

Breach it and they will come:
Invasive plants are the uninvited guests to
the South Bay Salt Pond restoration party

South Bay Salt Pond
Science Symposium
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Native Pacific Cordgrass *Spartina foliosa*
Pond A20 in August 2019 (breached 2006)



Native marsh vegetation establishment Pond A6 (Knapp Tract) in Sept. 2021 (breached 2010)



Northern A6 just rounding the corner to widespread vegetation over the past couple years

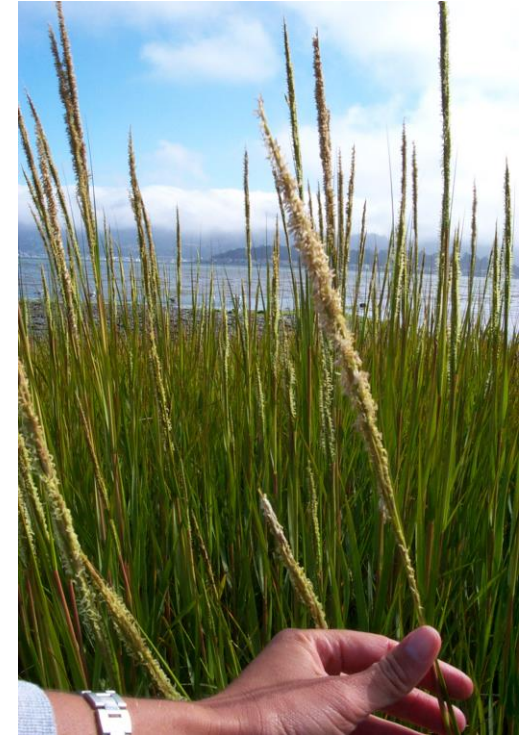
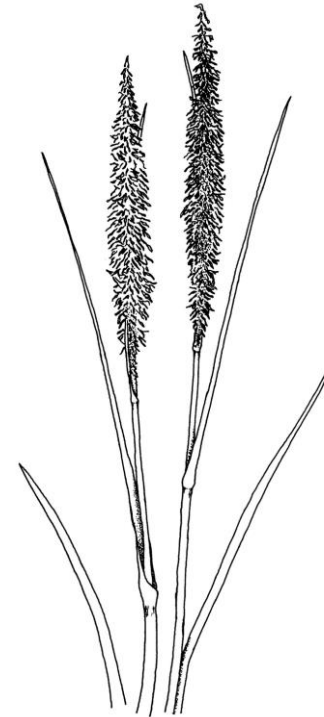
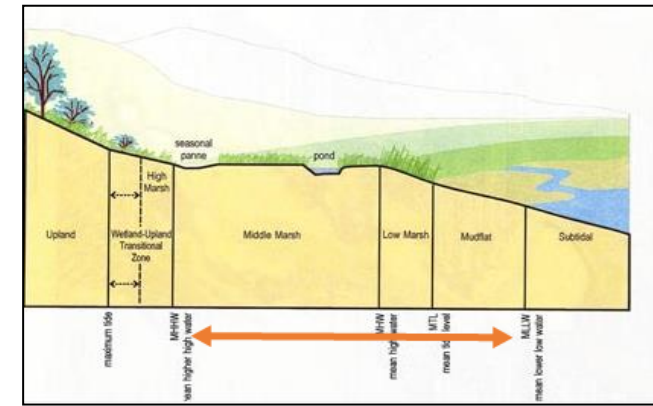
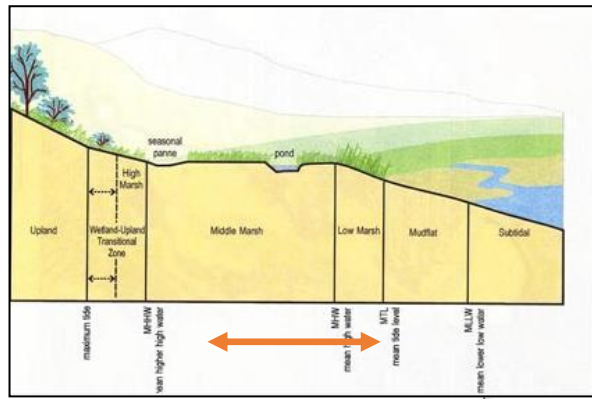
Most vulnerable to invasion at EARLY stages of development w/ less biotic resistance

East Coast species *Spartina alterniflora*,
introduced in the 1970's



Native *Spartina foliosa* hybridized with East Coast *Spartina alterniflora*

Hybrid can pollen-swamp the native, using it as a factory to produce hybrid seed, accelerating spread



Spartina foliosa

Hybrid *Spartina* (*alterniflora* x *foliosa*)

Why is hybrid *Spartina* a problem?

- Displaces native plants, degrading tidal marsh ecosystem
- Dominates mudflats, impacting shorebird foraging
- Changes benthic invertebrate community
- **Threatens native tidal marsh restoration**
- Endangers native Pacific cordgrass
- Reduces flood control capacity
- Creates mosquito breeding areas





SF Estuary Invasive *Spartina* Project

In response to the threats to the Estuary, the ISP was initiated to coordinate Estuary-wide *Spartina* control efforts

