Assessing Spatio-temporal Changes of Invasive *Limonium ramosissimum* in San Francisco Bay Wetlands

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Invasive *Limonium ramosissimum*

Limonium ramosissimum (Poir.) Maire

CalFlora.org/Margo Bors

- Algerian sea lavender
- **Family:** Plumbaginaceae
- **Origin:** Western Mediterranean
- **Discovered in SF Bay:** 2007

Native
Limonium californicum

Invasive
Limonium ramosissimum

Seal Slough, SF Bay July 2015

LIRA's Potential Impacts

LIRA 'mat' formation at Sanchez Creek Marsh, SF Bay July 2015

Salt marsh harvest mouse
(*Reithrodontomys raviventris)*

California Ridgway's rail
(*Rallus longirostris obsoletus*)

SF Bay LIRA research

- 20 locations: 15,000m^2
- Disturbed, upper marsh
- Prolific seed producer
- Co occurring native halophyte cover decreased
- Seeds tolerate high salinities
- Germinates faster than natives
- Reduced soil salinity and moisture

(Cleave 2012; Archbald and Boyer 2014a; 2014b)

- Temporal processes: modulate impacts of invading sp. (Strayer et al. 2006)
- Lack of studies: multiple time scales since invasion (Hendersen et al. 2006; Strayer et al. 2006)
- Long-term studies useful for management decisions (Blossey 1999; Robison 2009;)

Research Objectives

- Assess changes in abundance and distribution of LIRA populations throughout the Bay-Area.
- Assess changes to native species composition and soil properties.

- Field methods of Archbald (2011) followed

Current study is two-fold:

1) Bay-wide mapping of LIRA populations

2) Mensurate surveys at established study sites to determine changes:

-native species composition

-soil properties

Bay-wide mapping

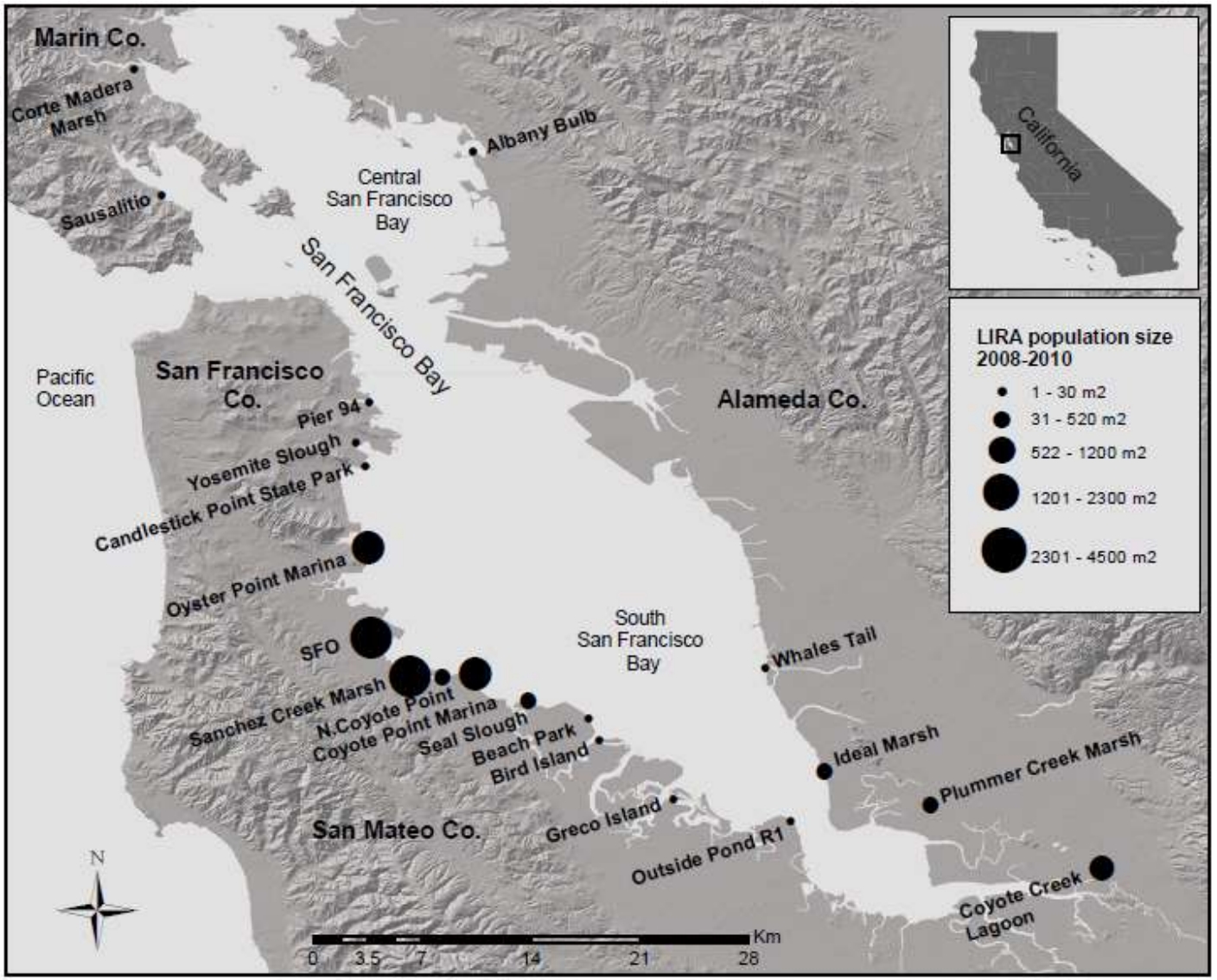


Fig. 1: Size and location of LIRA populations growing at the 20 saltmarsh sites identified in 2008-2010. (Data courtesy G. Archbald)

Mensurate surveys

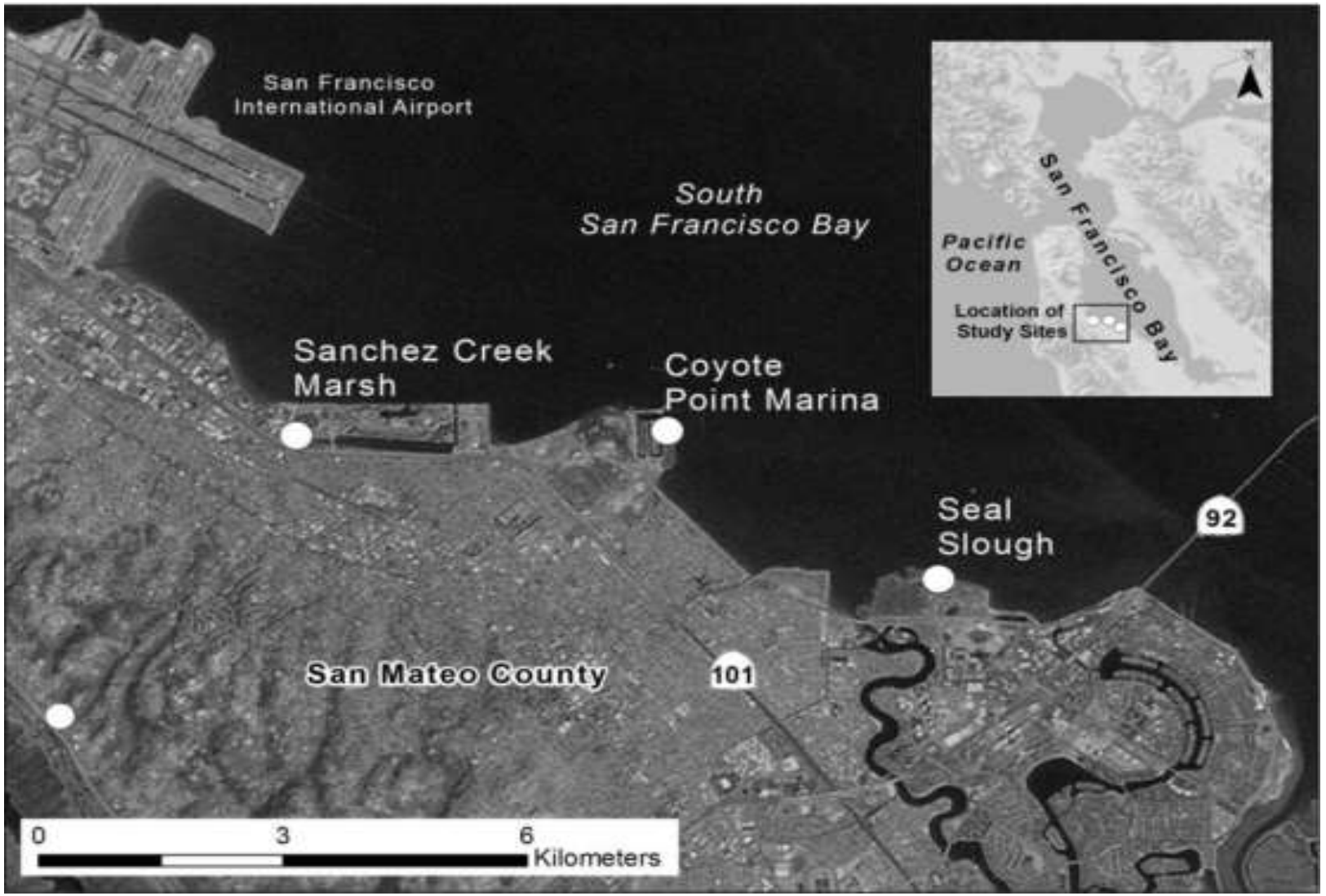
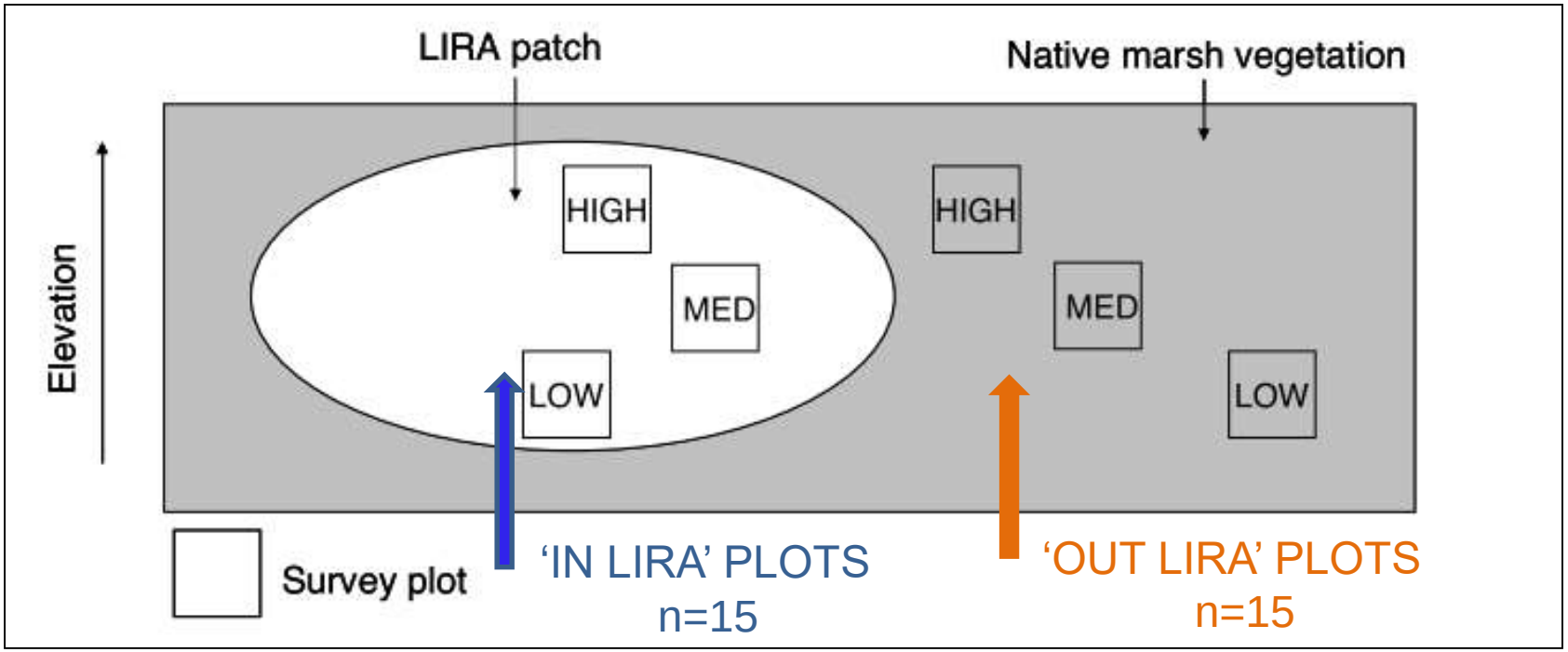


