Eelgrass restoration in San Francisco Bay: a primer

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Diaspora Arts Connection

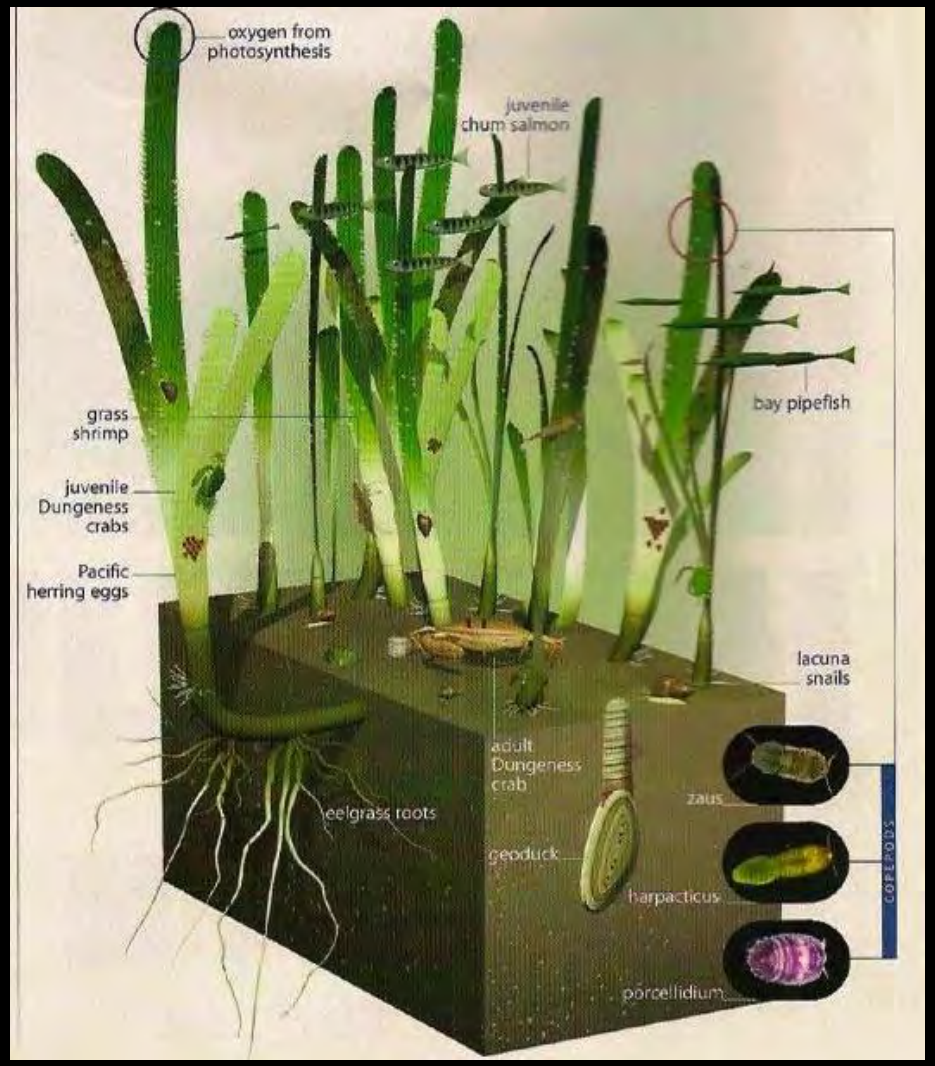
Eelgrass – why restore?

Global distribution
Losses in many regions

Eelgrass, *Zostera marina*

Eelgrass – why restore?

Losses of associated fauna



Foundational habitat

Pacific herring eggs

Juvenile Dungeness crab

Bay pipefish

Photos, S. Kiriakopolos

Eelgrass – why restore?

Losses of services, including:

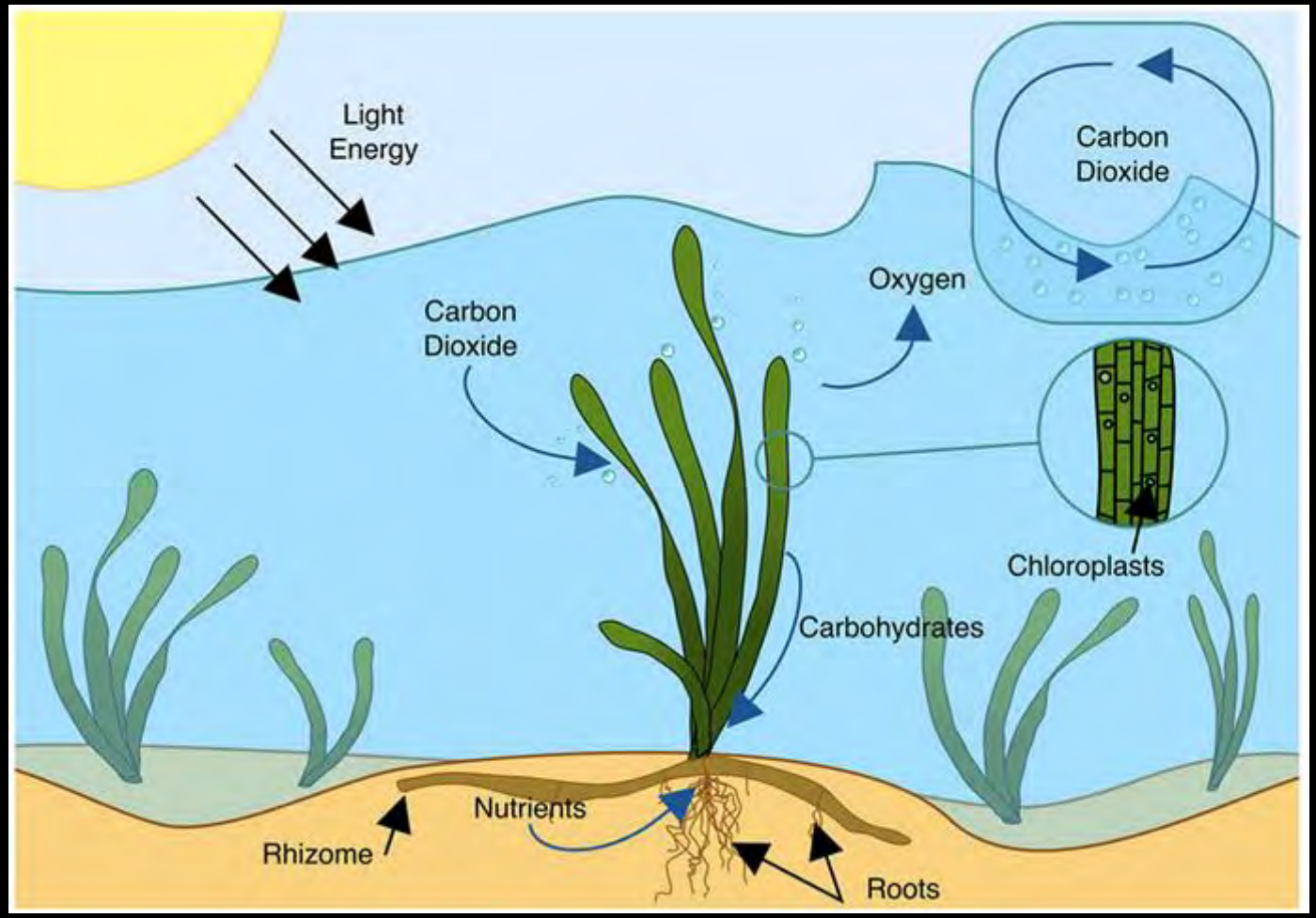
Sediment stabilization

Uptake of nutrients

Uptake of CO_2

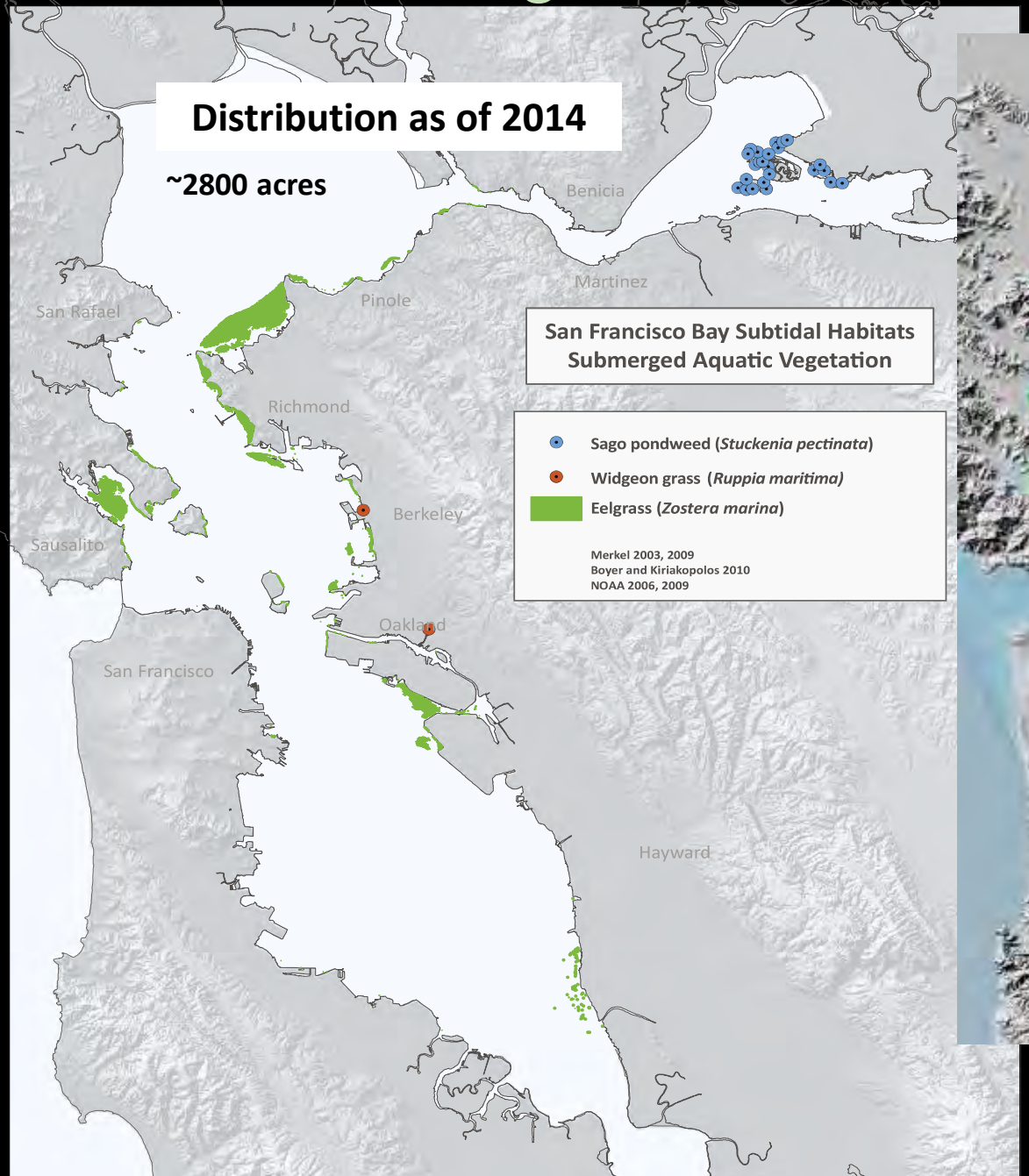
C sequestration in sediments

Localized increase in pH
(countering acidification)



Historic and ongoing impacts in San Francisco Bay

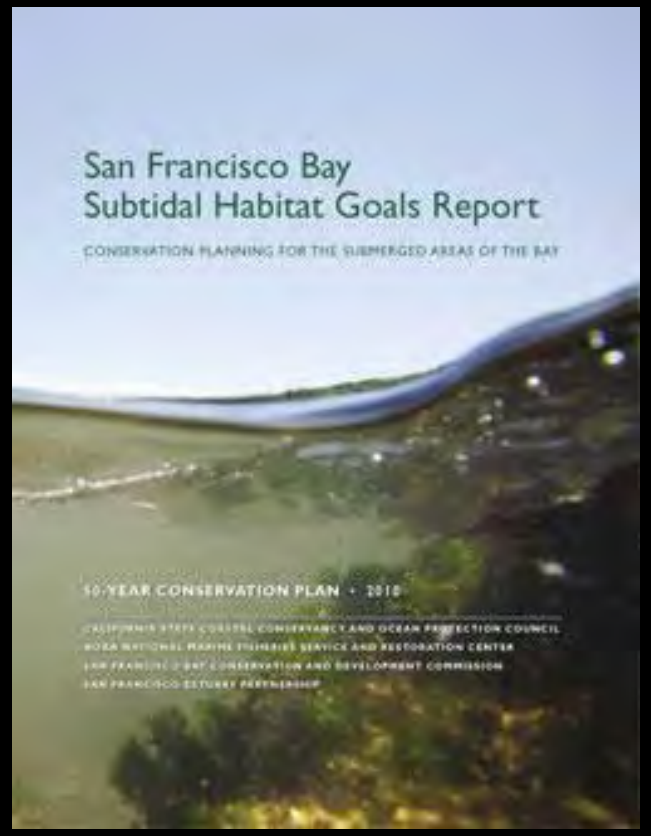
What is the eelgrass and where could it be?



Order of magnitude more eelgrass possible?

Merkel and Associates 2005, 2014

Goals and motivations



2010 baywide goal:
8000 acres of restoration in 50 years

Mitigate Cosco Busan oil spill :
36 acres in 9 years, starting 2014

Recent shift in motivation: contribute to shoreline protection / ameliorate ocean acidification

Funding

Bond funding through Coastal Conservancy
NOAA Restoration Program / NMFS
Cosco Busan oil spill responsible parties / NFWF
PGE settlement with Herring Fisherman's Association
Ocean Protection Council / Prop 1
Measure AA / Restoration Authority

Restoration – how do we do it?