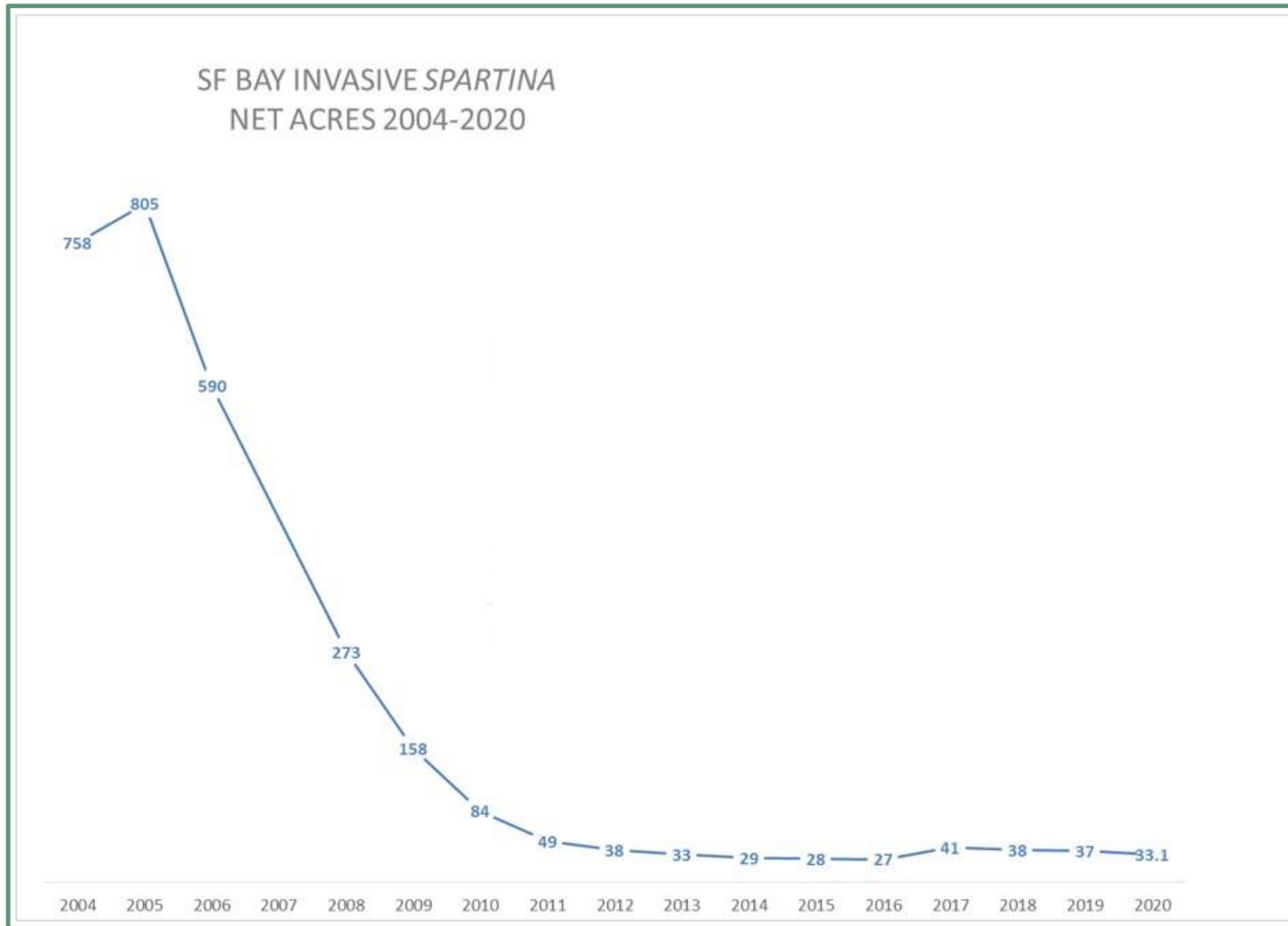
USFWS Federal lead

Coastal Conservancy
State lead

Began full-scale
implementation in 2005

Hybrid *Spartina* reduced by 97% Estuary-wide

Net Acres



Year

- 805 net acres in 2005 down to **23 acres in 2021**
- Removing or reducing the threat from hybrid *Spartina* supports regional native tidal marsh restoration

OEI biologists inventory up to 70,000 acres of San Francisco Bay marsh each year to inform invasive *Spartina* treatment
Trained in hybrid *Spartina* ID to protect native cordgrass



Mapping Hybrid *Spartina*:
“Inventory Monitoring”