Fig 2. Archbald (2011) study sites

(From Archbald 2011)

Mensurate surveys

- 30 1-m^2 survey plots at each site established 2008



Survey plot (n = 5)

Fig 3: Survey plot schematic

(Archbald and Boyer 2014a)

Mensurate surveys: Vegetation Surveys

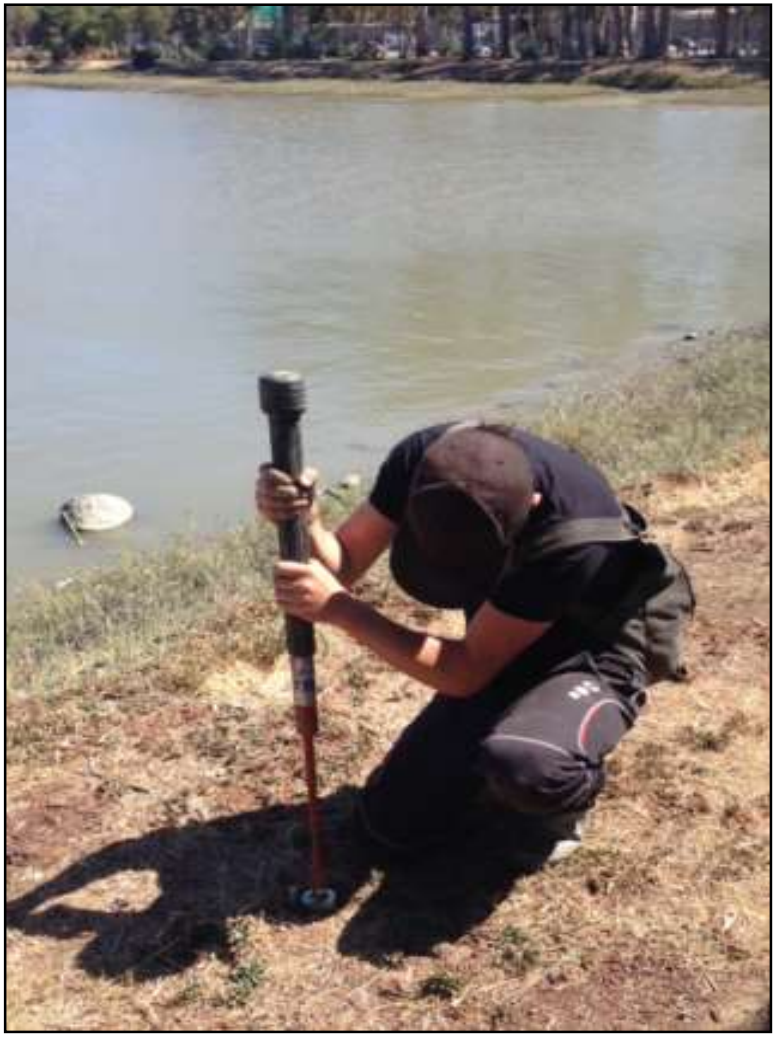
1-m^2 sampling quad with 100 cell grid

- Vegetation surveys:
  - **-August 2015**
  - **-March 2016**
- Record species present in every other cell*

(LIRA, natives: JACA, DISP, SAPA)

***change in vegetation survey**

Mensurate surveys: Soil Analysis



Collecting soil samples with the soil corer

- Soil properties analyzed:
  1. Soil moisture
  2. Bulk density
  3. Soil salinity
  4. Soil organic matter (SOM)

Statistical analysis: (alpha <0.05)

Vegetation:

- ANOVAs analyze percent cover data
- Friedman test (non-parametric 1-way ANOVA)
- 3-way ANOVA and 2-way mixed ANOVA = bootstrapped (10,000 iterations)
- Paired t-tests

Soil:

- 3-way ANOVA (2015 data only)
- 2-way and 3-way mixed ANOVAs

Bay-wide mapping

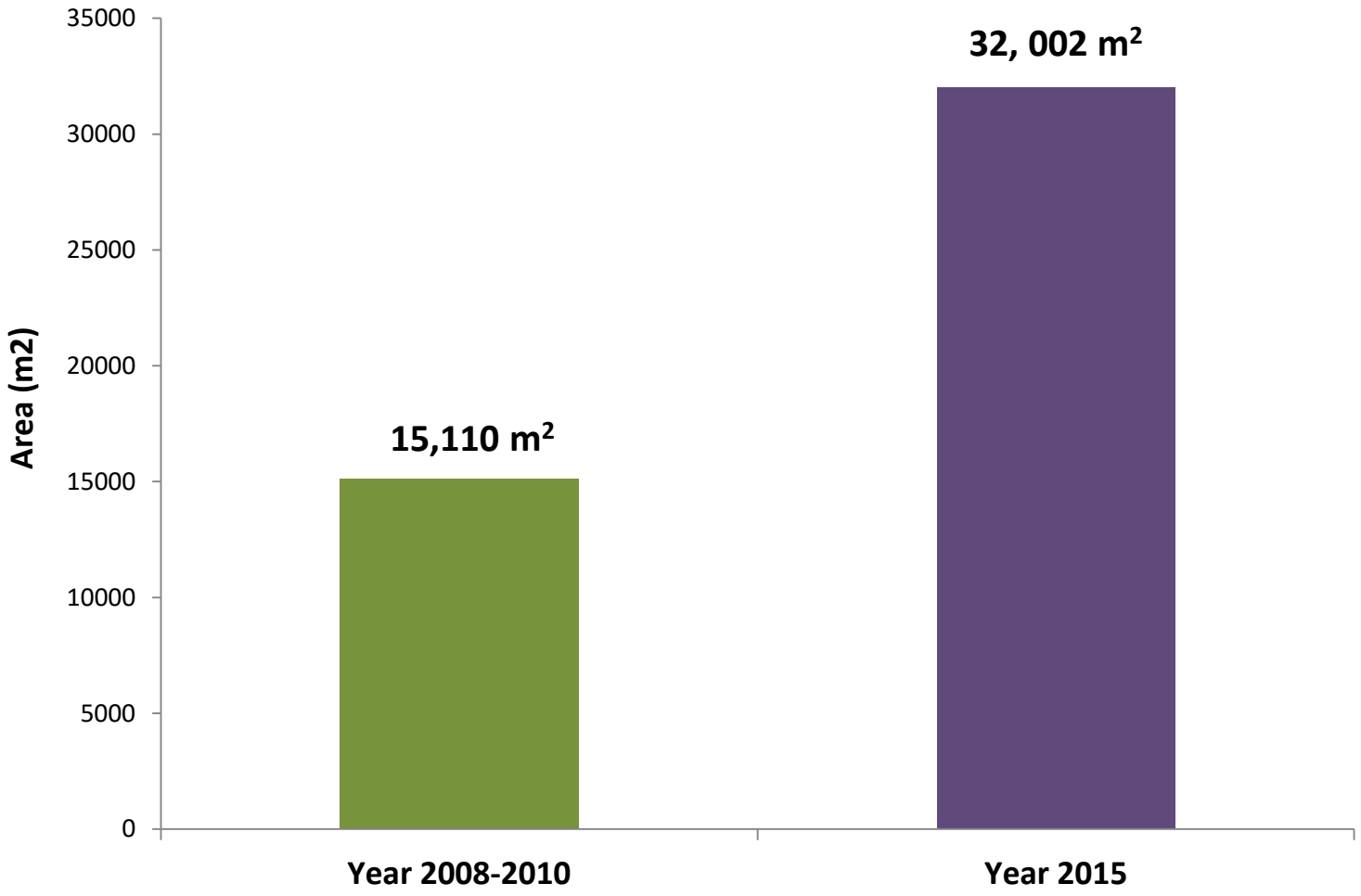


Fig 4: Total LIRA population size from the two study periods 2008-2010 and 2015.

