Evaluating the Potential for Spread of an Invasive Forb, *Limonium ramosissimum*, in San Francisco Bay Salt Marshes

Gavin Archbald, Kathy Boyer
Cal-IPC Symposium. October 8, 2009
Outline

- Why investigate invasive plants
- How we evaluate spread potential
- Results highlights
- Spread prediction & next steps

Algerian sea lavender
(*Limonium ramosissimum*)
South SF bay tidal salt marsh

Brown pelican

Salt marsh bird’s beak

Salt marsh harvest mouse

Snowy egret

Photos: cdpr.ca.gov
srmist.gightinc.com
goldrushcam.com
Historic S.F. Bay salt marsh extent

~2200 km²

21%

Current S.F. Bay salt marsh extent

~460 km²

90%

All other CA salt marshes

~50 km²

Tidal wetland restoration projects

~200 km²

Adapted from Takekawa et al, 2006
Photo: sfbare.com
Remaining salt marsh is prone to plant invasions

- Fragmented
- Disturbed
- Fertilized
- Seeded
- Inhibit or outcompete native plants
- Alter habitat structure
- Invade restoration sites
- Leave legacy effects
In 2007, Algerian sea lavender was found in a SF bay marsh. 

- From Mediterranean
- Currently invading S. California marshes
- Horticultural escapee.

Will it spread?

Sanchez Marsh, Burlingame

Photos: G. Archbald
srmist.sightinc.com
Plants require to invade:

1. An “invasible” landscape

Q. What habitat types are commonly invaded?

2. Propagules arrive

Search: marshes & shoreline

3. Plants establish and reproduce

Davis, Grime & Thompson, 2000
Photo: G. Archbald
Q. What habitat types are commonly invaded?
Q. What habitat types are commonly invaded?
Q. What habitat types are commonly invaded?

Restoration project completed in 1987 (Wetland Tracker, 2009)

20 years later...
Q. What habitat types are commonly invaded?
Total invasion: 3 acres

~ 120 million seeds/yr
Plants require to invade:

1. An “invasible” landscape
   Q. What habitat types are commonly invaded?
   A. High marsh, disturbed and restored marshes.

2. Propagules arrive
   Q. Can seeds reach additional habitat?
Q. Can seeds reach additional habitat?

Floated seeds in aquaria tanks:

**Salinity:**
- 0
- 15
- 30

Grossinger, Alexander & Cohen, 1998
Seeds float longer in salt than fresh water

Q. Can seeds reach additional habitat?
Q. Can seeds reach additional habitat?

Removed seeds from tanks and germinated in fresh water:

**Time (days):**

0
1
2
4
7
14
High germination regardless of salinity or how long floating in aquaria.

Q. Can seeds reach additional habitat?
Plants require to invade:

1. An “invasible” landscape
   Q. What habitat types are commonly invaded?
   A. High marsh, disturbed and restored marshes.

2. Propagules arrive
   Q. Can seeds reach additional habitat?
Output from NOAA Tap model 1.2

- 5 day model run
- 100 gallons
- Medium-crude
Plants require to invade:

1. An “invasible” landscape

Q. What habitat types are commonly invaded?
A. High marsh, disturbed and restored marshes.

2. Propagules arrive

Q. Can seeds reach additional habitat?
A. Local dispersal likely.
B. Estuary wide dispersal biologically possible

3. Plants establish and reproduce

How does growth and reproduction vary with salinity and inundation?
Moisture and salinity co-vary with elevation

\[ R^2 = 0.45 \]

**Moisture and salinity co-vary with elevation**

How does growth and reproduction vary with salinity and inundation?
Crossed design

Salinity
0
15
30

Inundation
daily
2x week
2x month

How does growth and reproduction vary with salinity and inundation?
Longest leaf length after 63 days

- Bi-monthly
- Bi-weekly
- Daily

Inundation frequency

- Salinity: p = .000
- Inundation: p = .000
- Interaction: p = .408
Indicates higher seed output at low elevations in fresher marshes.
Plants require to invade:

1. An “invasible” landscape

Q. What habitat types are commonly invaded?
A. High marsh, disturbed and restored marshes.

2. Propagules arrive

Q. Can seeds reach additional habitat?
A. Local dispersal likely
B. Estuary wide dispersal biologically possible

3. Plants establish and reproduce

Q. How growth and reproduction vary with salinity and inundation?
A. Relaxing salinity or inundation stress increases growth and reproduction
Potential for spread?

- Likely to invade high marsh, disturbed and restored marshes.
- Estuary wide dispersal biologically possible
- Relaxing salinity or inundation stress increases growth and reproduction
- Potentially higher invasion rates in lower salinity marshes.
Next steps:

- **Outcome:** survey data to evaluate impact
- Quantify risk of spread w/GIS
- **BCDC requiring** *L. ram* monitoring in marsh restoration site permits
- Share mapping data w/BAEDN
Thanks to:

Dr. Kathy Boyer, Mark Page, Tom Parker, Peter Baye, The Boyer Lab Team, The Invasive Spartina Project staff, SF State Geography Department, San Francisco Estuary Institute.

Funded By:

San Francisco State Biology Dept (Nelson) & COSE (Maxwell) Scholarships, UBM Program, Northern California Botanists, Association for Environmental Professionals, ARCS Foundation.
Questions?
• 2007-08 visually searched marshes and shoreline.
• Mapped *L. ram* at patch scale w/GPS
• Measured vertical range at 3 marshes w/RTK GPS
Total invasion: $\sim 12,000 \text{ m}^2$

$\times 10,000 \text{ seeds/m}^2 = \sim 120 \text{ million seeds/yr}$
Known distribution of *L. ramosissimum* populations in San Francisco Bay marshes

Mapping: results

% cover increases with area

$R^2 = 0.84$

- Strawberry Marsh
- *L. ramosissimum*
- *L. ramosissimum provinciale*
- Sanchez Marsh
- Coyote Point Marina
- Seal Slough
- N. Coyote Pt.
- Beach Park

Graph: Avg % cover vs Total area

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 0 1000 2000 3000 4000 5000 6000

4878m²
Well-established in high marsh
Q. What habitat types are commonly invaded?