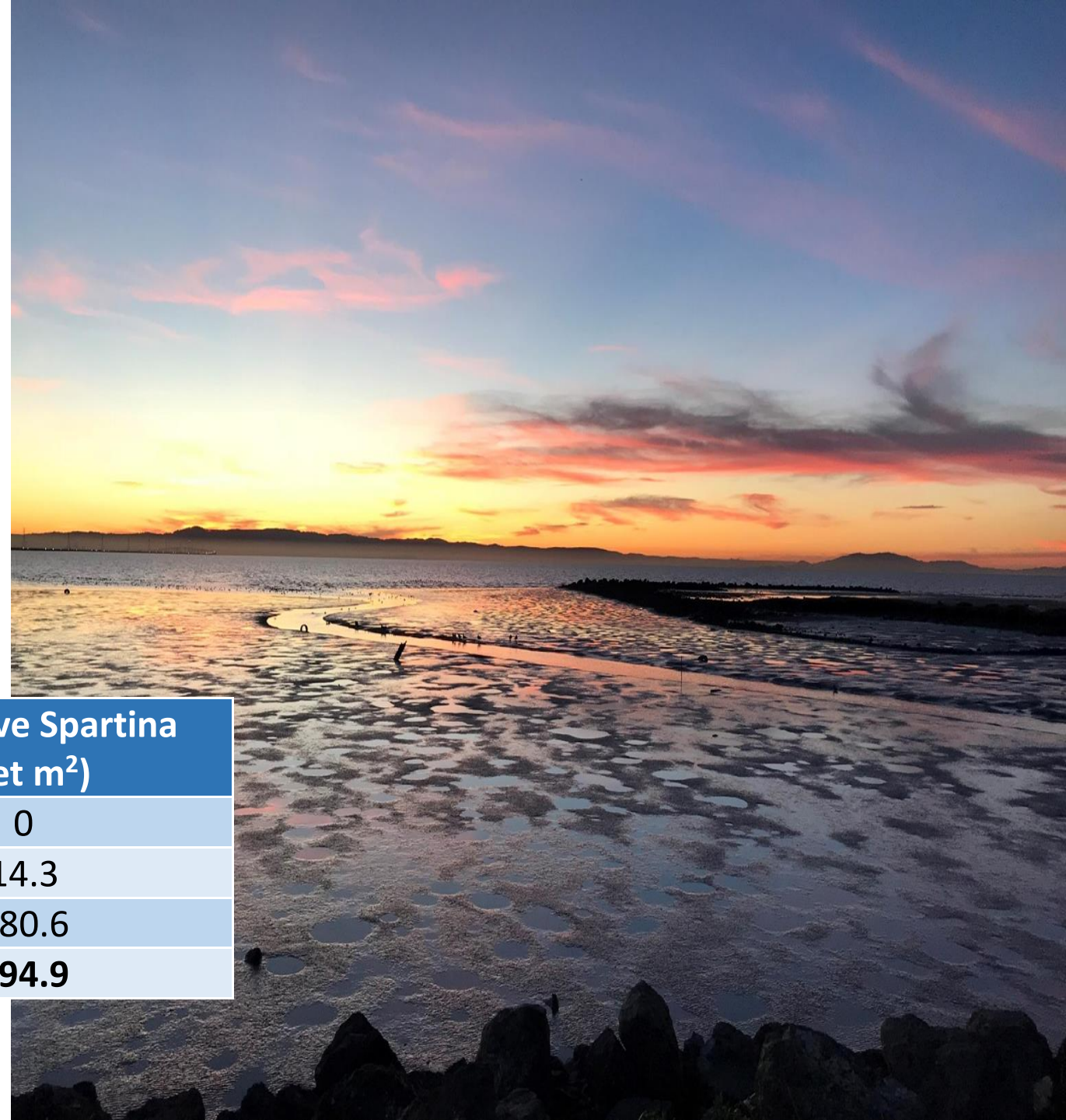
Treatment Program

- Narrow timing windows for species/habitat protection:
 - Airboat essential at SBSP and other DENWR sites
 - Most sites treated by backpack on foot
 - Targeted spot treatment, minimizes impacts to habitat

2021 Invasive *Spartina* Status

- As of 2021, 157 of 220 ISP sites now contain under 10m² of invasive *Spartina* with a total of just 195m² net cover
- 57 at Zero Detection, many for 3 or more years
- These ISP sites encompass tens of thousands of acres of marsh and mudflat

Spartina Status (net m ²)	# Sites	Collective Spartina (net m ²)
Zero Detect	57	0
0-1 m ²	52	14.3
1-10 m ²	48	180.6
TOTAL < 10m²	157	194.9



ISP Restoration Program

- 11 years: 2011-2022
- Focus on critical components of Ridgway's rail habitat: cover from predators for foraging, nesting, high tide refuge
- **Planted 530,000+ at 40+ sites**
- Re-establishing native *Spartina* where extirpated by hybrid swarm
- Planting *Grindelia stricta* along channels/etc.
- Constructed 72 high tide refuge islands at 16 sites



Eden Landing Ecological Reserve – North Creek Marsh
Early restoration of former salt pond: Largely unvegetated 2011



2012



2018

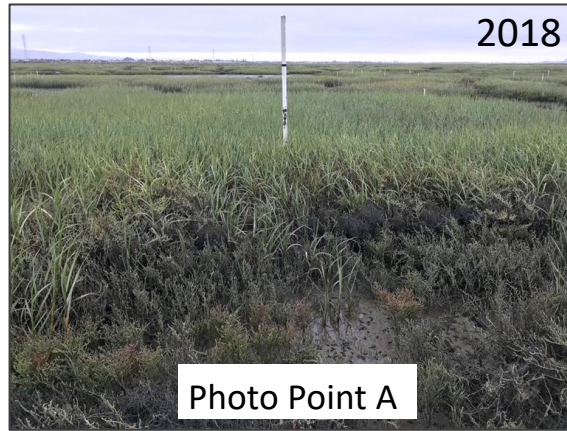


Photo Point A

2017



2018

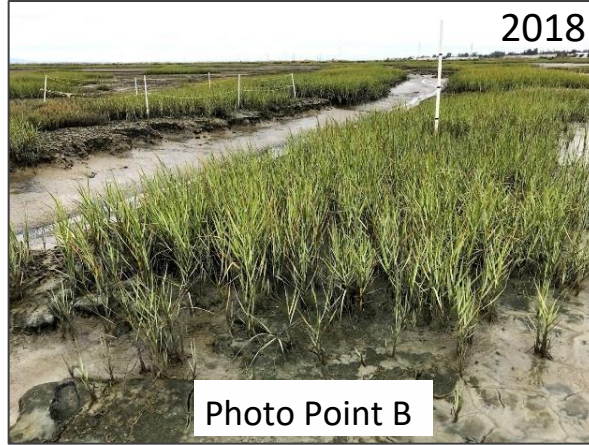
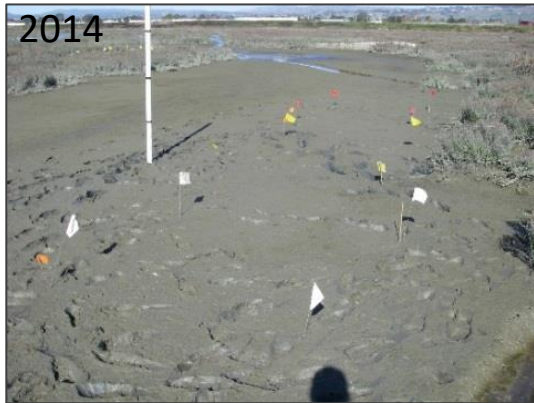