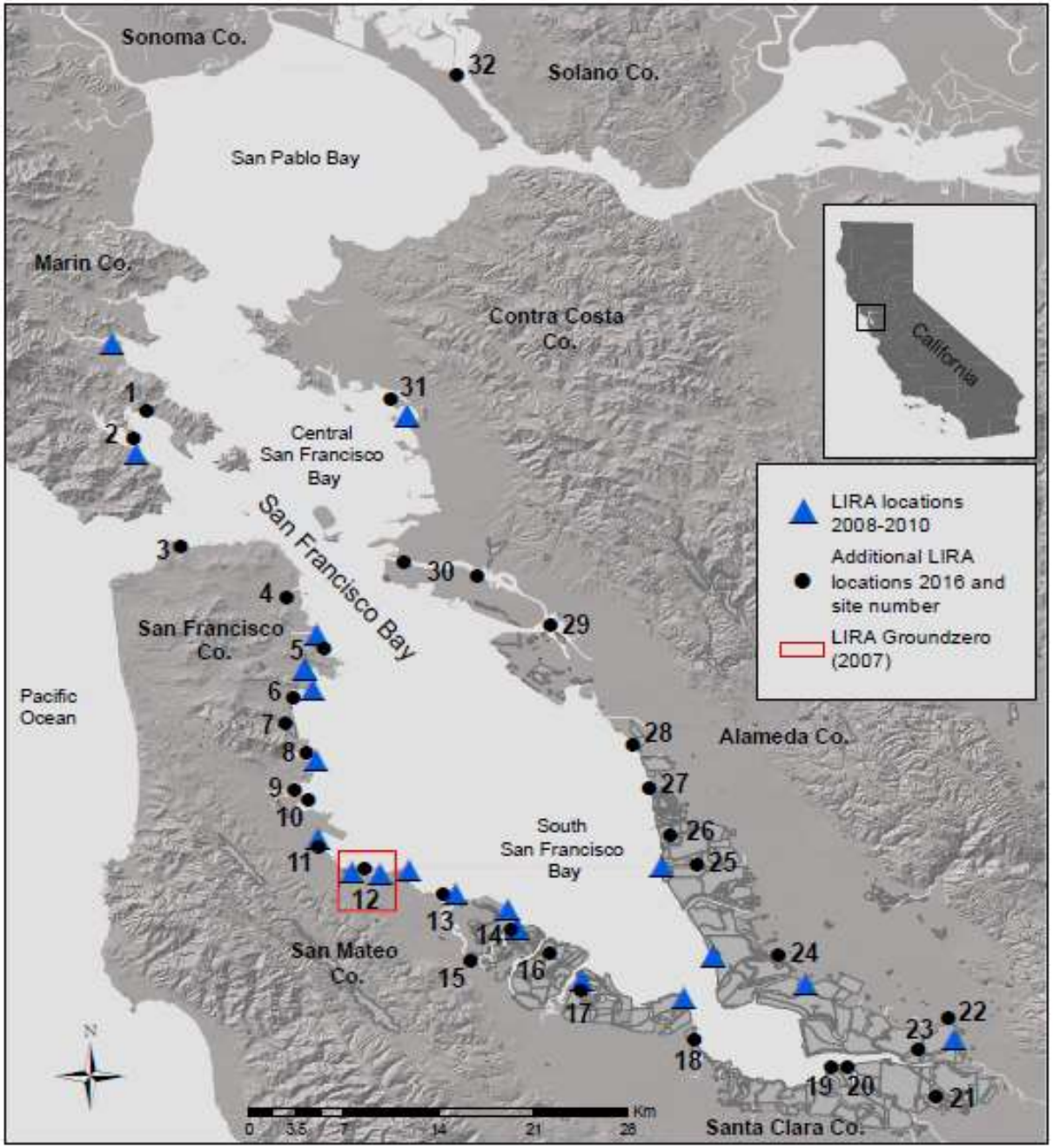


Fig. 7: Map with current known locations of LIRA (2016) in the San Francisco Bay Area. (Showing LIRA presence only)

Mensurate surveys: LIRA

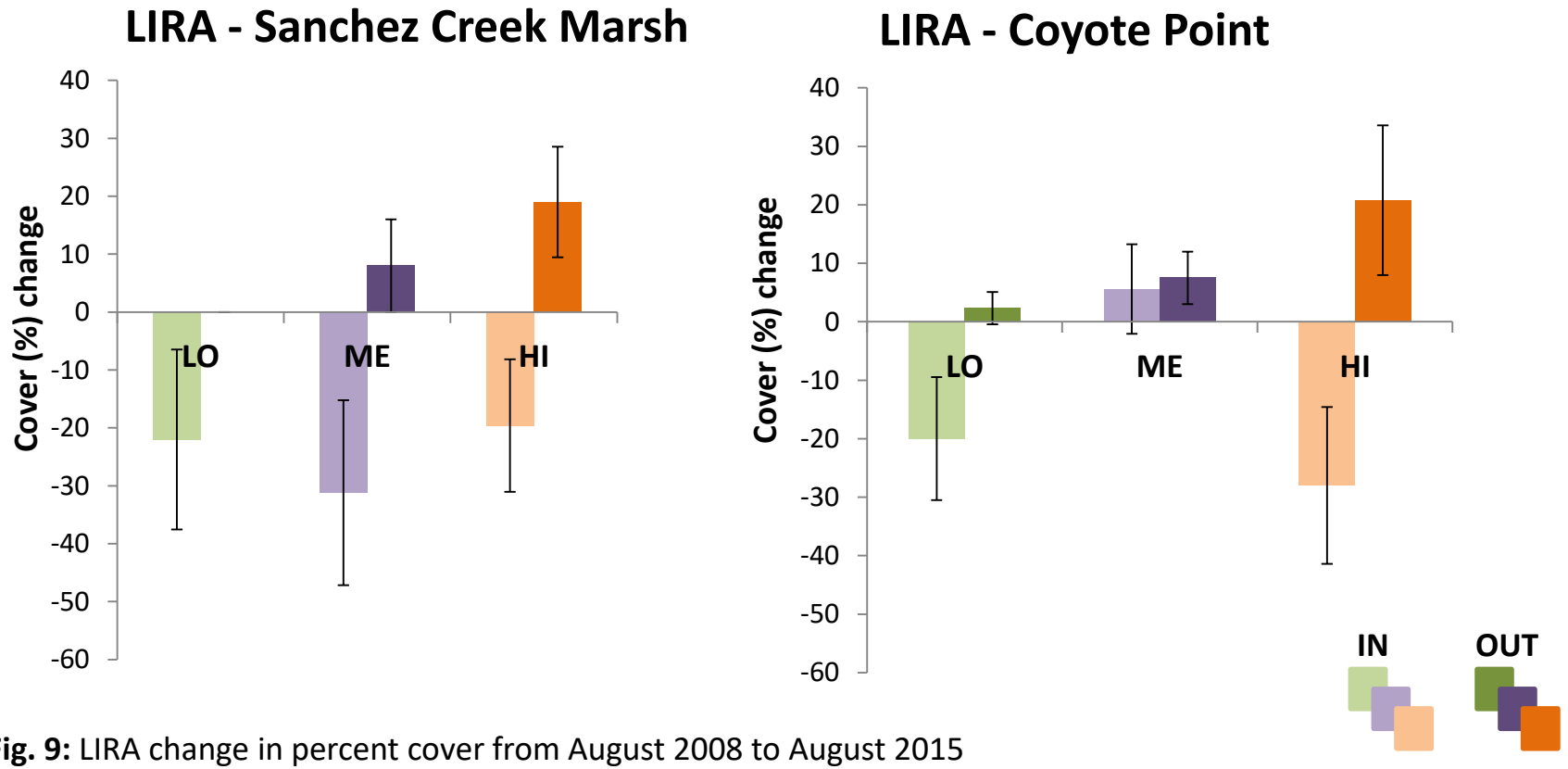


Fig. 9: LIRA change in percent cover from August 2008 to August 2015
Error bars represent 1 S.E. and n=30 for each graph.

