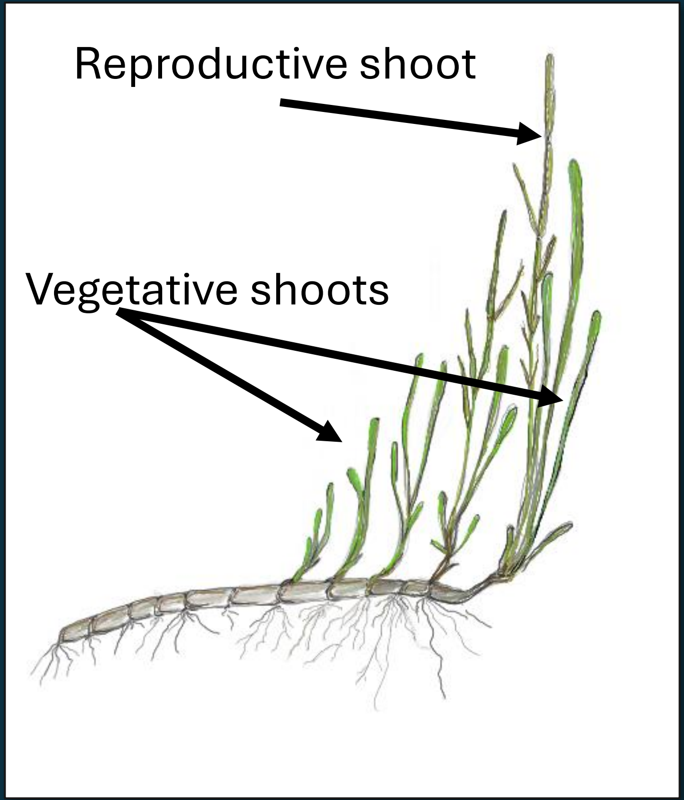


Image Credit: Adam Starke

Photo Credit: Brad Peterson

Reproductive shoot collection

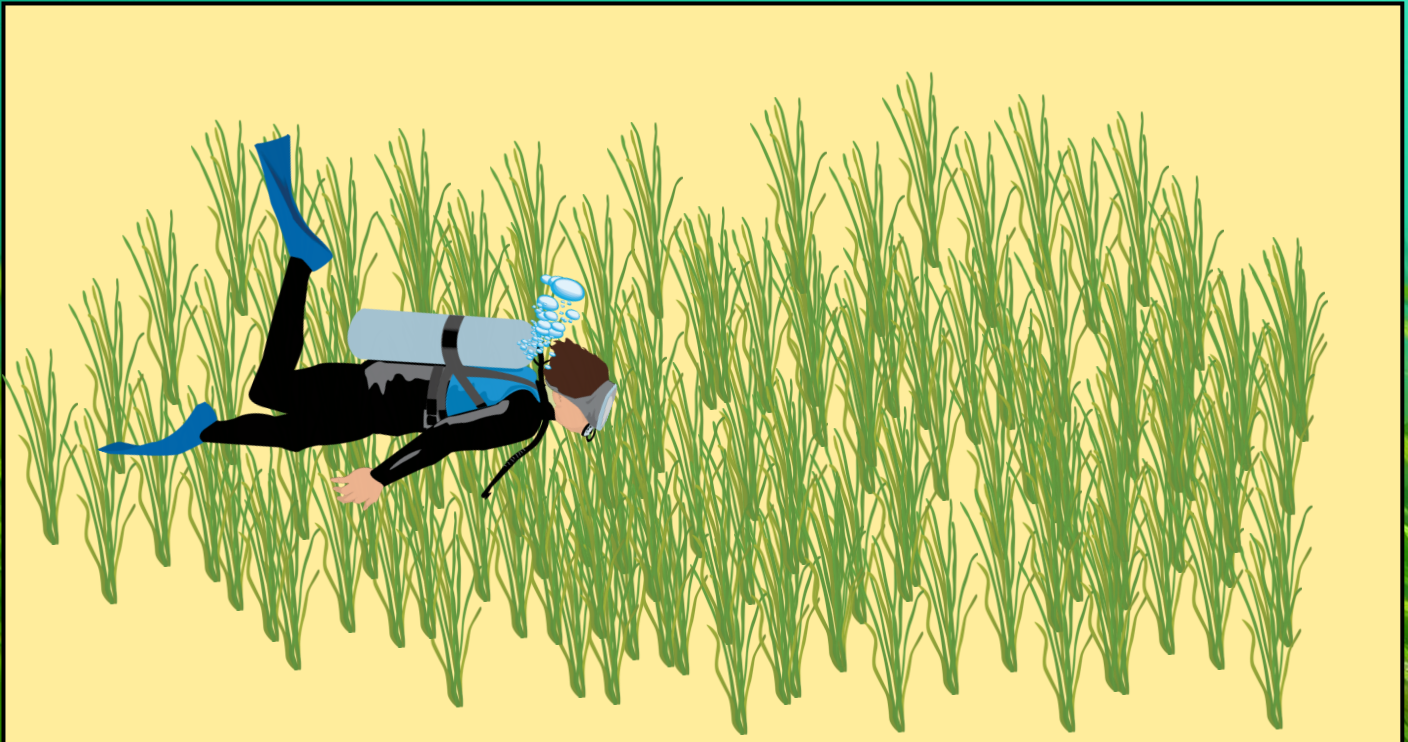


Image Credit: Dieter Tracey, Annie Carew, Max Hermanson (UMCES IAN)

- Disperse collection across different healthy eelgrass meadows to minimize negative impacts.