Photo Point B

2014



2018

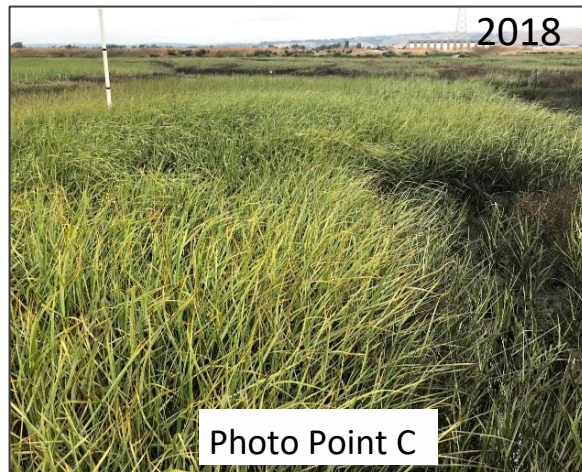
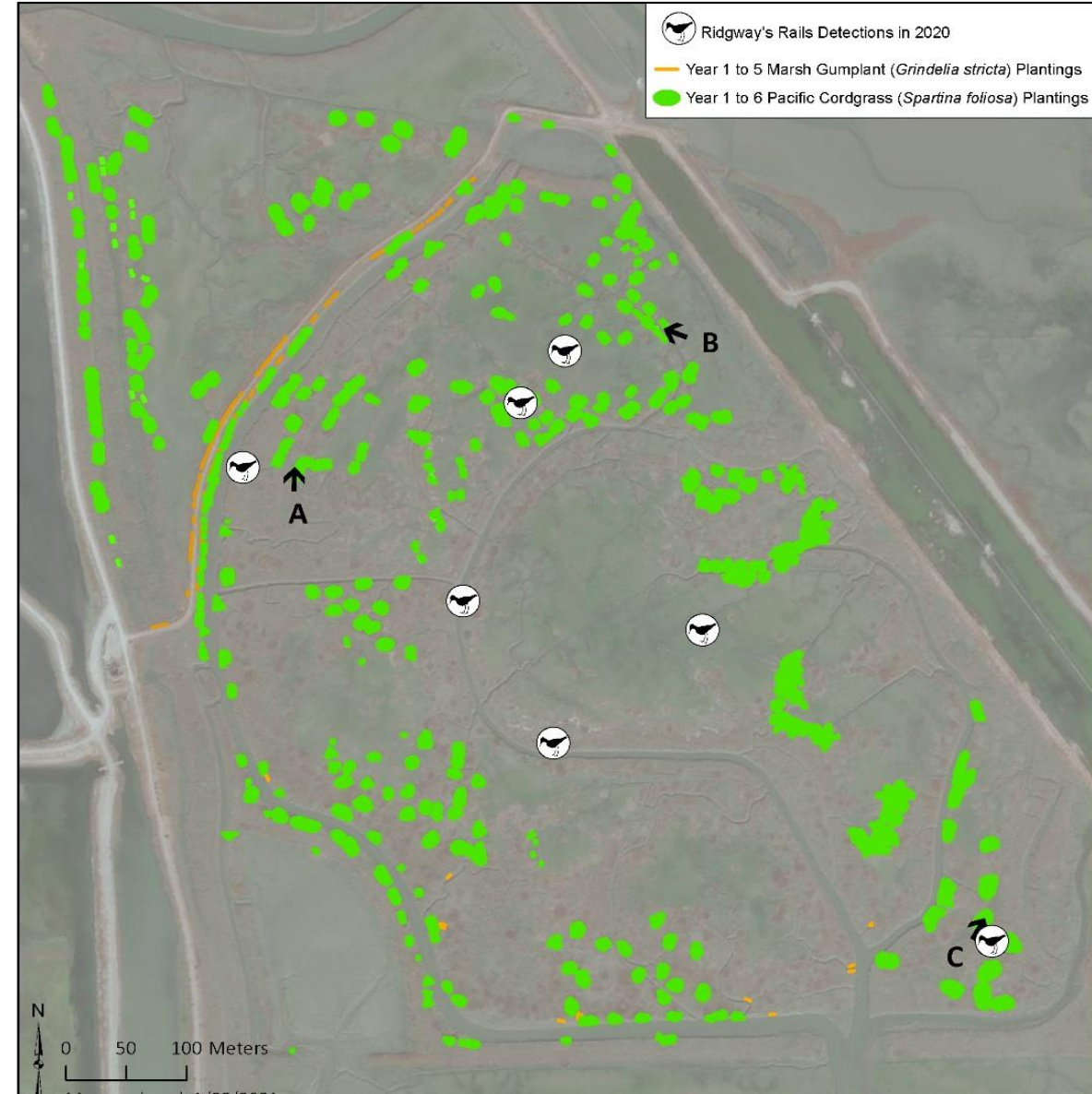


Photo Point C

Eden Landing Ecological Reserve

Active planting native *Spartina* in the absence of propagules
Adjacent to hybrid invasion epicenter



Successful *Spartina foliosa* plantings at Eden Landing in Hayward has converted this former salt pond into a marsh that now supports Ridgway's Rail (13 detected in 2021; first 1 in 2018)



Alameda Flood Control Channel
Original *Spartina alterniflora* introduction Site - 2003



Alameda Flood Control Channel Original Introduction Site - 2005



It is easy for folks to forget the scale of these monocultures (& threats posed) once the ISP has eliminated them.

SBSP sites are open mud & vulnerable in early stages like this site was

Alameda Flood Control Channel in 2019



Invasive *Paspalum vaginatum*

Chronology of a Relatively Early Detection & Rapid Response

- Called out in the annual Weed Alerts at the 2020 Cal-IPC Symposium by Jutta Burger & Bob Price
- Alert generated conversation with Alameda County Ag Commissioner who confirmed a prior report
- Simon Gunner (OEI) sampled & keyed to the invasive *Paspalum*
 - Upper glume glabrous was a missing Jepson key character to differentiate from native *P. distichum*
- Brought to attention of DENWR & Coastal Conservancy
- Initiated discussion with DENWR about developing an ED/RR plan and acquiring funding
- SBSP planned to breach from Mud Slough into Island Ponds A19 & A20 in autumn 2021; generated an initial management effort to reduce dispersal