Mensurate surveys: JACA

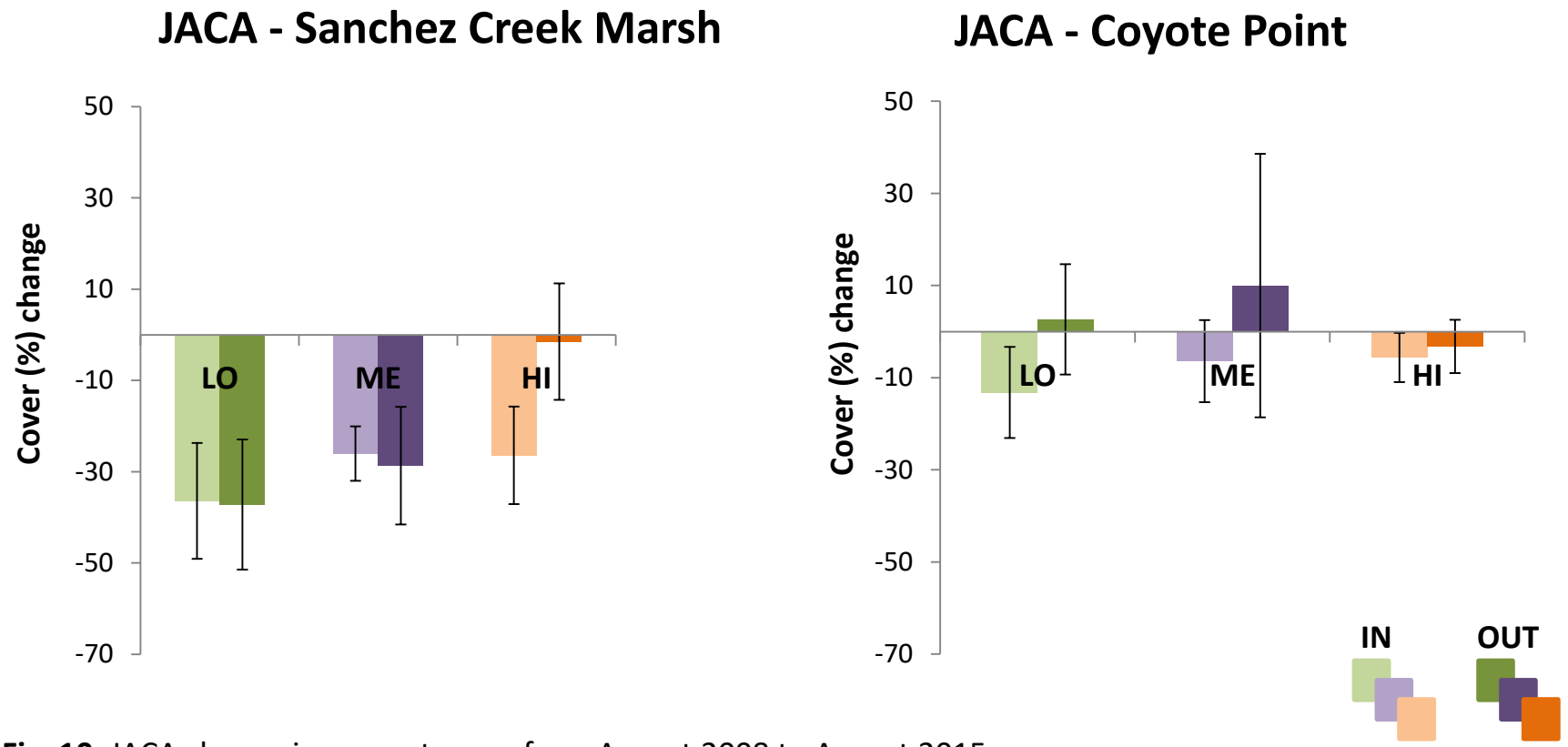


Fig. 10: JACA change in percent cover from August 2008 to August 2015
Error bars represent 1 S.E. and n=30 for each graph.

Mensurate surveys: DISP

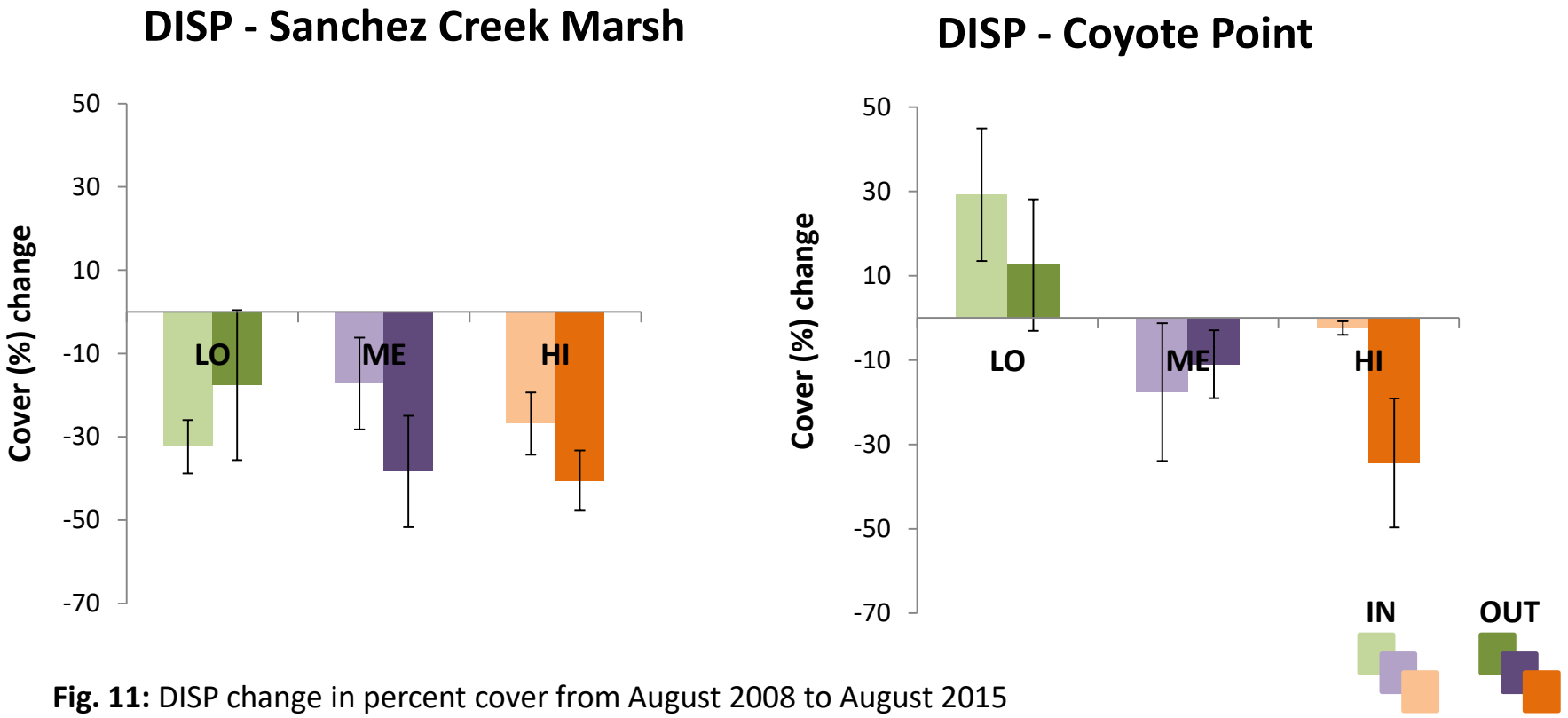


Fig. 11: DISP change in percent cover from August 2008 to August 2015
Error bars represent 1 S.E. and n=30 for each graph.