First: site selection

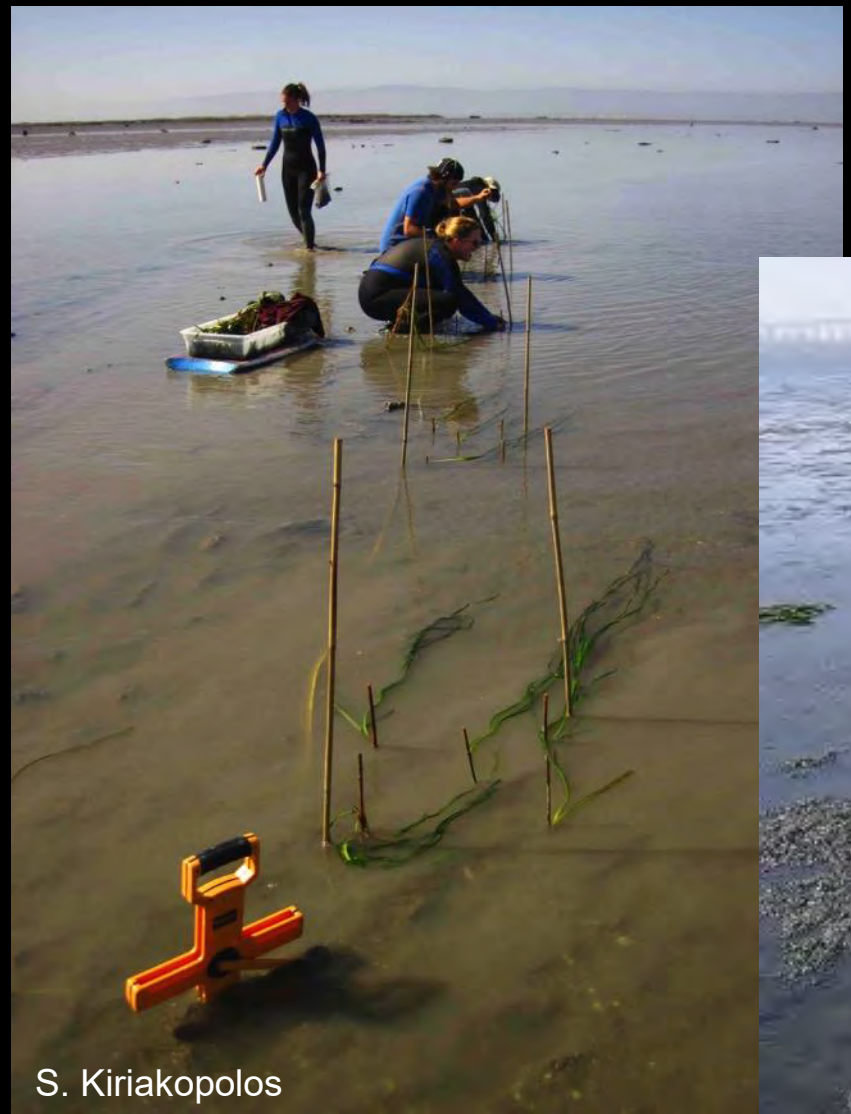
Start with biophysical model

New effort to update model: collaboration with CA Audubon and Merkel & Associates

Merkel and Associates 2005

Restoration – how do we do it?

Then, test plots critical: start small, scale up



S. Kiriakopolos

K. Boyer

Restoration – how do we do it?

Can capitalize on two reproductive modes

Use transplants? Adult plants less vulnerable than seeds/seedlings, instant restored bed

Use seeds? Enhanced genetic diversity and possibly resiliency, minimal damage to donor beds

Restoration – how do we do it?

Direction of ephemeral flow

Two transplant methods work well: mostly logistics

Bamboo stake transplants

Paper stick transplants

Photos, S. Kiriakopolos

Restoration – how do we do it?

Seeding can be valuable, but we now do after we test the site by transplanting

Buoy-deployed seeding:
Pickerell, et al. 2005

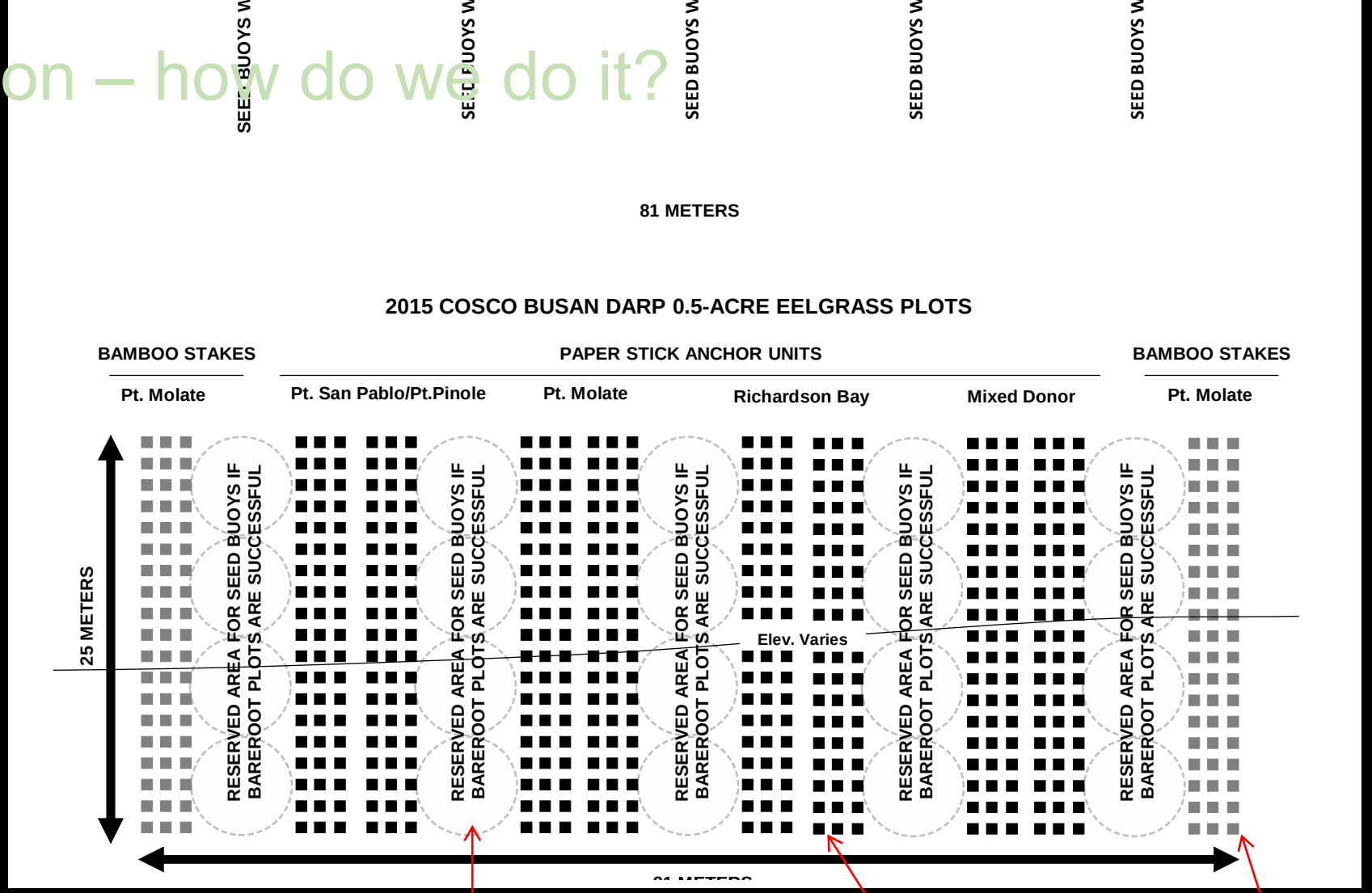
Restoration – how do we do it?