Invasive *Paspalum vaginatum*

Key Traits & Fun/Disturbing Facts

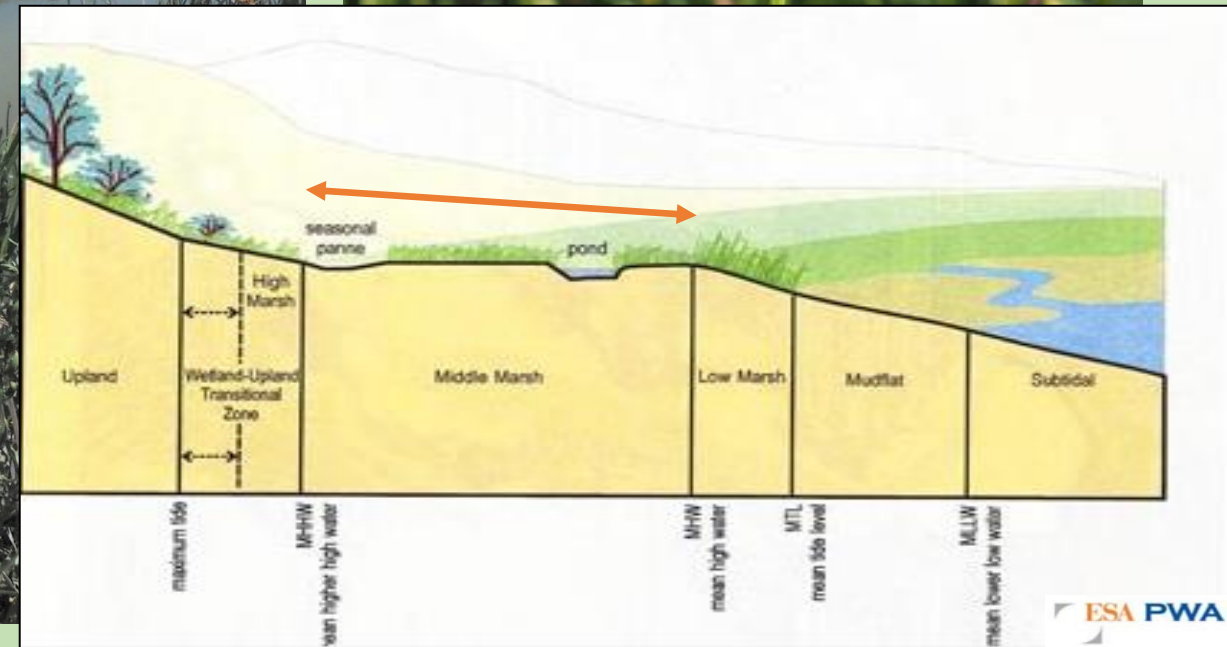
from USDA NRCS fact sheet & Wikipedia

- Native to the southeastern U.S. seaboard from Texas to North Carolina
- Commonly associated with brackish and freshwater wetlands
- Similar to Bermuda grass; spreads by rhizomes and stolons, forming a thick turf. One common name is “marsh couch”
- Bred into cultivars for the turf industry
- Can survive being waterlogged or submerged for several days at a time
- So salt-tolerant that can even be irrigated with saltwater!!
- Been shown to survive pollution with crude oil!!
- USDA NRCS stated “No environmental concerns”; Illustrates a common problem with new introductions, especially to novel habitats

Source of the San Francisco Estuary PAVA infestation is still unknown...

Invasive *Paspalum vaginatum*

Coyote Creek Lagoon



Invasive *Paspalum vaginatum* at Coyote Lagoon



Expands by stolons (aboveground runners)
Engulfing & entwining the adjacent native mid-marsh vegetation such as these *Grindelia* (left),
and bulrush (below)

Thick mats will likely inhibit native regeneration



Invasive *Paspalum vaginatum*



Northern interior of A20 (Mud Slough just beyond the levee).
OEI biologists demonstrating that the invasive PAVA is
penetrating back into the thick bulrush stand via stolons.

PAVA colonizing bare mud bench below the
marsh scarp along upper Coyote Creek



Still very early in this invasion:
75m² net cover detected along upper
Coyote Creek
134m² net within A20



Invasive *Paspalum vaginatum*

Establishing in A19 on open mud at mid-elevation
1st colonizer can OWN the space & inhibit native plants
69m² net cover detected within A19



Shown at high tide to enable airboat access;
surprising to see PAVA beat *Spartina foliosa* to this spot

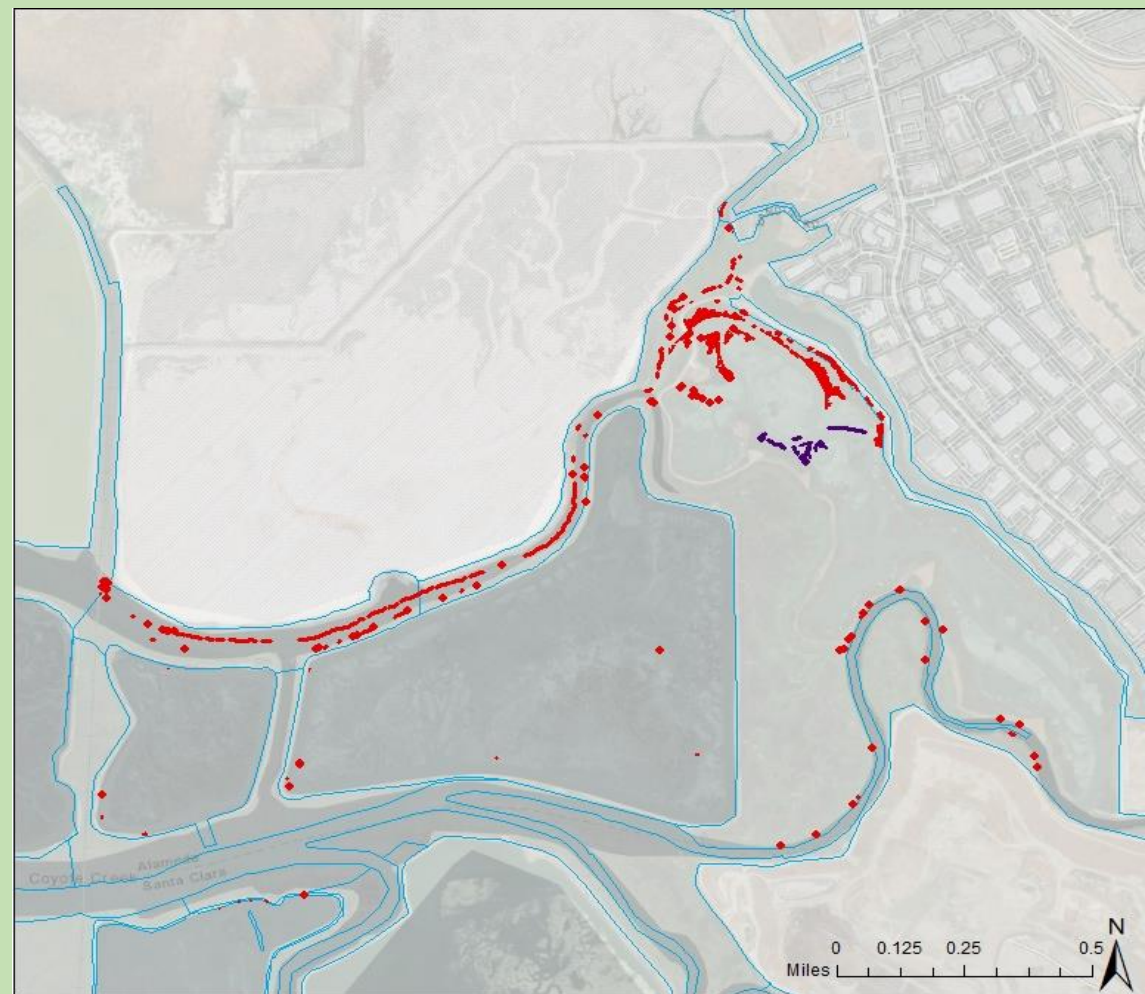
Invasive *Paspalum*: Epicenter & proximity to Island Ponds

Net cover of PAVA mapped by OEI in
initial project area 2021 = 14,835 m²
(3.67 ac.)