Photo Credit: Diana Chin

Photo Credit: Bart Michiels

Eelgrass Reproduction

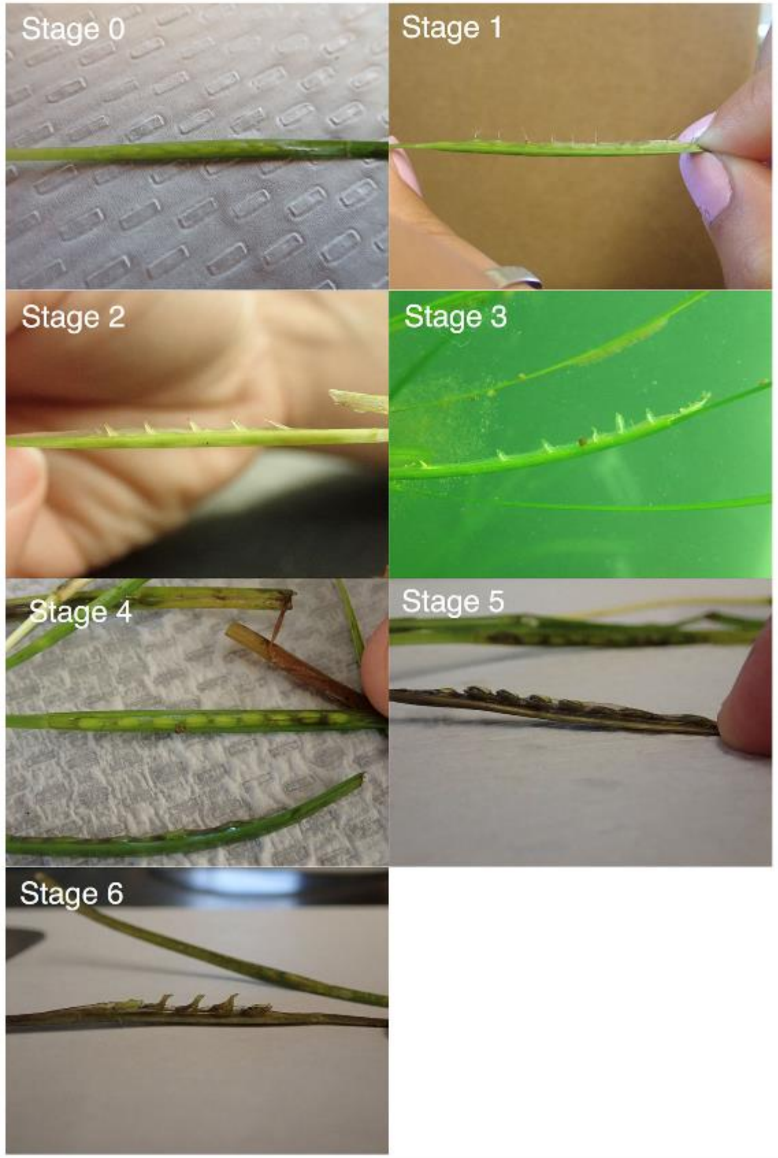


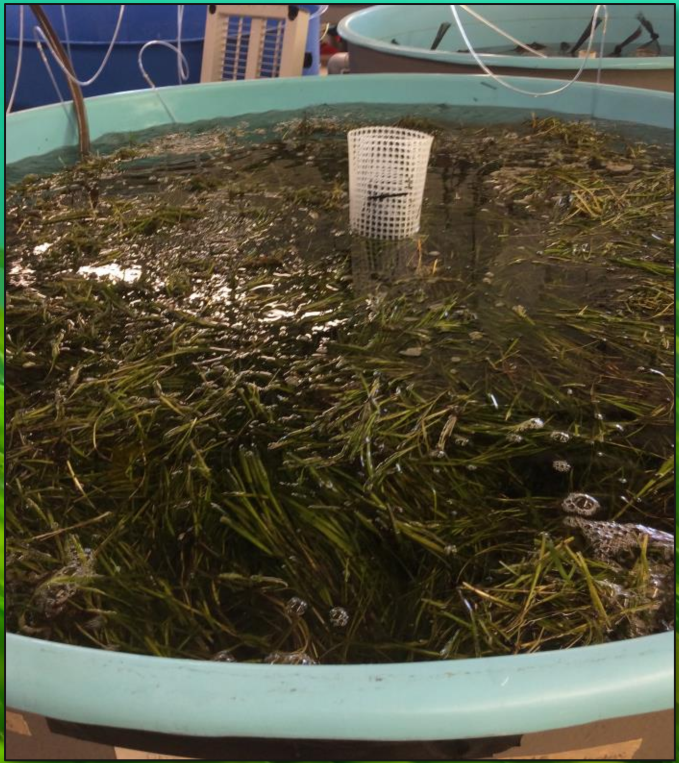
Fig. 2 Flowering stages of *Z. marina*. Stage 0: Spathes have developed, but styles have not yet erected; stage 1: Styles erect out of spadix; stage 2: Styles bend back into spathe after pollination; stage 3: Half-anthers release pollen; stage 4: Half-anthers have been released, seeds maturing; stage 5: Seeds are starting to release; and stage 6: Post-seed release and the flowering shoot begins to wither. Stages 1–6 are described in more detail in De Cock (1980)

Von Staats et al. 2021

- Generally collect reproductive shoots when seeds are developing and between stages 4 and 5.
- Ideally later stages, but trade-off between collection timing and when seeds start dropping.

Eelgrass Reproductive Shoot Storage

Photo Credit: Diana Chin



- Raw flowing seawater
- Heavy aeration to minimize anoxia
- No use of freshwater in washdowns, etc.
- Short term (2 weeks max.)