Donor material: mix or match?

Genotypic or allelic richness = resiliency to stress, other functions
(e.g., Hughes and Stachowicz 2009, Reynolds et al. 2012)

Significant genetic structure: 5 beds genetically distinct from each other
(Ort et al. 2012, 2014)

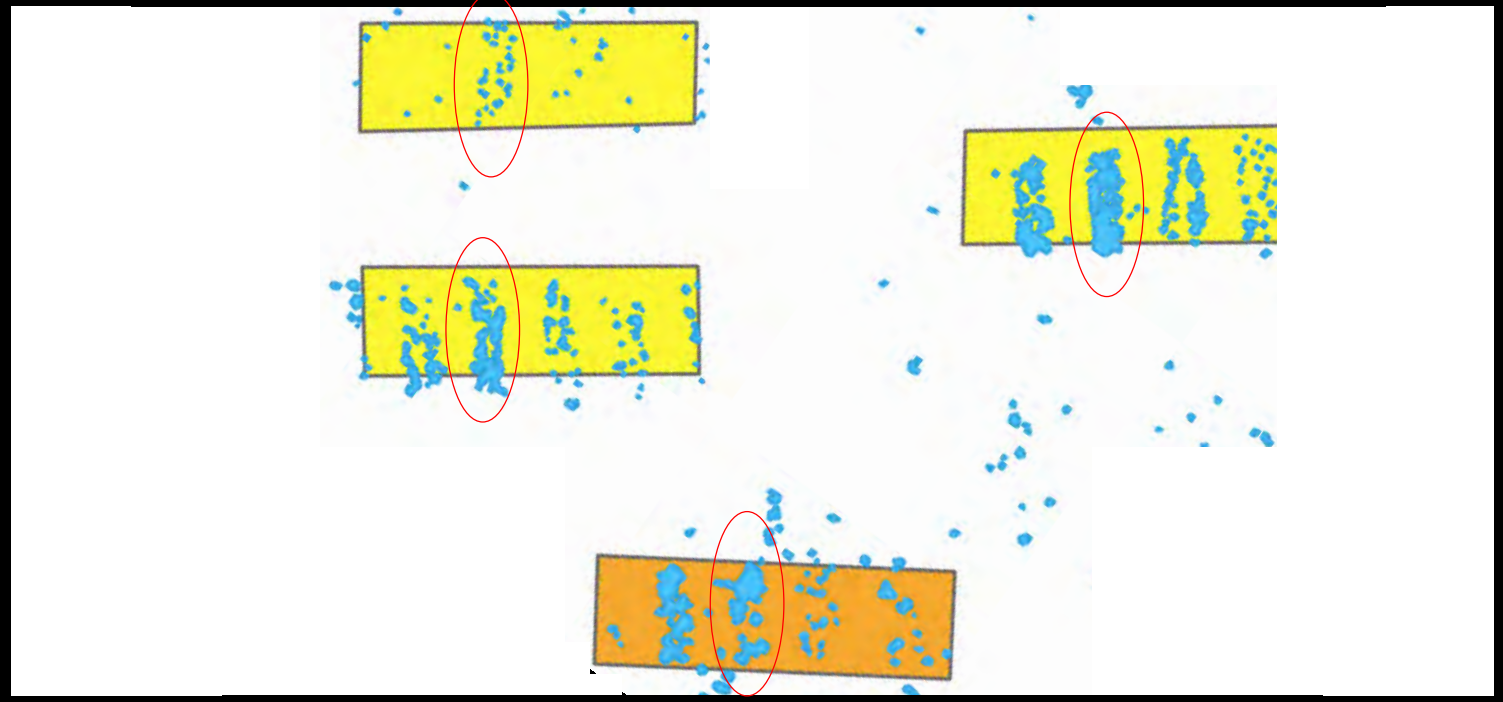
Restoration – how do we do it?



Merkel & Associates and Boyer Lab

Restoration – how do we do it?