Treated PAVA net cover 2021 =
13,945 m² (3.45 ac.); 94% of what was
mapped

Two other substantial infestations not
yet mapped or treated:
Laguna Creek upstream of Coyote
Lagoon & Northern A21

Illustrates importance of vigilance by
knowledgeable biologists/stewards



■ TREATED *Paspalum*
■ UNTREATED *Paspalum*
□ Waterways boundaries

Invasive *Paspalum* Project San Francisco Bay, CA

Alameda Co.: Ponds A19 & A20, Coyote
Creek, Coyote Lagoon, Mud Slough.
Santa Clara Co.: Pond A17.

Survey Dates:

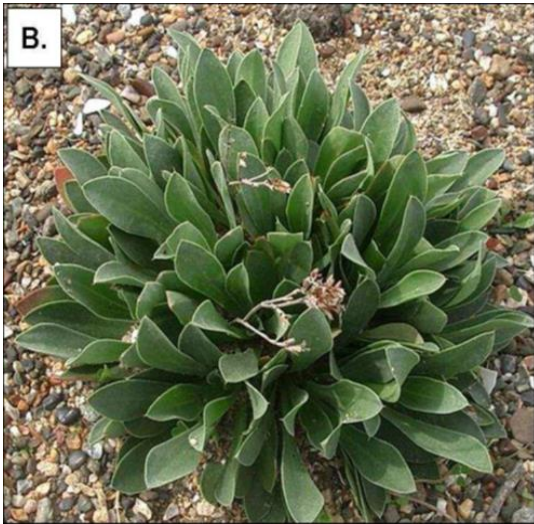
1st — 6/22/2021
2nd — 6/28/2021
3rd — 7/20/2021



Map produced
on 7/30/2021

Background: World Map (ESRI) and BAARI (SFEI)

Limonium ramosissimum (LIRA; Algerian sea lavender) in the San Francisco Estuary



From Archbald & Boyer 2014



- First discovered in the San Francisco Estuary in 2006-2007 (Sanchez Marsh in San Mateo County, just south of SFO)
- LIRA grows most vigorously (and produces the most seed) in the high marsh and the estuarine-terrestrial transition zone
- Vast majority found above Mean High Water (MHW), although LIRA has thrived at marshplain and along channel banks when established at intact marshes
- Can grow as a dense substratum *beneath* native marsh veg, eventually displacing it, especially at regeneration cycles

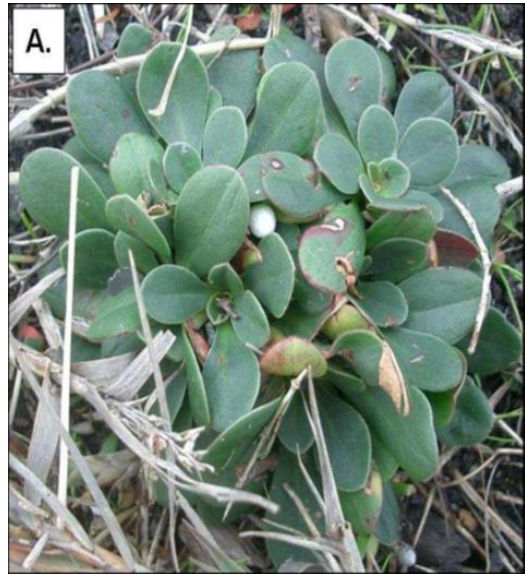
Limonium ramosissimum
(LIRA; Algerian sea lavender)

Photos from Vanderhoff



LIRA acute (pointed) leaf tips;
while LIDU has rounded

Limonium duriusculum (LIDU; European sea lavender) in the San Francisco Estuary



From Archbald & Boyer 2014

- First documented in the San Francisco Estuary in 2006-2007 (Richardson Bay in Marin County)
- Cal-IPC recently discovered established infestation on Bair Island (Deepwater Slough) likely an independent introduction not natural dispersal
 - Not previously known outside Marin area of introduction aside from two tiny patches at Inner Bair Island & Oyster Cove
 - More widespread in SoCal where it is the bigger problem of the two invasive *Limoniums*; able to grow lower in tidal elevation into *Spartina* zone



Invasive *Limonium ramosissimum* (left)
& native *Limonium californicum* (right)

Both plants are bolting (generally throughout May)



Data-Driven Prioritization of Targets

- ▶ SFSU research (Boyer lab) was critical in the **decision to take action**
- ▶ Impacts to native marsh & vigorous spread were well documented
- ▶ USFWS identified LIRA as one of three “Highest Concern” plant species in the South San Francisco Bay Weed Management Plan
- ▶ **Carpets of short rosettes of LIRA/LIDU cannot provide our native wildlife vertical plant structure comparable to natives for refugia from predators (esp. at high tides when they are most vulnerable)**
- ▶ Displaces native plant cover/high tide refugia for two federally-endangered species: the California Ridgway’s rail and salt marsh harvest mouse
- ▶ Manual removal very effective; local stewards can follow through to eradication once large infestations are reduced down to a manageable level by Cal-IPC grant-funded investments in contractor treatment
One example: Literacy for Environmental Justice (LEJ) at Heron’s Head Park with Port of SF



Cal-IPC received
1st NFWF grant in
2016

Sites were added
over time as our
modest budget
would allow
(mapping &
treatment)

Peak infestation ~
25 net acres

Many of the
Top 10 largest
sites have been
reduced 70-90%+
since 2016-2018

Cal-IPC Invasive Limonium Project Area
2020 National Fish & Wildlife Foundation grant proposal