Mensurate surveys: SAPA

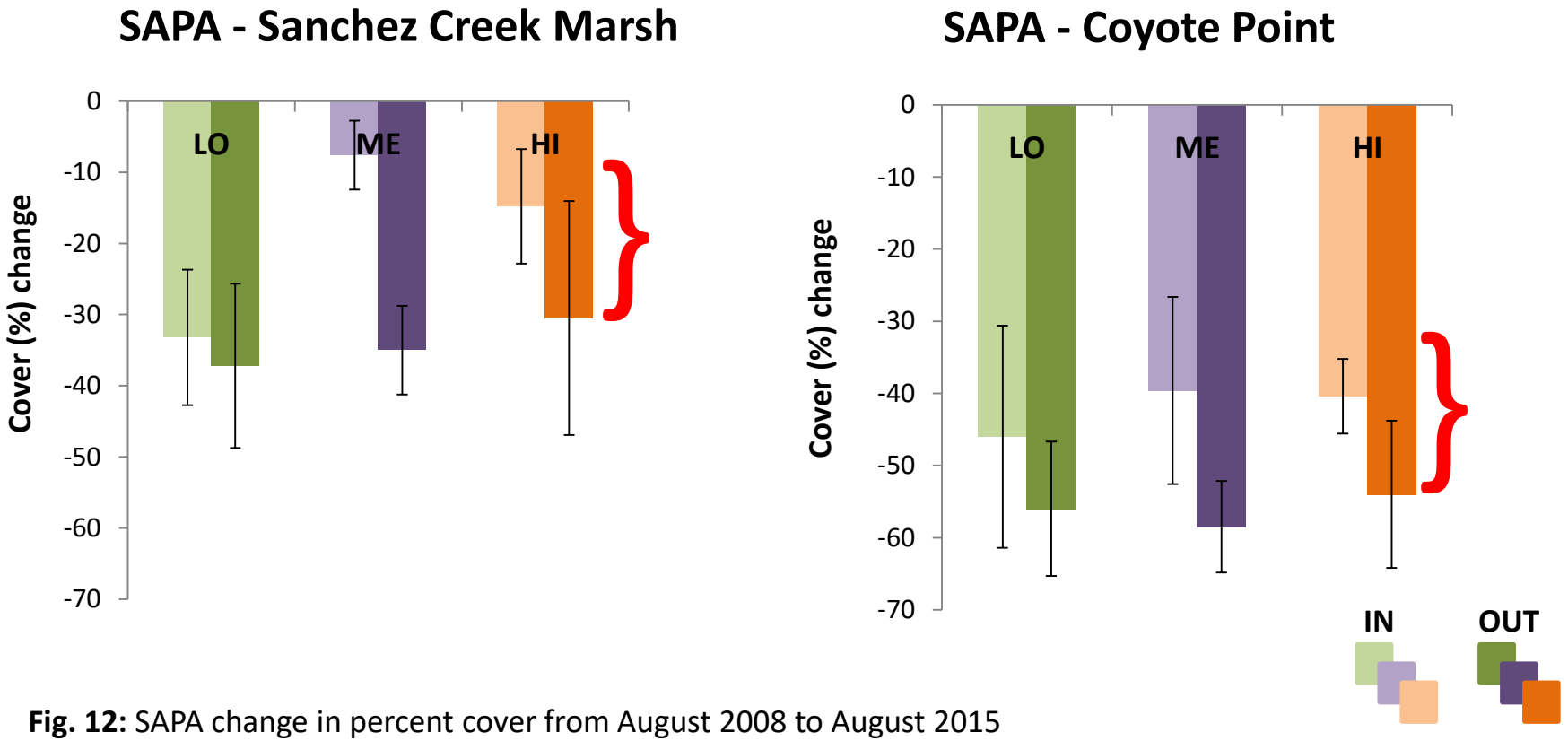
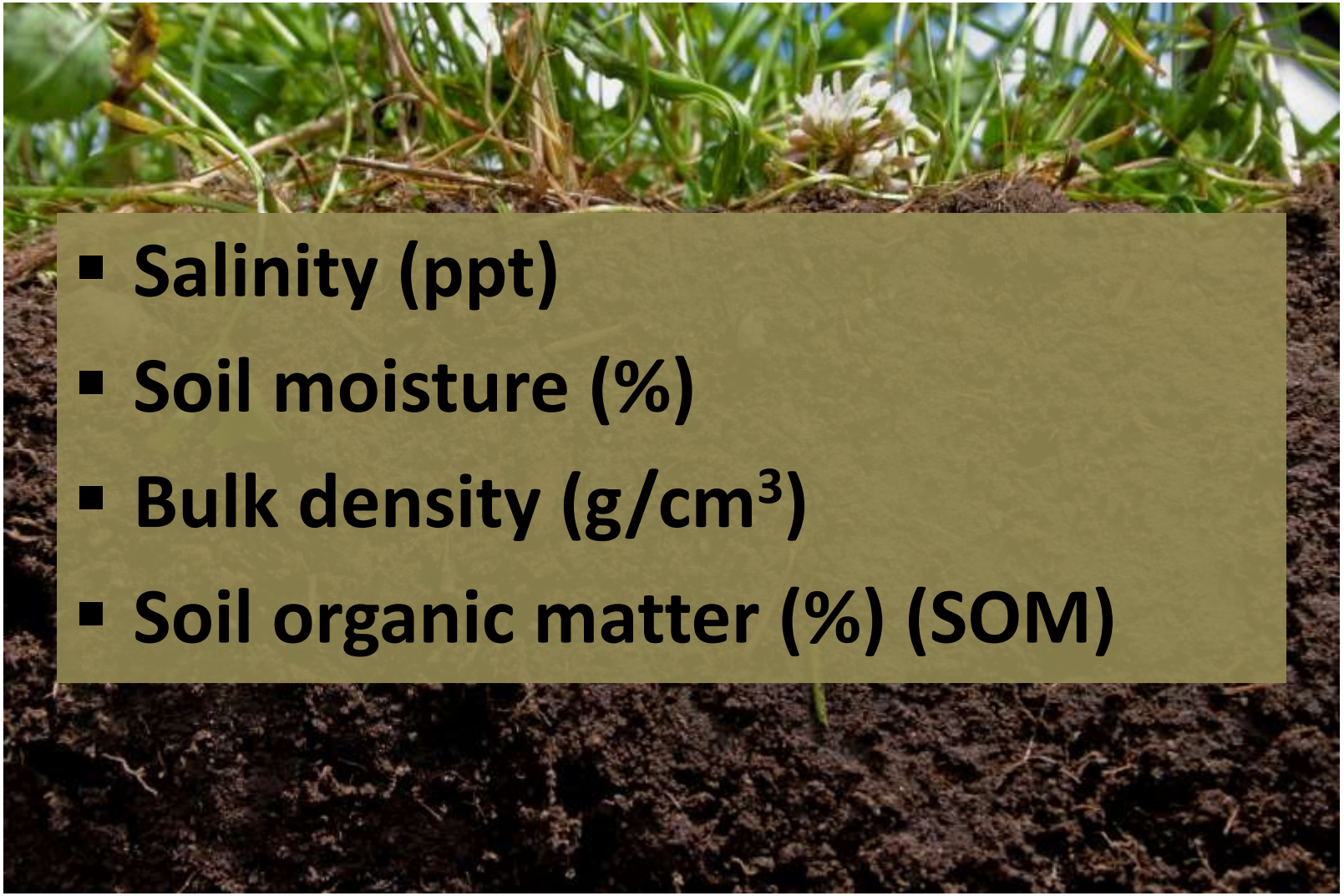


Fig. 12: SAPA change in percent cover from August 2008 to August 2015
Error bars represent 1 S.E. and n=30 for each graph.

Mensurate surveys: Soil Surveys



- Salinity (ppt)
- Soil moisture (%)
- Bulk density (g/cm^3)
- Soil organic matter (%) (SOM)

Salinity

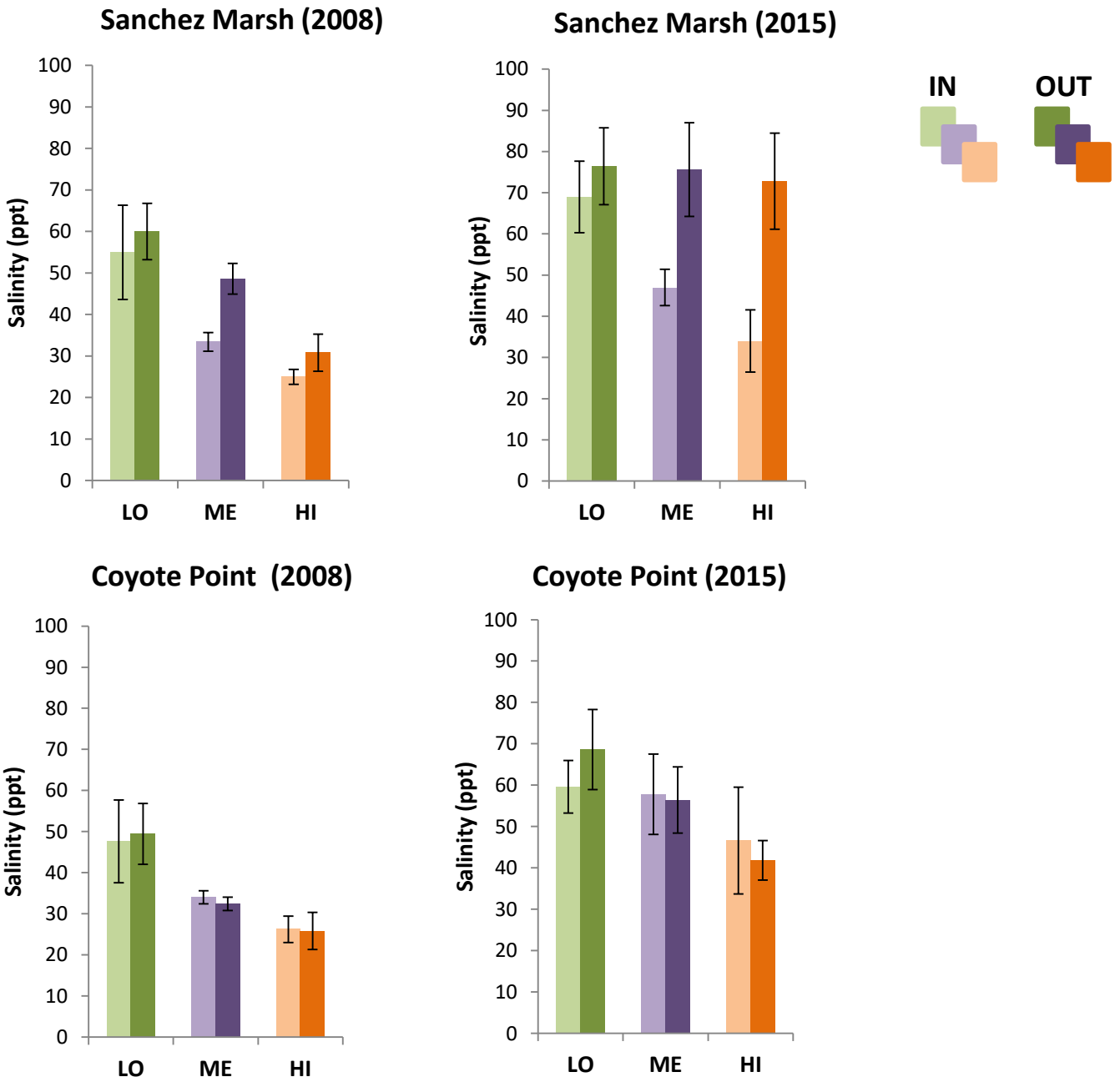


Fig. 13: Salinity from 9/2008 and 9/2015. Error bars represent 1 S.E. and n=30 for all graphs.