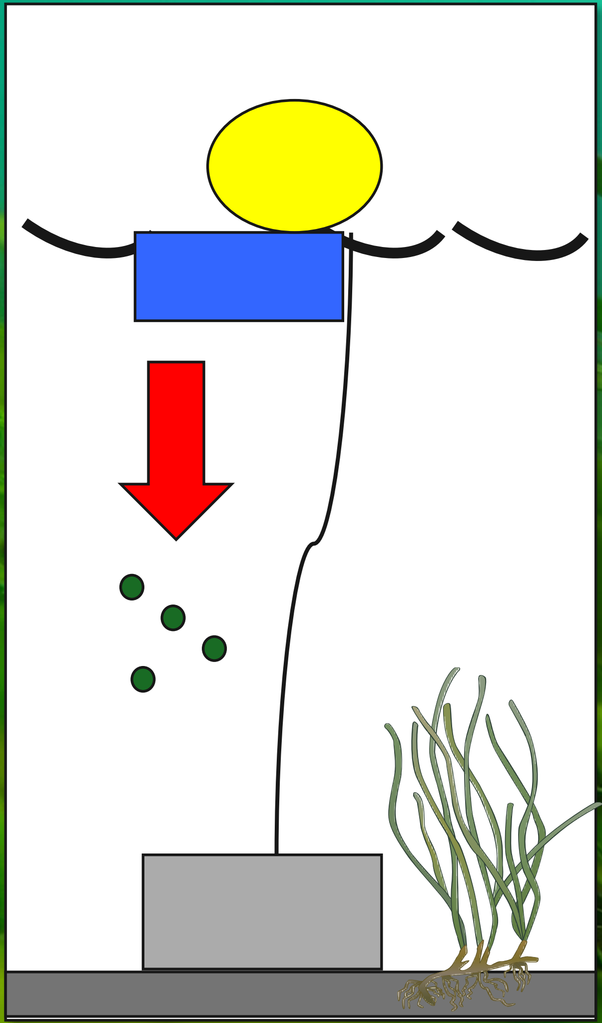
Buoy-deployed seeding

Buoy-deployed seeding: Demonstration of a new eelgrass (*Zostera marina* L.) planting method

Christopher H. Pickerell[a,*], Stephen Schott[a], Sandy Wyllie-Echeverria[b]

[a] *Cornell Cooperative Extension, Suffolk County, Marine Program, 3690 Cedar Beach Road, Southold, NY 11971, USA*
[b] *Center for Urban Horticulture, University of Washington, Box 355685, Seattle, WA, USA*

Buoy-deployed seeding



- Short time period in holding tanks
- Release at a similar timing to nature (early July)
- Lots labor upfront to deploy the buoy systems
- Lots of volunteers and serves as an educational event as well

Eelgrass seed storage & broadcast seeding

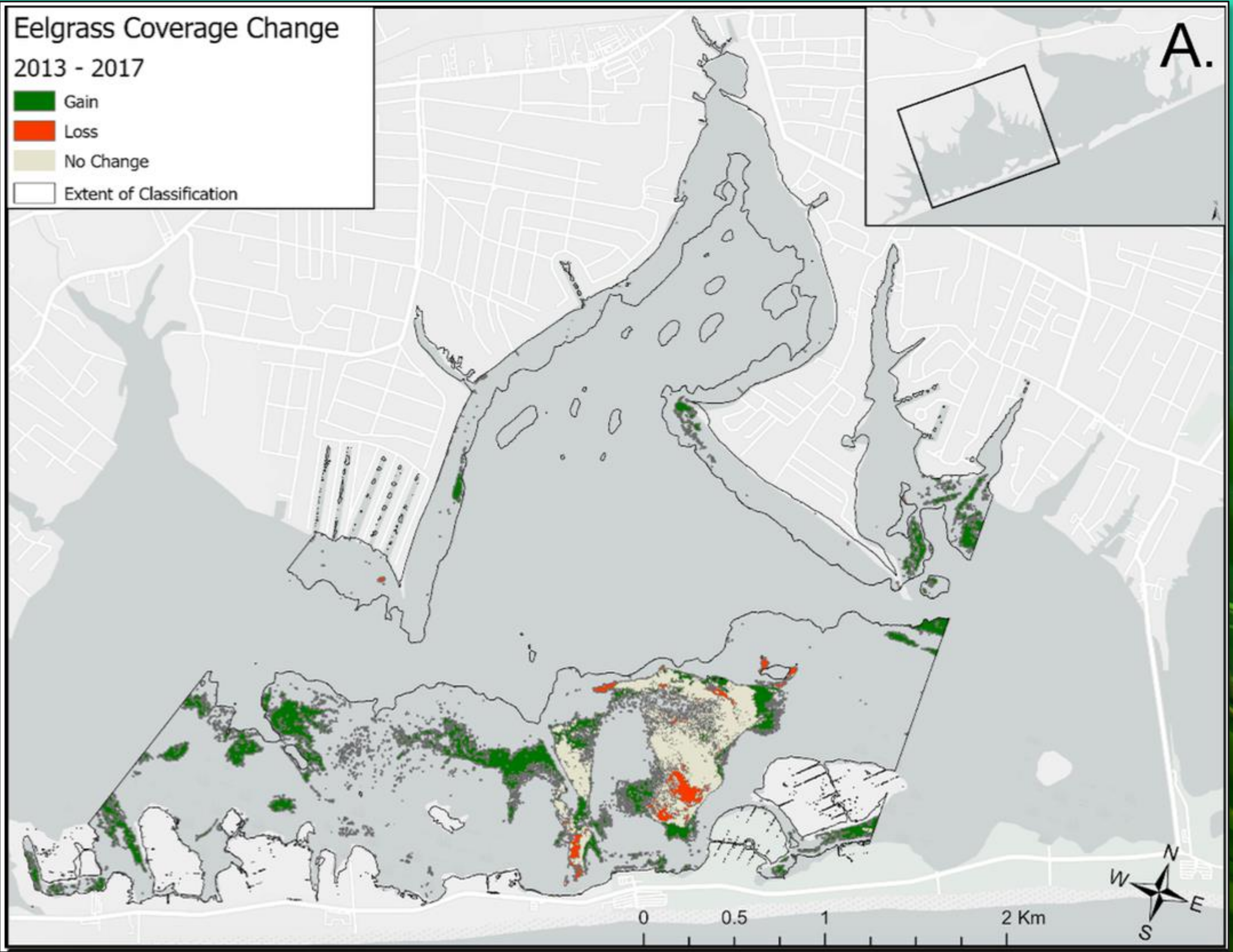
- Longer time period in holding tanks.
- Water quality issues led to use of a recirculating water system.
- Seeds are held for longer in tanks in downweller silos.
- Released between October and November.
- Allows for separate storage of seeds from individual populations.