Invasive *Limonium* in San Francisco Estuary

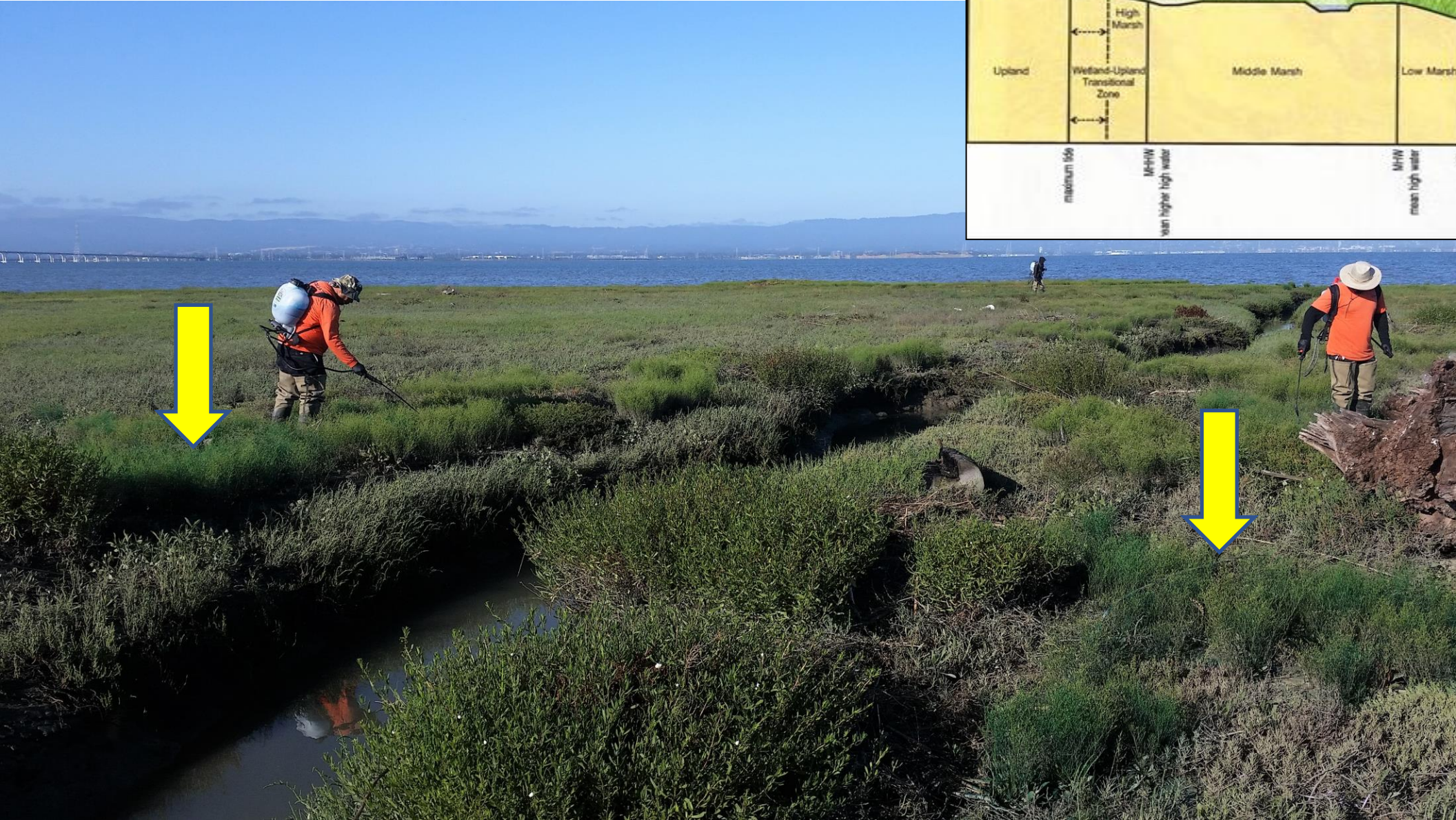
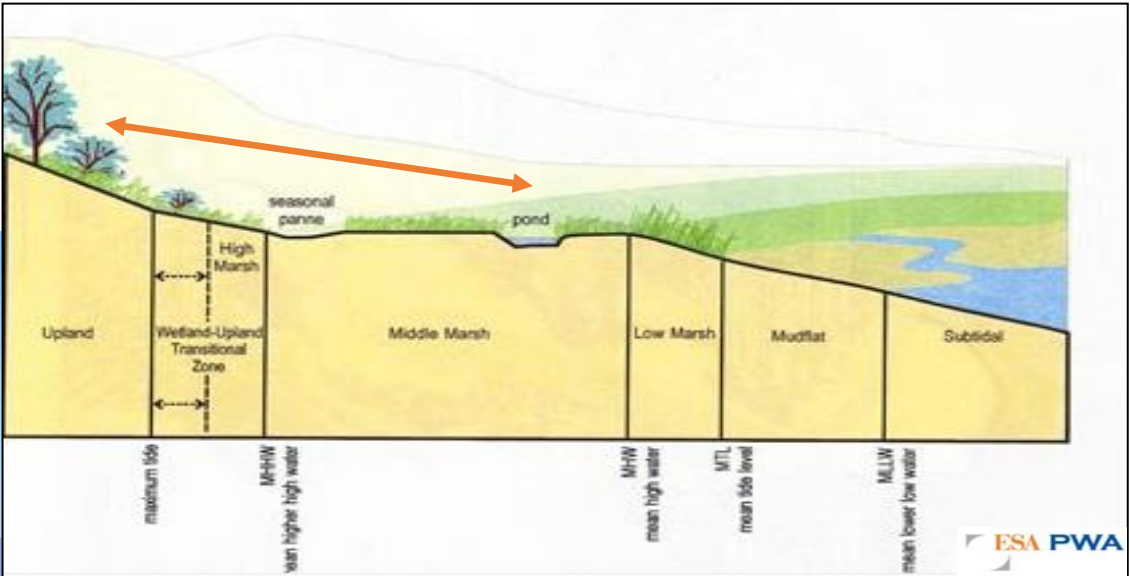
Shoreline infestation of
invasive LIRA

Colonizes & then thrives in
areas of disturbance like
wave swept shore or along
slough banks when
Grindelia cycles