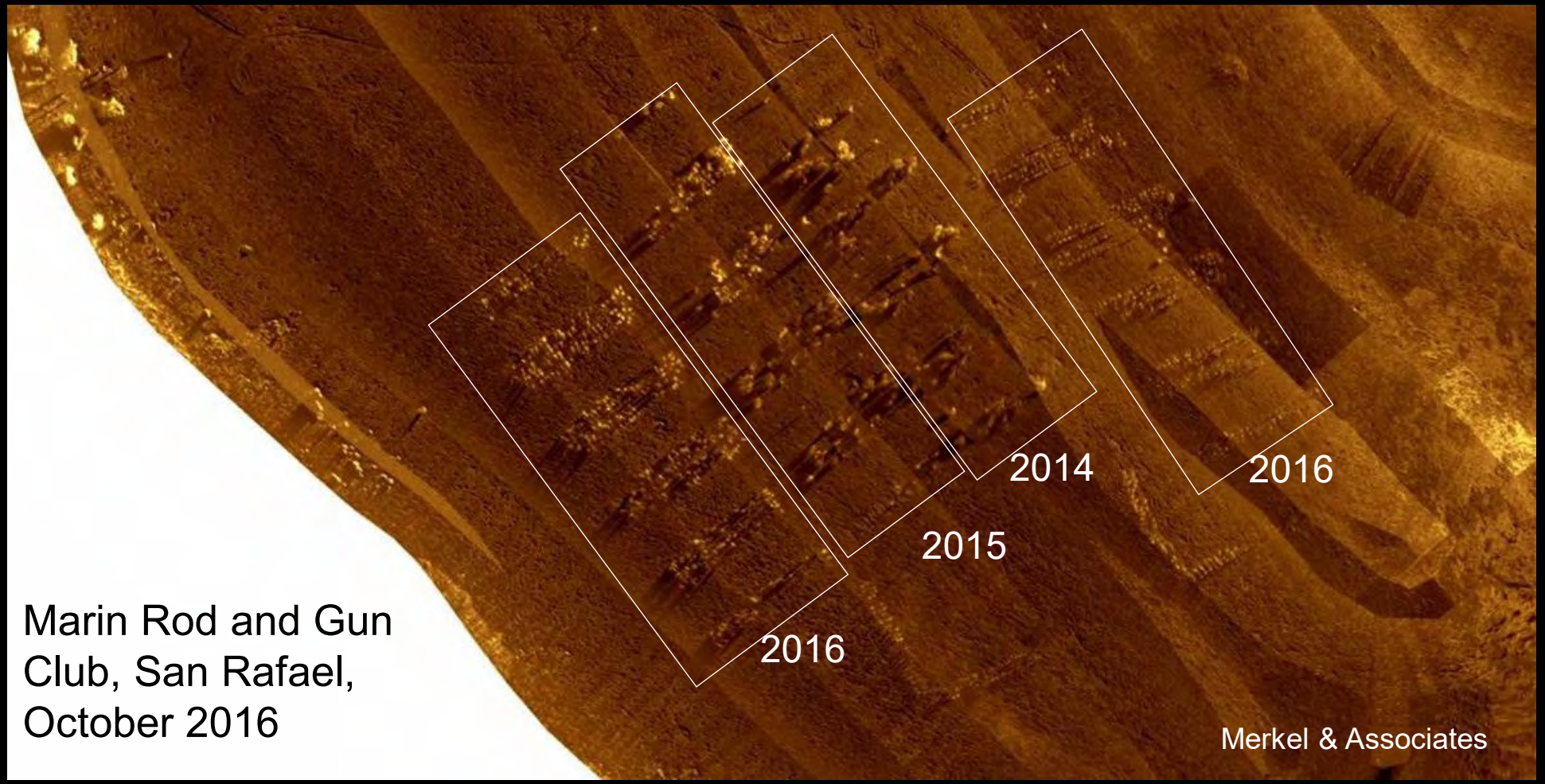
Preliminary support for matching donor and site
Local plants sometimes establish best
But finding that mixing hedges bets



Merkel & Associates
and Boyer Lab

Monitoring – what works best?

Interferometric sidescan sonar, coupled with density and qualitative measures



Example of "clipped" blades due to bird herbivory

Herring eggs on restored eelgrass at Richardson Bay (Dec. 2018)