Soil moisture

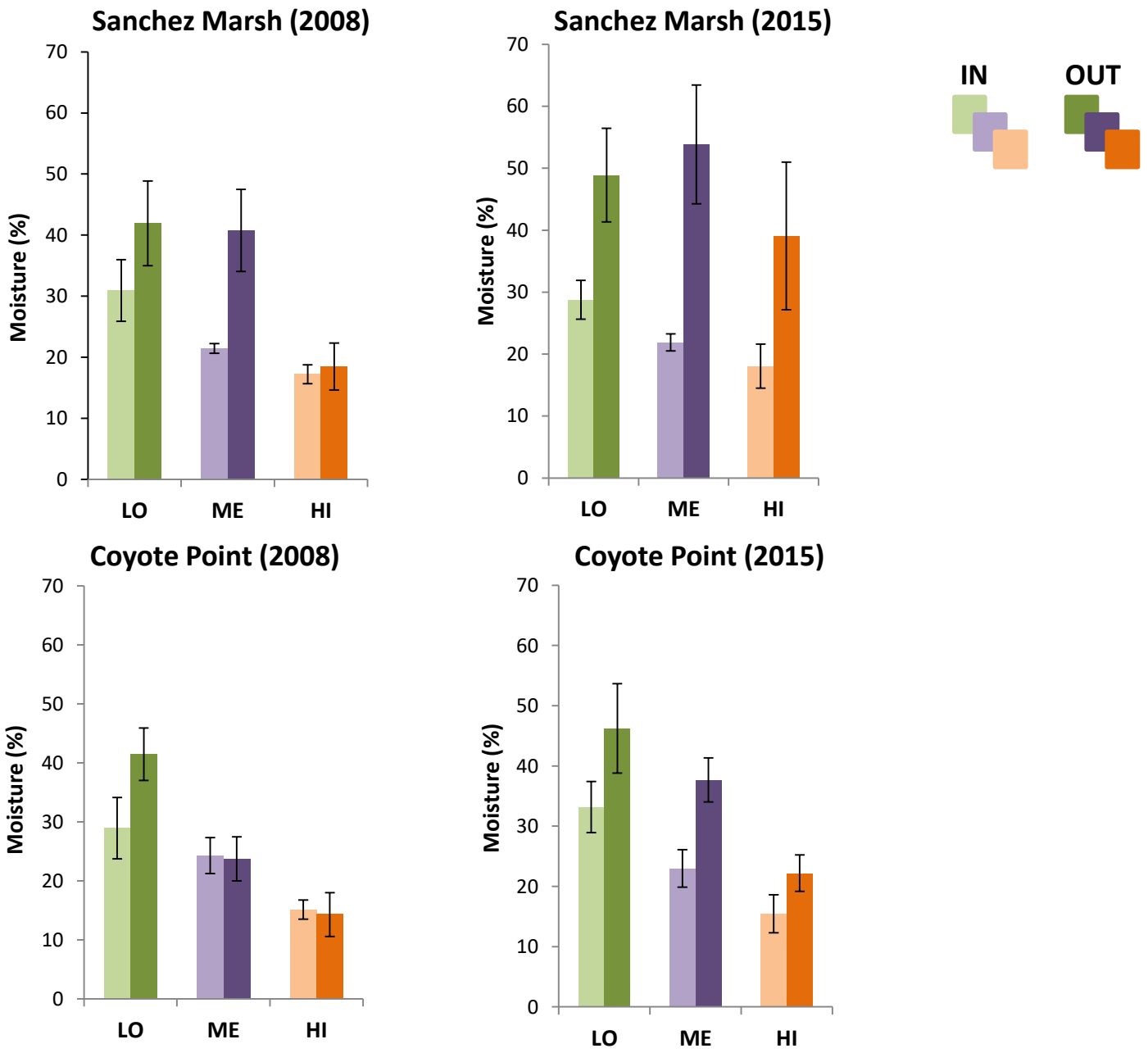


Fig. 14: Soil % moisture from 9/2008 and 9/2015. Error bars represent 1 S.E. and n=30 for all graphs

Bulk density

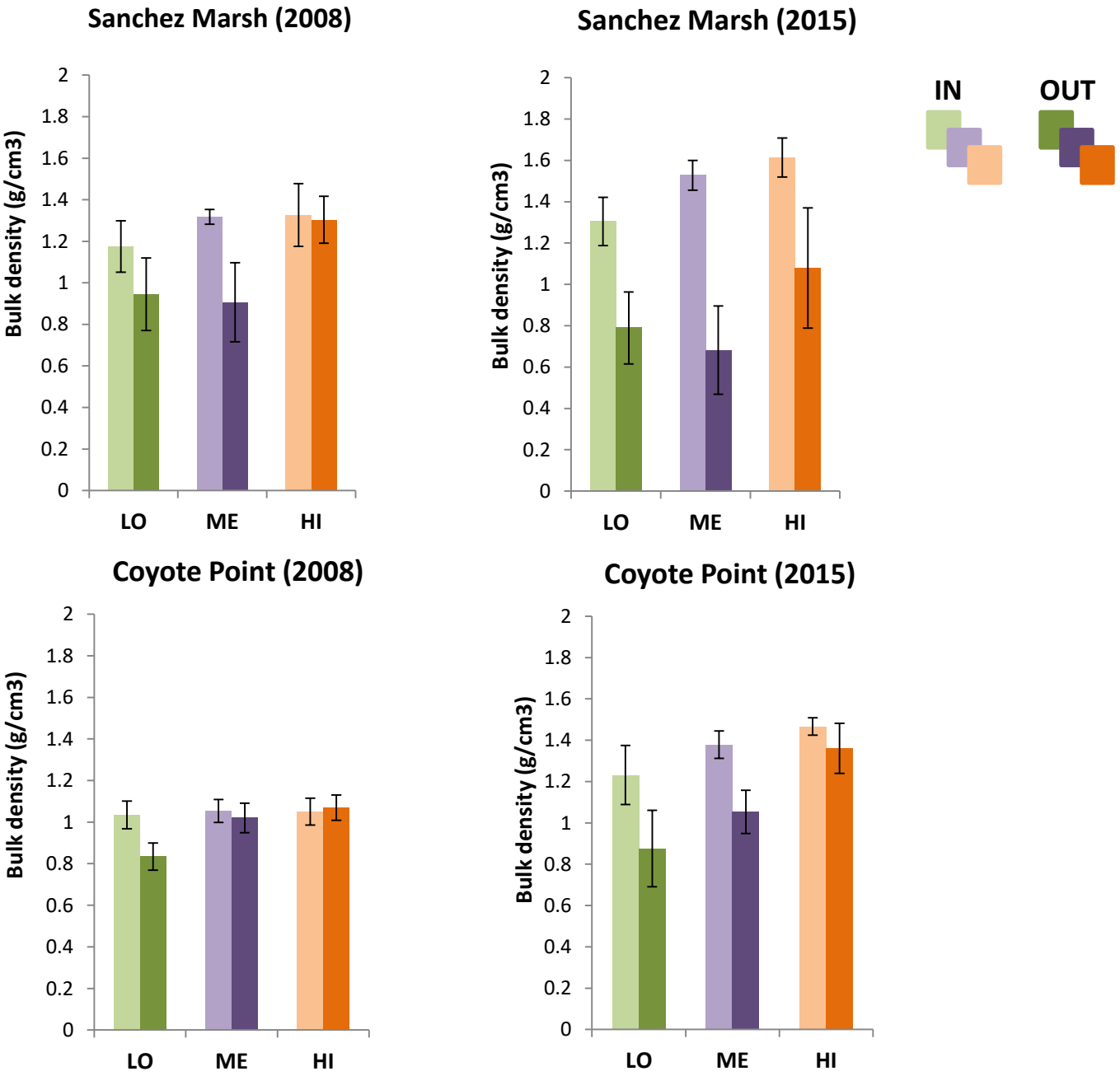


Fig. 15: Bulk density (g/cm^3) from 9/2008 and 9/2015. Error bars represent 1 S.E. and n=30 for all graphs

Soil Organic Matter (SOM)