Then dominates and
excludes future native
plant regeneration
OWNS THE SPACE



Invasive *Limonium ramosissimum*



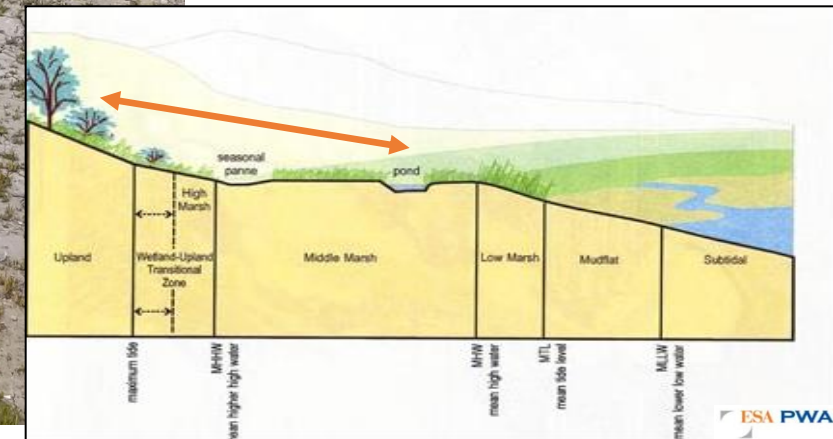
Invasive *Limonium ramosissimum*



LIRA thrives on these edges around the Estuary, above MHHW

SBSP has MANY MILES of these edges that can harbor LIRA

Act as vectors of dispersal to existing marshes and inhibits future high marsh vegetation at developing SBSP sites



The Trouble with Tribbles/LIRA



With high seed production & viability, long seedbank life, and a virtually 12-month growing season, LIRA can feel like the Tribbles from Star Trek

The carpets of tiny red leaves in the photo (left) are 1000's MORE seedlings

130,000 seeds/m²
(Archbald & Boyer 2014)

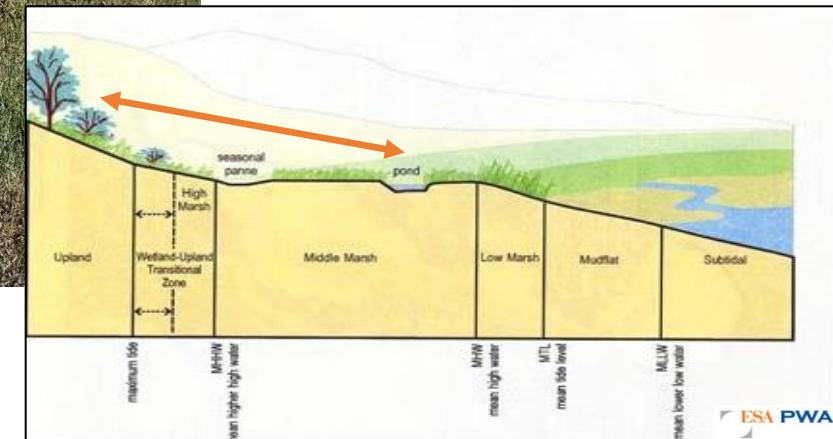
Invasive *Limonium ramosissimum* at Knapp Tract (A6)

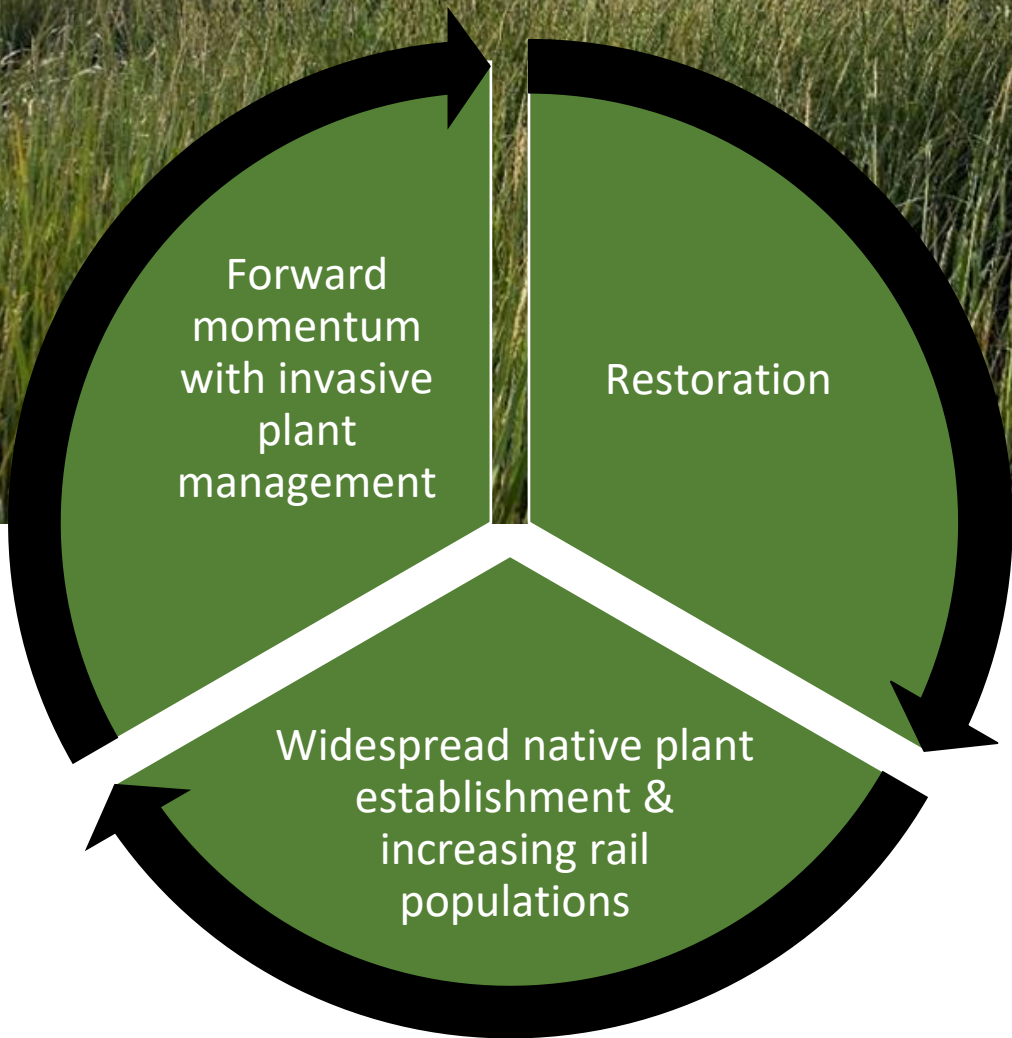


LIRA thrives at the elevation of these eroded berms around the Estuary, which mimic high marsh and estuarine-terrestrial ecotone

Displaces *Grindelia stricta* (marsh gumplant), *Frankenia salina* & others

Corrupted UTZ seed mix (~2014) dispersed it to remote parts of Estuary





Goal of healthy,
resilient NATIVE marshes

Ongoing stewardship is essential
to maintain the health of our marshes &
guard against future threats