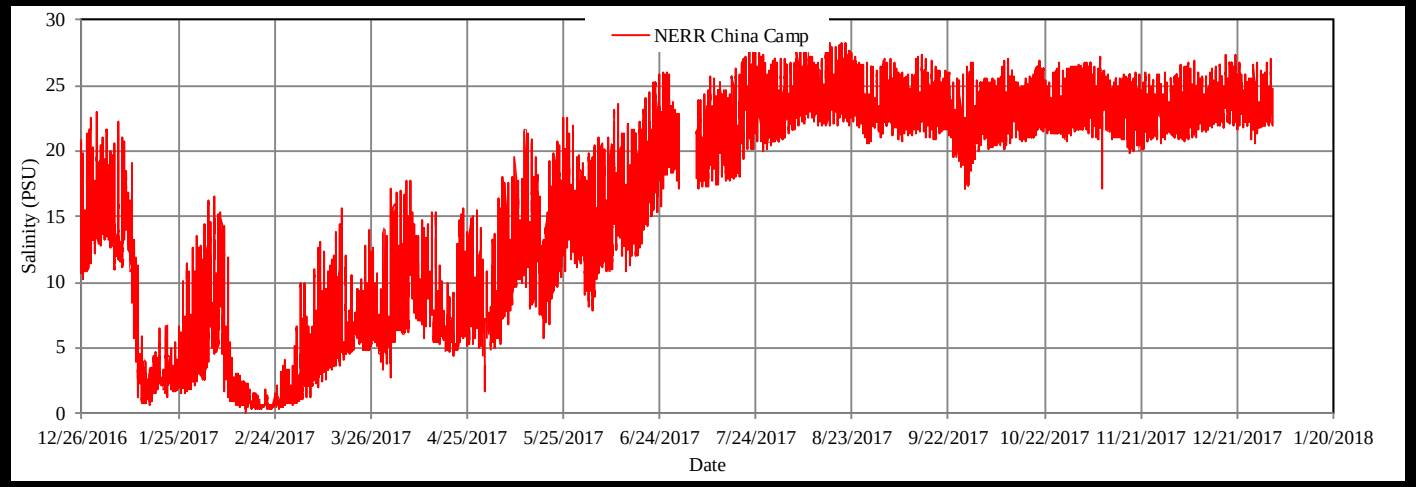
Defining success

Eelgrass present and expanding clonally
Self-seeding
Resilient to disturbances

But….not expected in all years

Complications: interannual variation and climate change

Greatest rainfall on record in winter 2016/17
Plants damaged, but recovering
Restoration takes sustained effort



2017: salinity ~10 ppt for 4 mo

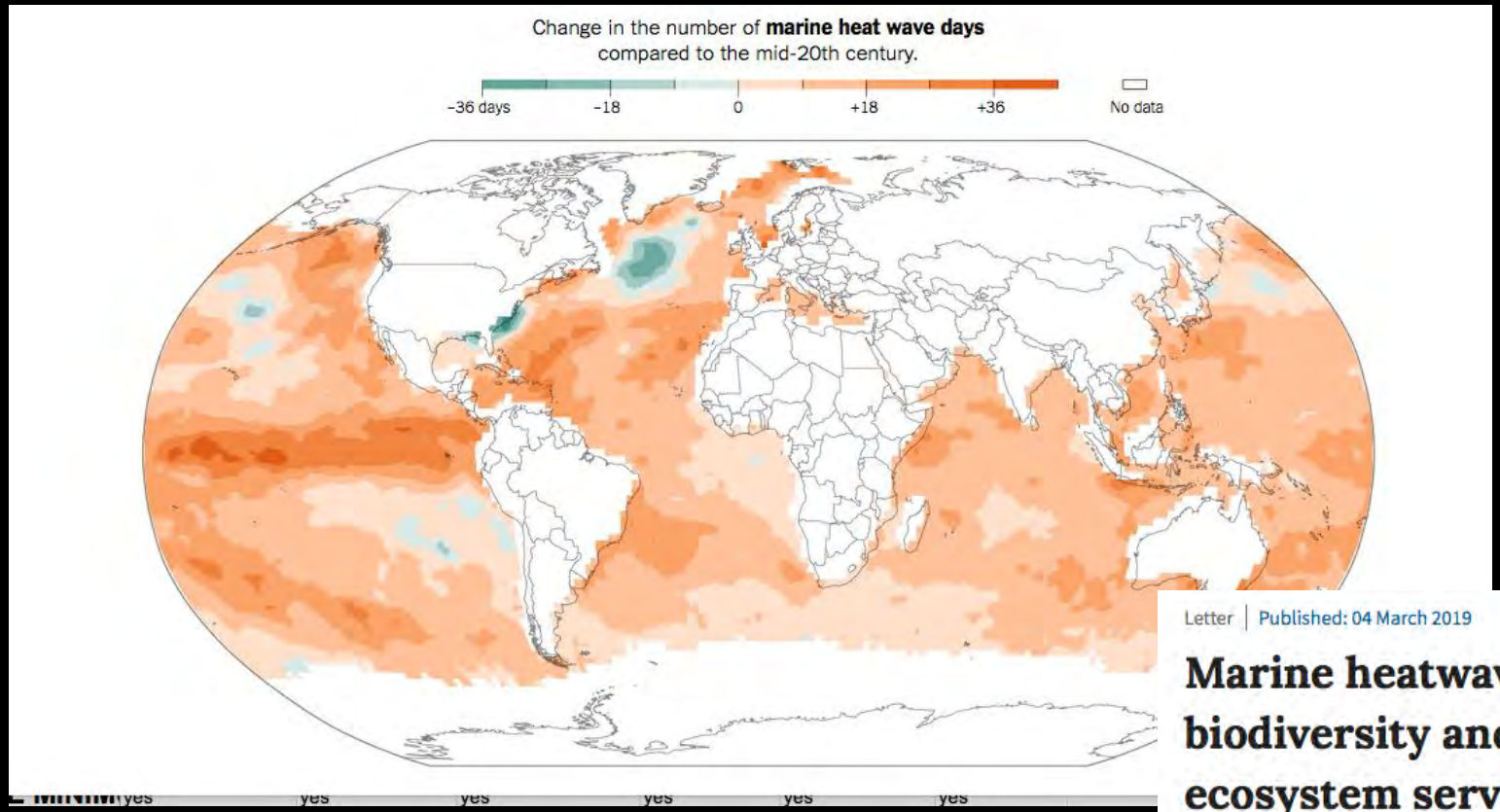
Loss of oysters, eelgrass, and other associated species