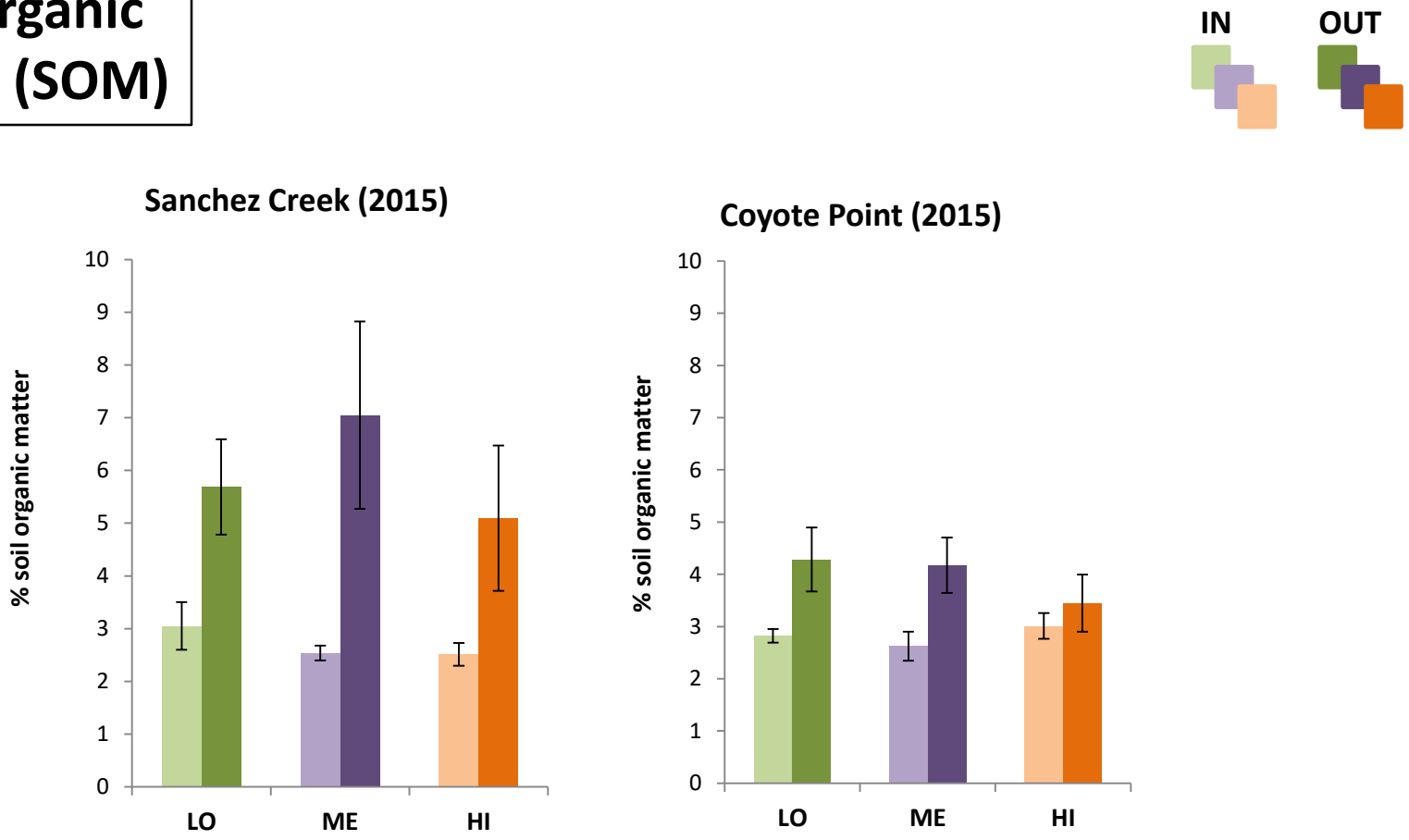
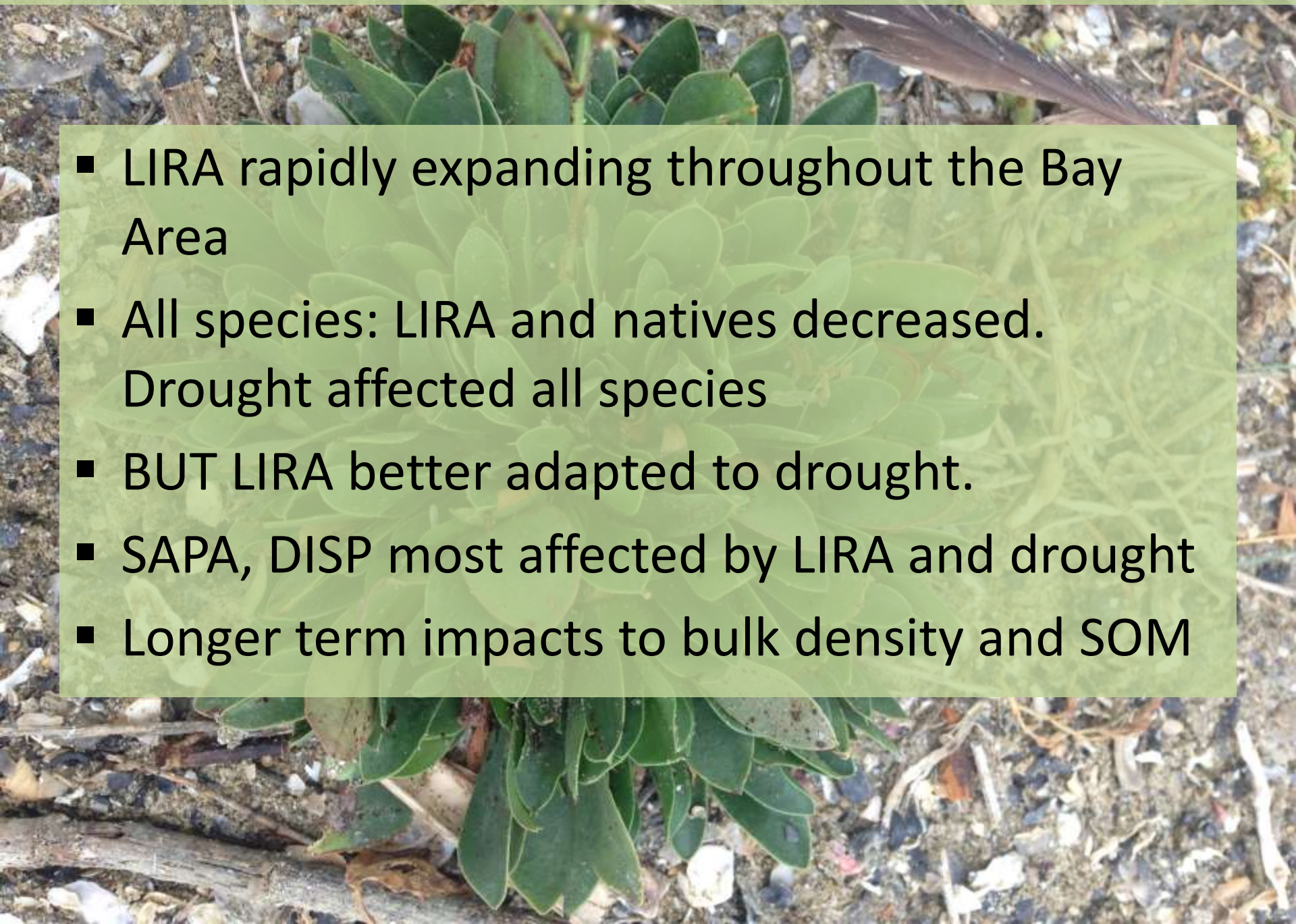


Fig. 16: Soil organic matter (%) from 9/2015. Error bars represent 1 S.E. and n=30 for all graphs



- LIRA rapidly expanding throughout the Bay Area
- All species: LIRA and natives decreased. Drought affected all species
- BUT LIRA better adapted to drought.
- SAPA, DISP most affected by LIRA and drought
- Longer term impacts to bulk density and SOM

- LIRA: hardy, drought tolerant species
- **Marsh level:** dominant player
- Long-term competitive ability in Bay-Area wetlands

Recommendations

- Reinvigorate removal efforts
- Research on seed bank dynamics (seed viability)

- Thesis committee!
- Gavin Archbald
- Foster City, City of Burlingame and San Mateo Co. Parks
- Invasive *Spartina* Project: Whitney Thornton and Drew Kerr
- Judy Stalker (Marin Audubon Board)
- Dr. Ed Connor (statistical analysis)
- Dr. Jerry Davis (plot elevations)
- Department of Geography & Environment
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- Boyer lab at Romberg Tiburon Center
- COSE travel grant
- Family and Friends: Anthony Copioli, Darren Blackburn, Laura Branagan and Melissa Kent for field and lab assistance

SF STATE

SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT

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ANY QUESTIONS?