Eelgrass recovery

Rebuilding A Collapsed Bivalve Population, Restoring Seagrass Meadows, and Eradicating Harmful Algal Blooms In A Temperate Lagoon Using Spawner Sanctuaries

Christopher J. Gobler[1*†], Michael H. Doall[1*†], Bradley J. Peterson[1], Craig S. Young[1], Flynn DeLaney[1], Ryan B. Wallace[1], Stephen J. Tomasetti[1], Timothy P. Curtin[1], Brooke K. Morrell[1], Elizabeth M. Lamoureux[2], Berry Ueoka[2], Andrew W. Griffith[3], John M. Carroll[4], Deepak Nanjappa[1], Jennifer G. Jankowiak[1], Jennifer A. Goleski[1], Ann Marie E. Famularo[1], Yoonja Kang[1], Ellen K. Pikitch[1], Christine Santora[1], Stephen M. Heck[1], Dylan M. Cottrell[1], Diana W. Chin[5] and Rebecca E. Kulp[1]


Photo Credit: Brad Peterson



Rising water temperatures

Influence of Rising Water Temperature on the Temperate Seagrass Species Eelgrass (*Zostera marina* L.) in the Northeast USA

Holly K. Plaisted[1], Erin C. Shields[2,3], Alyssa B. Novak[4], Christopher P. Peck[5], Forest Schenck[6], Jillian Carr[7], Paul A. Duffy[5], N. Tay Evans[6], Sophia E. Fox[8], Stephen M. Heck[9], Robbie Hudson[10], Trevor Mattera[11], Kenneth A. Moore[3], Betty Neikirk[2,3], David B. Parrish[2,3], Bradley J. Peterson[9], Frederick T. Short[12] and Amanda I. Tinoco[9]*

Above average summer water temperatures decrease probability of eelgrass presence

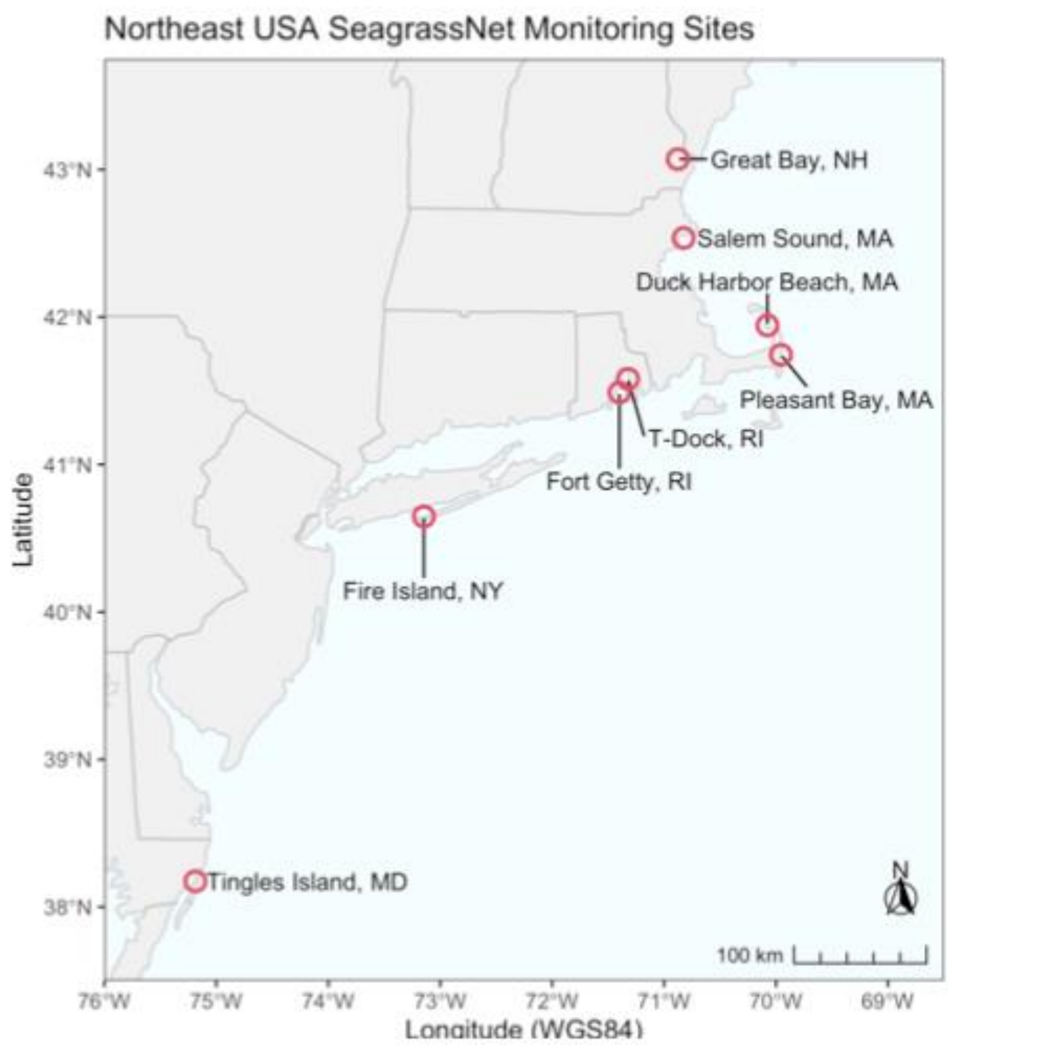
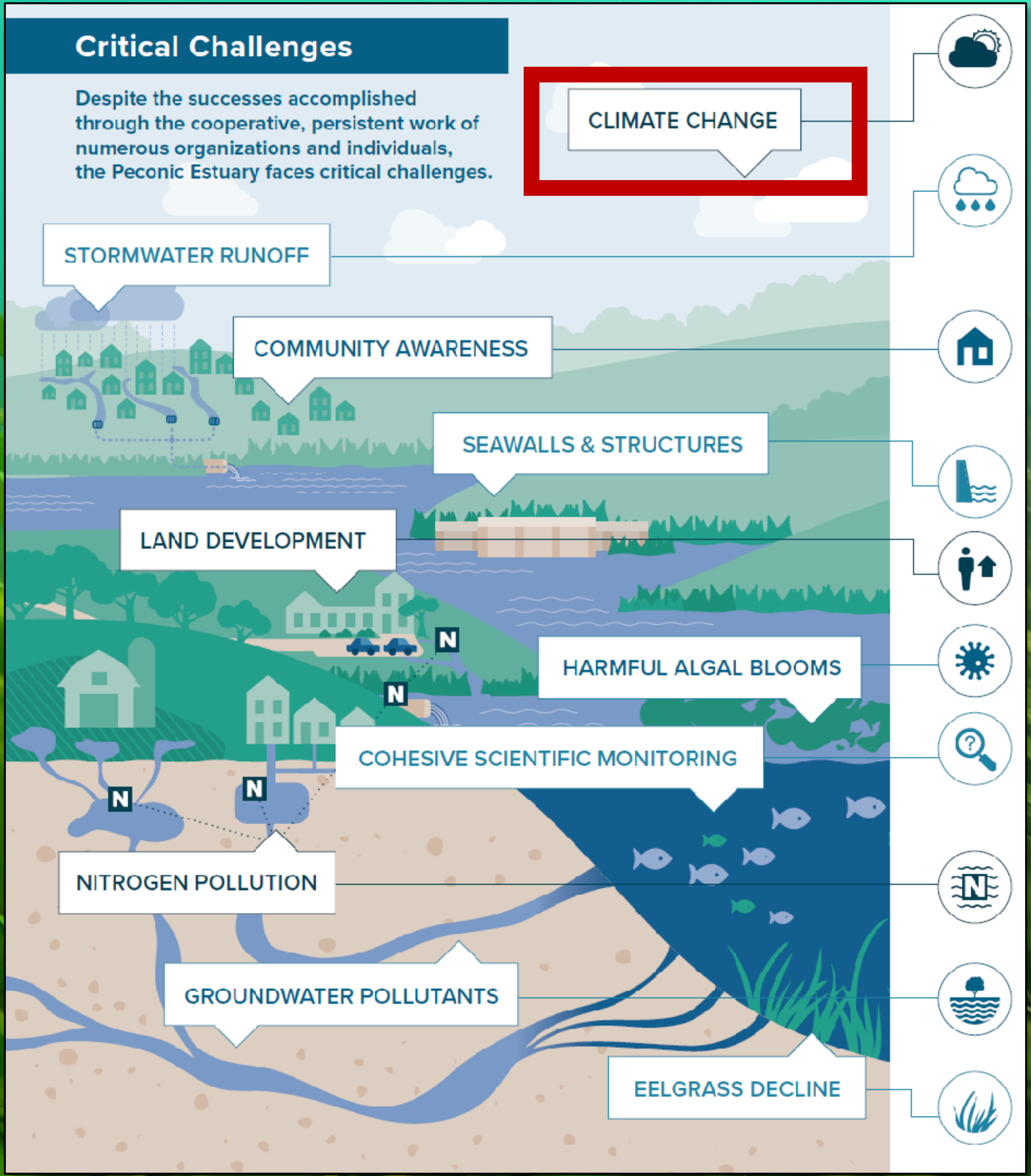