Pentidotea resecata

Phyllaplysia taylori

Complications: interannual variation and climate change

Also, increased frequency of heat waves



Letter | Published: 04 March 2019

Marine heatwaves threaten global biodiversity and the provision of ecosystem services

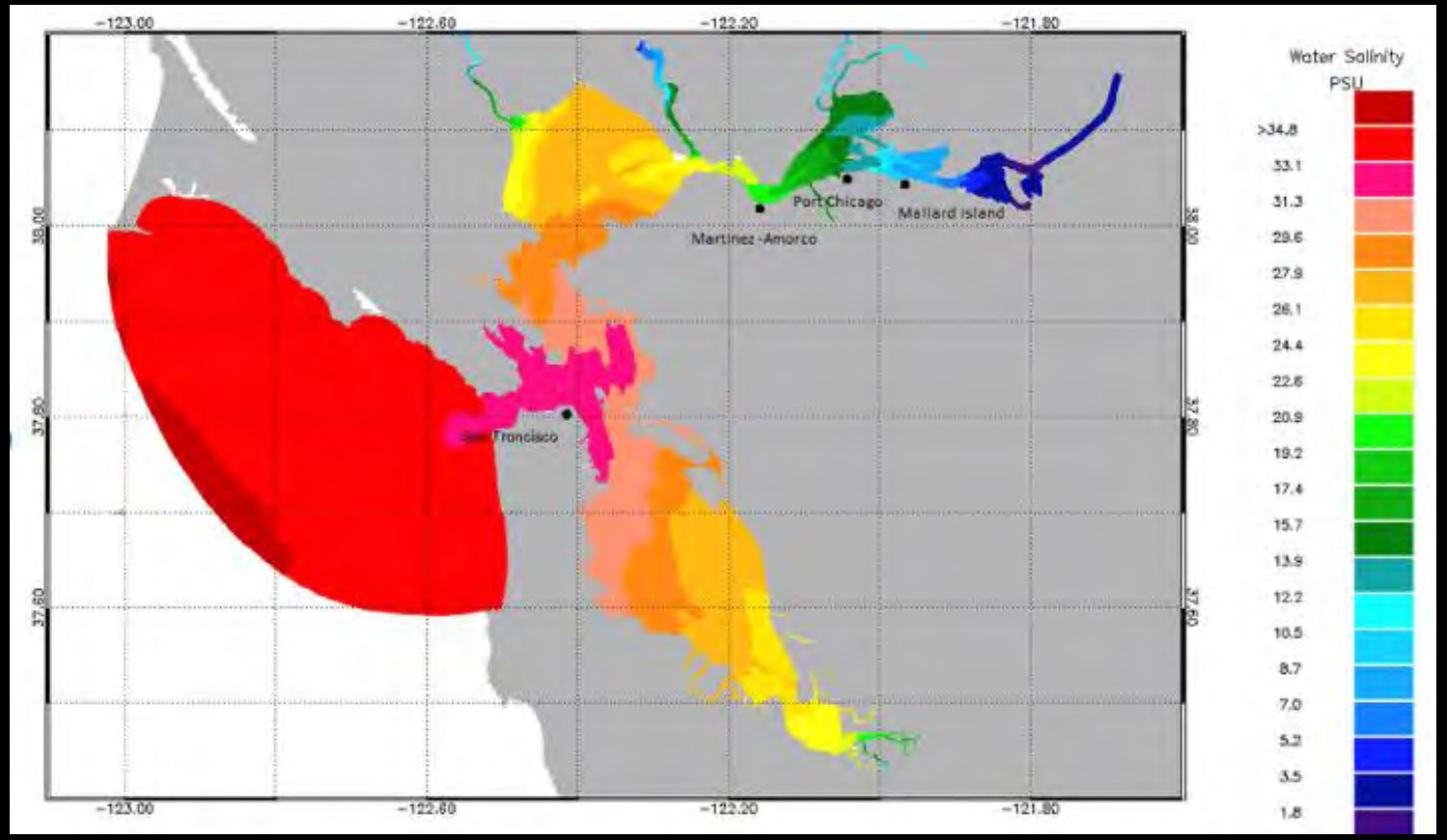
Dan A. Smale ✉, Thomas Wernberg, Eric C. J. Oliver, Mads Thomsen, Ben P. Harvey, Sandra C. Straub, Michael T. Burrows, Lisa V. Alexander, Jessica A. Benthuysen, Markus G. Donat, Ming Feng, Alistair J. Hobday, Neil J. Holbrook, Sarah E. Perkins-Kirkpatrick, Hillary A. Scannell, Alex Sen Gupta, Ben L. Payne & Pippa J. Moore

Nature Climate Change **9**, 306–312 (2019) | Download Citation ⭳

Reduced survival of eelgrass transplants in summer 2019

Expecting and planning for climate variability

- Identify refuges that limit salinity or heat stress
- Distribute projects to hedge bets
- Adjust timing



Experiment and monitor to learn

- Sustain effort
- Test sites and scale up
- Communicate results
- Update goals and expectations

Photos, K. Boyer

Thank you!

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