Bay-wide mapping

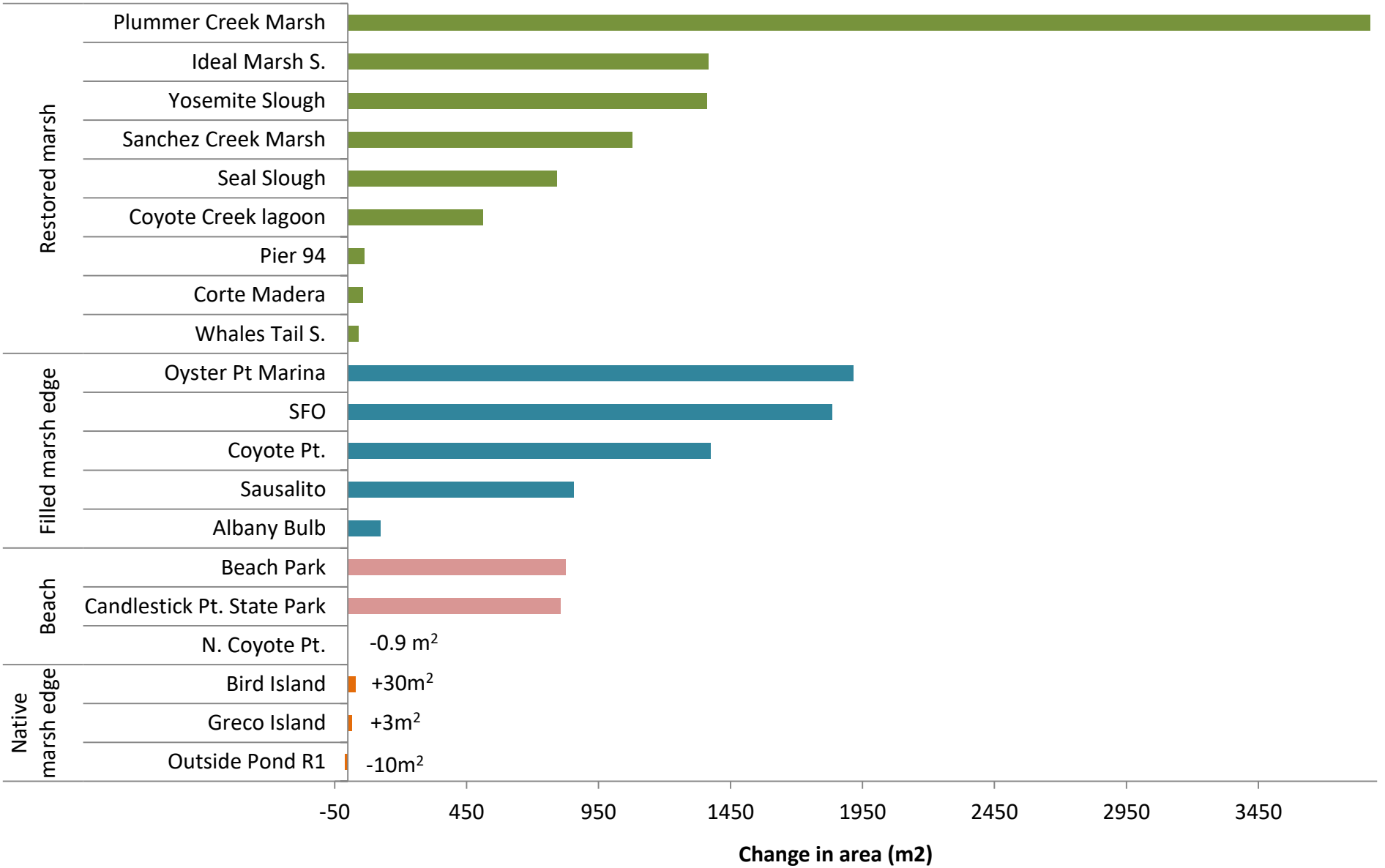

Fig. 6: Change in area of Bay-wide LIRA pop^{n} between two studies

Mensurate surveys: Vegetation

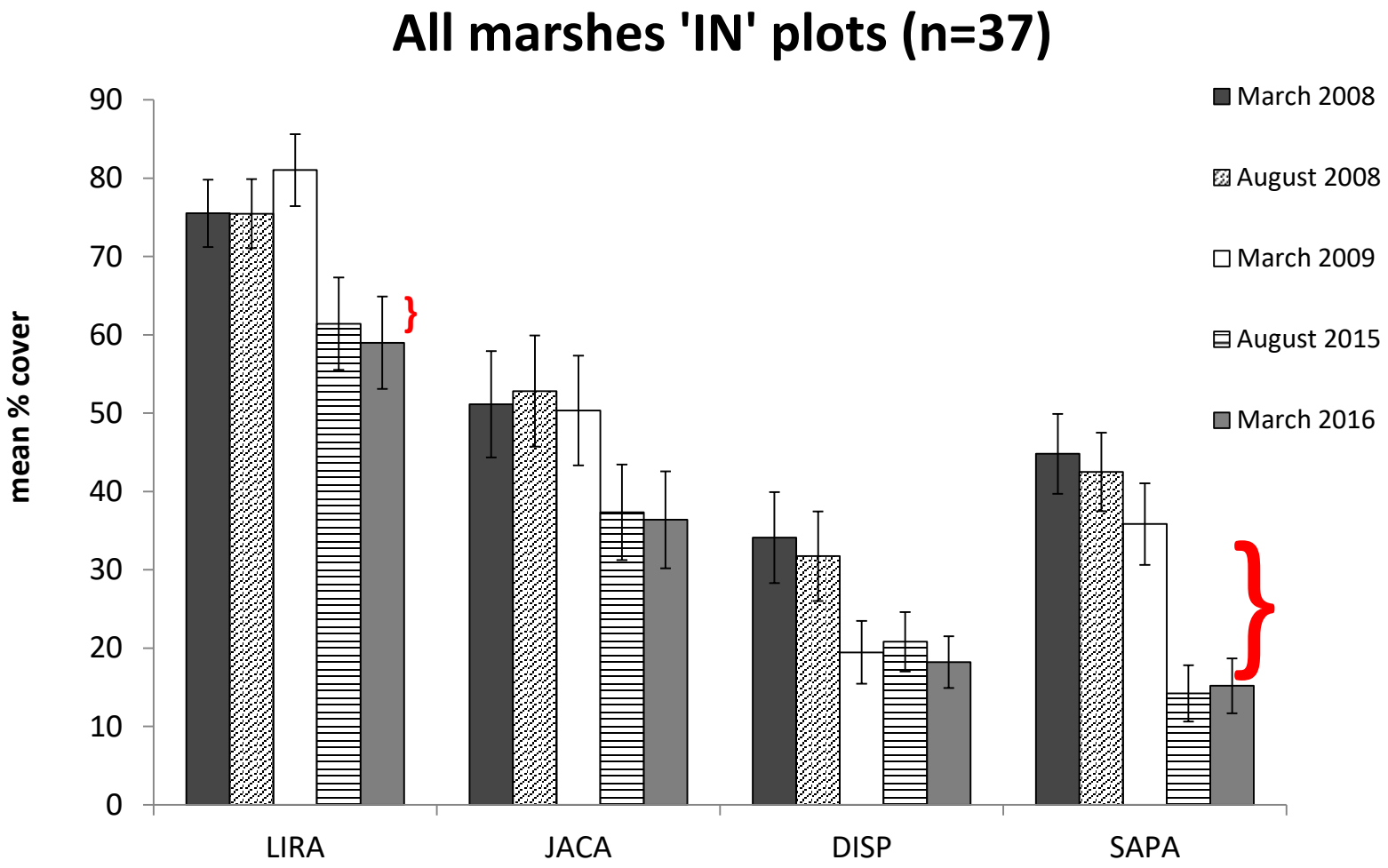

Fig. 8a: IN plots: LIRA and native species JACA, DISP and SAPA mean percent cover change over time

Mensurate surveys: Vegetation

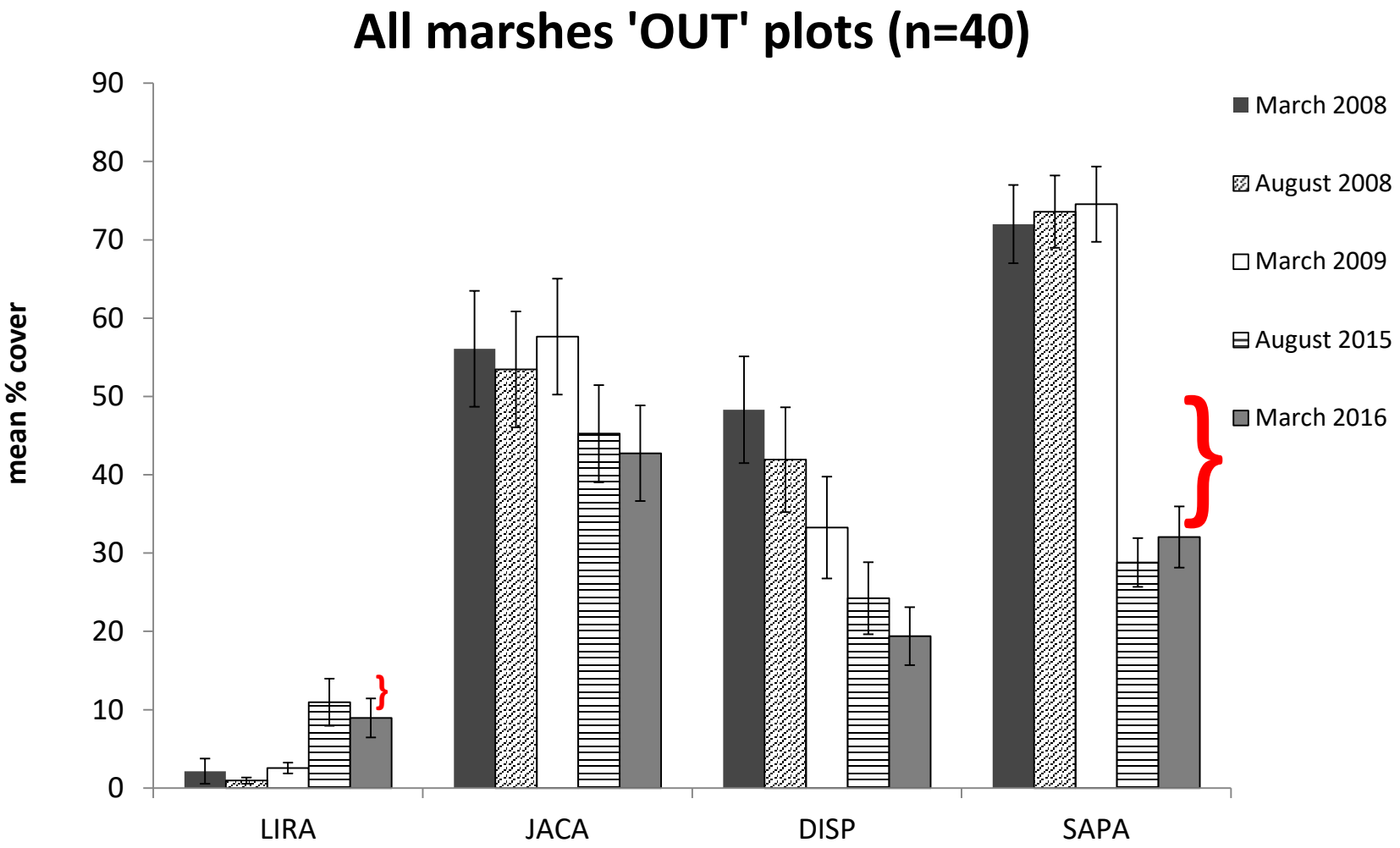

Fig. 8b: OUT plots: LIRA and native species JACA, DISP and SAPA mean percent cover change over time