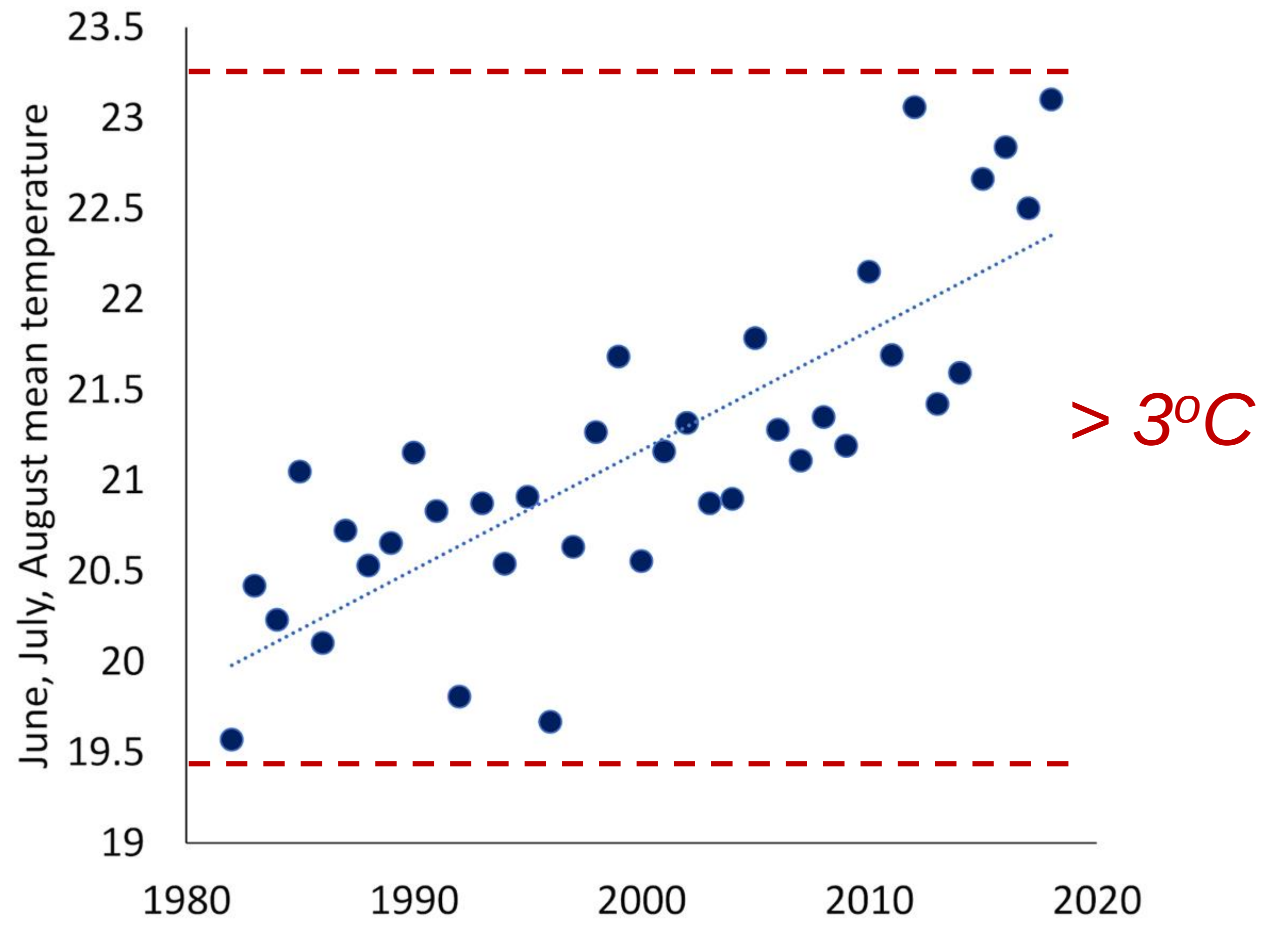
FIGURE 1 | SeagrassNet sites located in Northeast USA.

Rising water temperatures



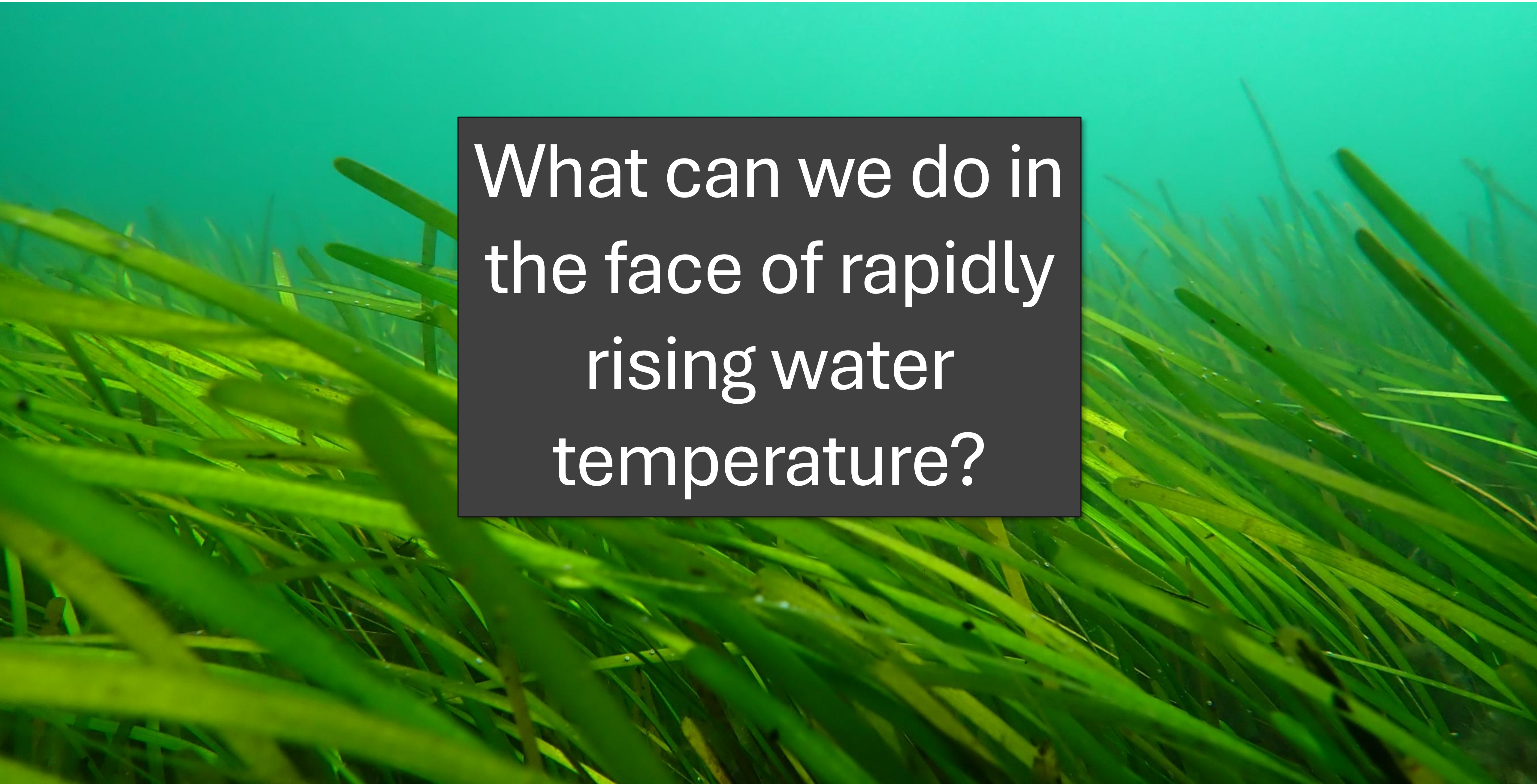
Peconic Estuary Partnership

35-year trend, summer water temperature around Long Island



Gobler et al. 2017

Rising water temperatures



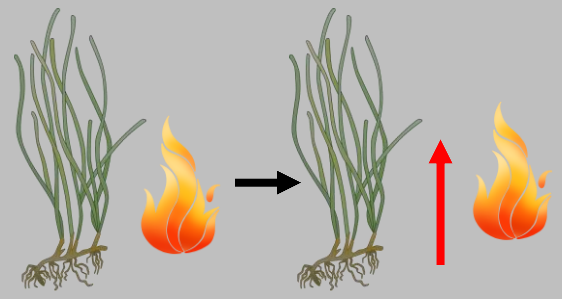
What can we do in the face of rapidly rising water temperature?

TNC Eelgrass Resiliency Workshop

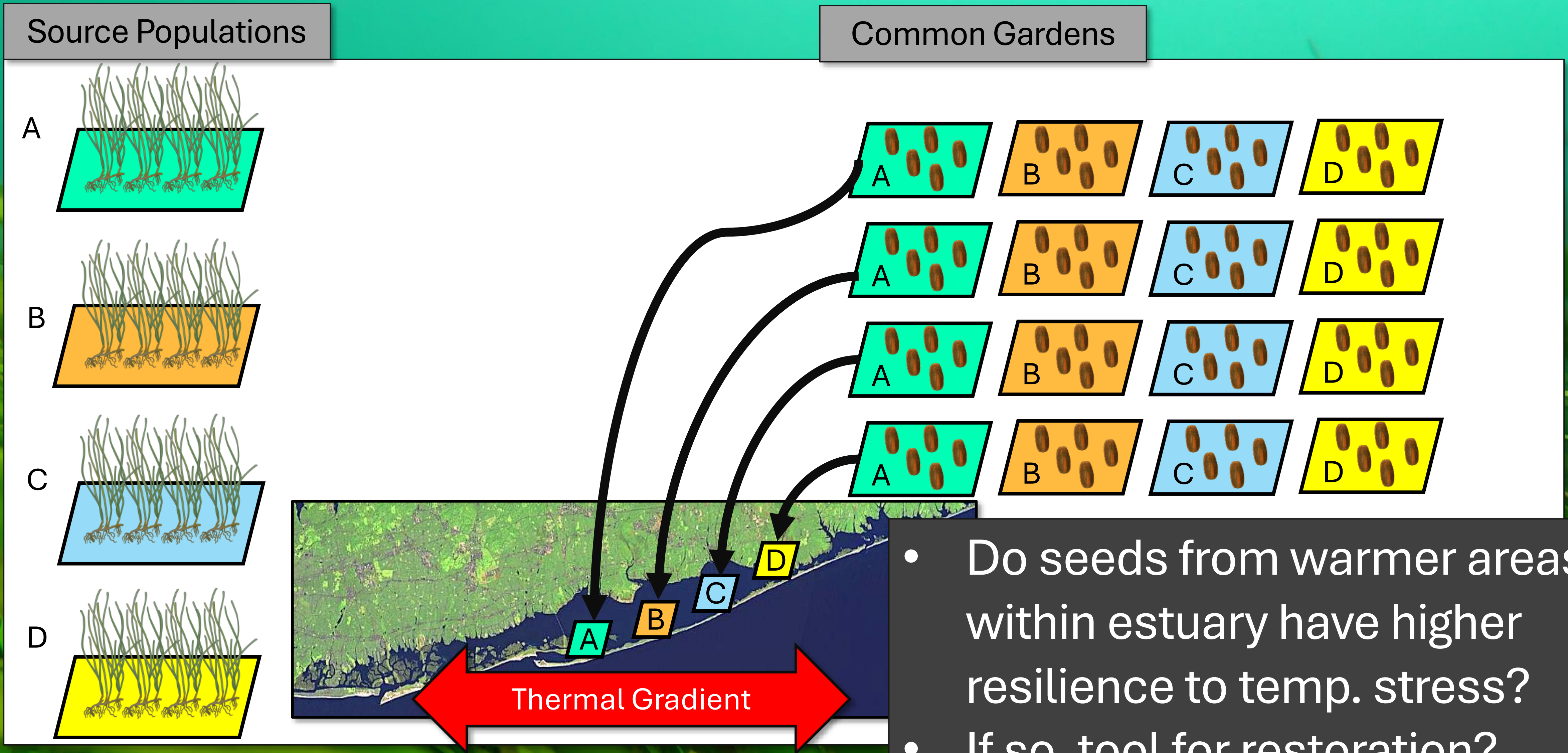
The Nature Conservancy

Most promising pathways towards building eelgrass resilience to thermal stress

Seed-based Assisted Gene Flow



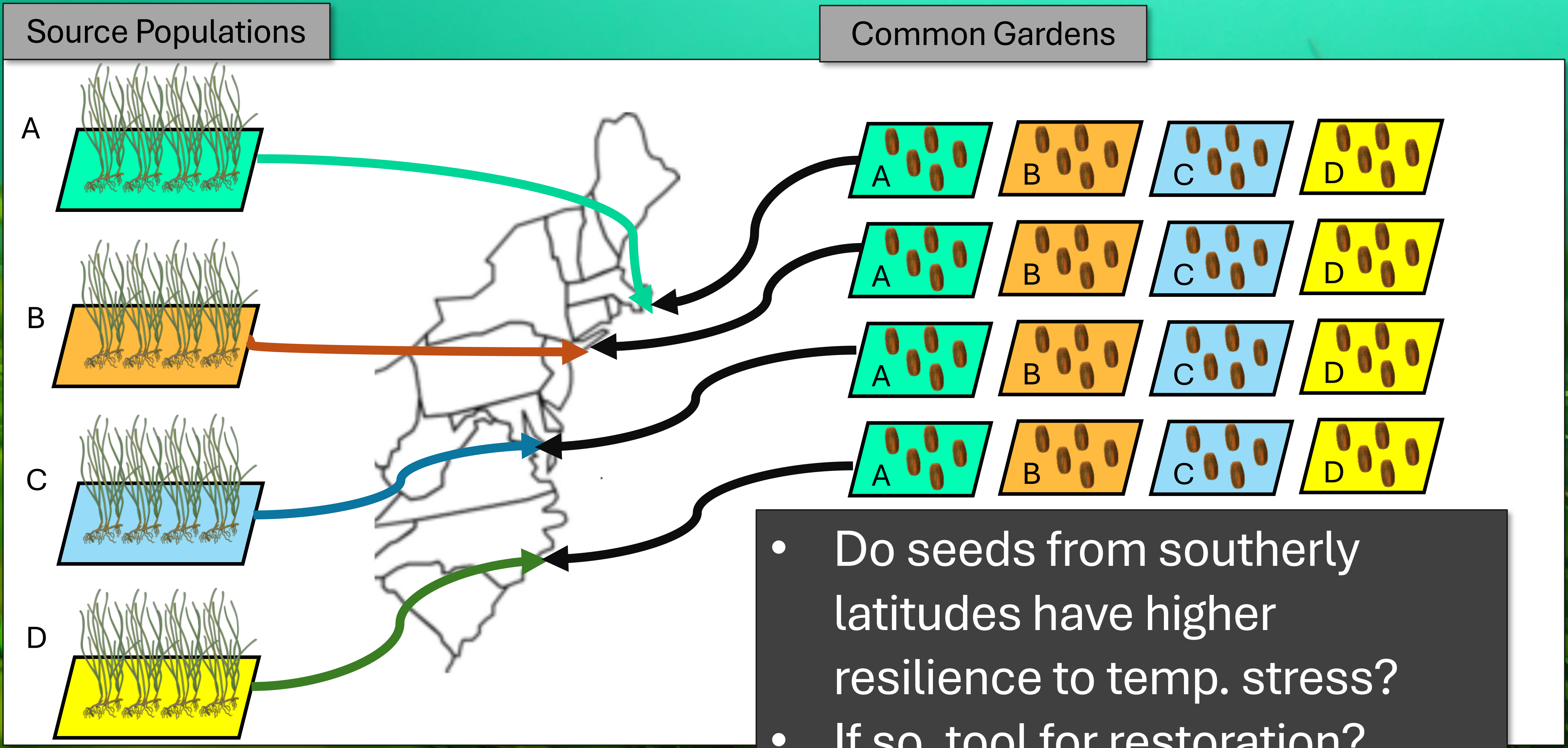
Assisted Gene Flow



- Do seeds from warmer areas within estuary have higher resilience to temp. stress?
- If so, tool for restoration?

Eelgrass drawing credit: VIMS; Eelgrass seed image credit: CCE

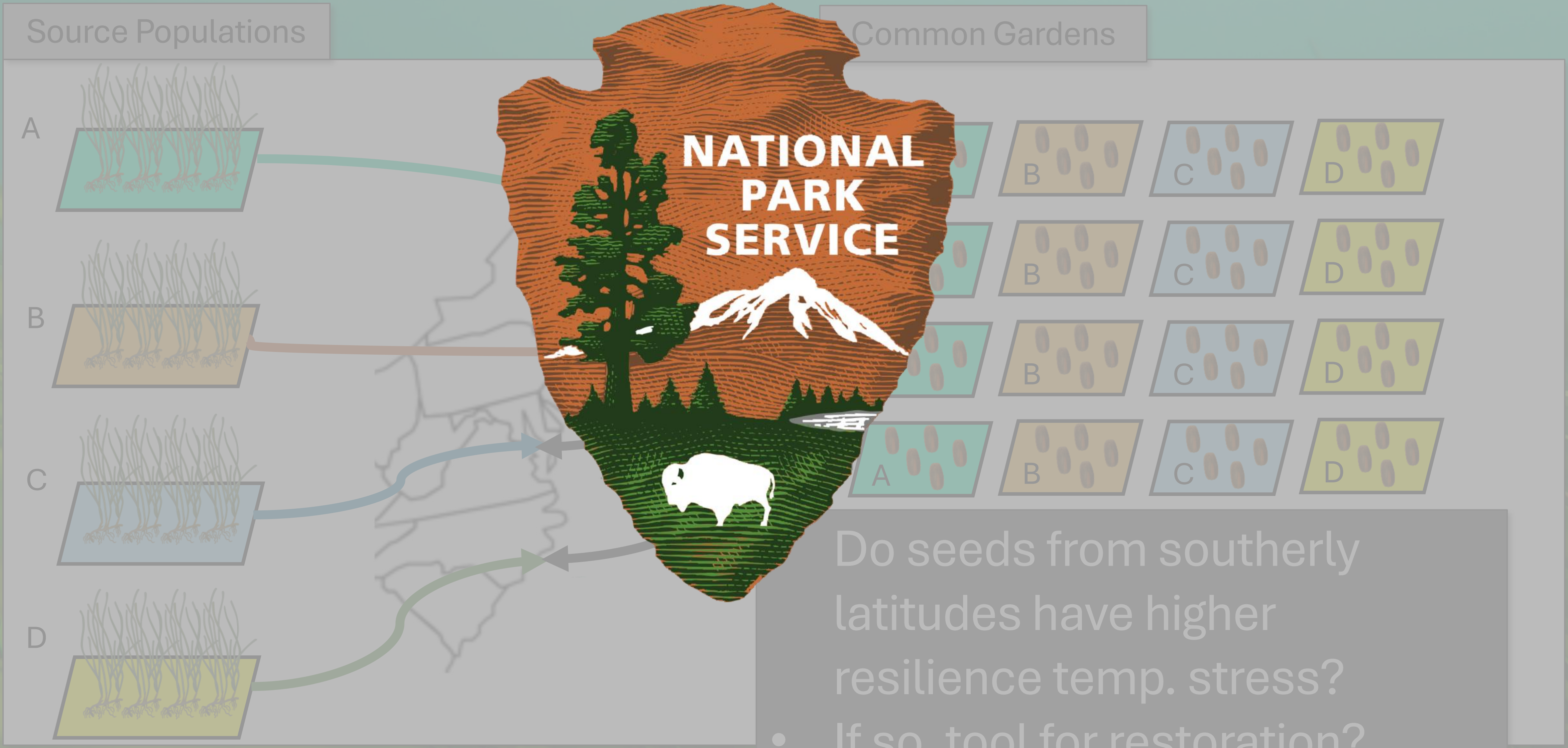
Assisted Gene Flow



- Do seeds from southerly latitudes have higher resilience to temp. stress?
- If so, tool for restoration?

Eelgrass drawing credit: VIMS; Eelgrass seed image credit: CCE

Assisted Gene Flow



Do seeds from southerly latitudes have higher resilience temp. stress?

- If so, tool for restoration?

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Interstate movement of seeds

- Required for testing latitudinal assisted gene flow in eelgrass
- Successful tool in terrestrial world
- Currently being evaluated in NC and VA/MD
- Small scale to assess potential benefits
- Permission from states is variable
- Precedent from other industries to move between states
- Protocols should be adhered to minimize risks

Interstate movement risks can be mitigated

- Genetic implication
  - Populations currently much more isolated compared to historic gene flow levels
  - Restore historic gene flow?

- Pathogens
  - Most found in most estuaries
  - Options for minimizing disease spread by seeds
    - Bleach
    - Copper sulphate
    - Relative evaluation of efficacy is needed
    - Tools to mitigate risks
    - Risk of removing beneficial bacteria?

Innovative Techniques for Large-scale Seagrass Restoration Using *Zostera marina* (eelgrass) Seeds

Scott R. Marion[1] and Robert J. Orth[1,2]

Copper treatment during storage reduces *Phytophthora* and *Halophytophthora* infection of *Zostera marina* seeds used for restoration

Laura L. Govers[1,2], Els M. van der Zee[3], Johan P. Meffert[4], Patricia C. J. van Rijswick[4], Willem A. Man in 't Veld[4], Jannes H. T. Heusinkveld[5] & Tjisse van der Heide[1]

Interstate movement logistics

- Form a collective group to share data in real time to speed up the process (time of the essence)

- Assisted gene flow is worth trying and could be a game changer but will be straightforward to assess efficacy and mitigate risks

- If deemed an effective restoration tool to facilitate adaptation of eelgrass to warmer temp, distribution network would need to be developed


Questions?