

European sea-lavender (*Limonium duriusculum*) impact on salt marsh bird's beak (*Chloropyron maritimum* subsp. *maritimum*) floral visitors

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Introduction

The salt marsh bird's beak, *Chloropyron maritimum* subsp. *maritimum*, hereafter CHMAMA, is a state and federally listed plant in the Orobanchaceae family that occupies coastal salt marshes from Monterey, CA to Baja California (Figure 1A and 1B). One of the many threats CHMAMA (Figure 1C) faces is competition from invasive species such as European sea-lavender, *Limonium duriusculum* (LIDU) (Figure 1D). LIDU often occurs intermixed with CHMAMA (Figure 1E). Studies have shown that CHMAMA grows and flowers more abundantly in locations where *Limonium* has been removed (Hubbard and Page 1997). While CHMAMA is self-compatible, insect visitation is necessary for seed set (Lincoln 1985) and larger-bodied bees are needed to access its reproductive parts (Lincoln 1985). Pollinators are declining around the globe (Burkle et al. 2013), and there is evidence that CHMAMA flower visitors have declined as well. Our repeat of a study at Point Mugu found only five visitors of two bee taxa as compared to 92 visitors from five bee taxa in 1985 (Lincoln 1985; Knapp & Schneider 2017). In 2017, we began collecting baseline data for an experimental study that compares insect floral visitors on CHMAMA and LIDU prior to and after removal of LIDU in the University of California Carpinteria Salt Marsh Reserve (CSMR), Carpinteria, CA (Figure 1B).

Project Questions:

- 1) Which floral visitors utilize LIDU vs. CHMAMA?
- 2) How does floral visitor response differ by LIDU abundance?

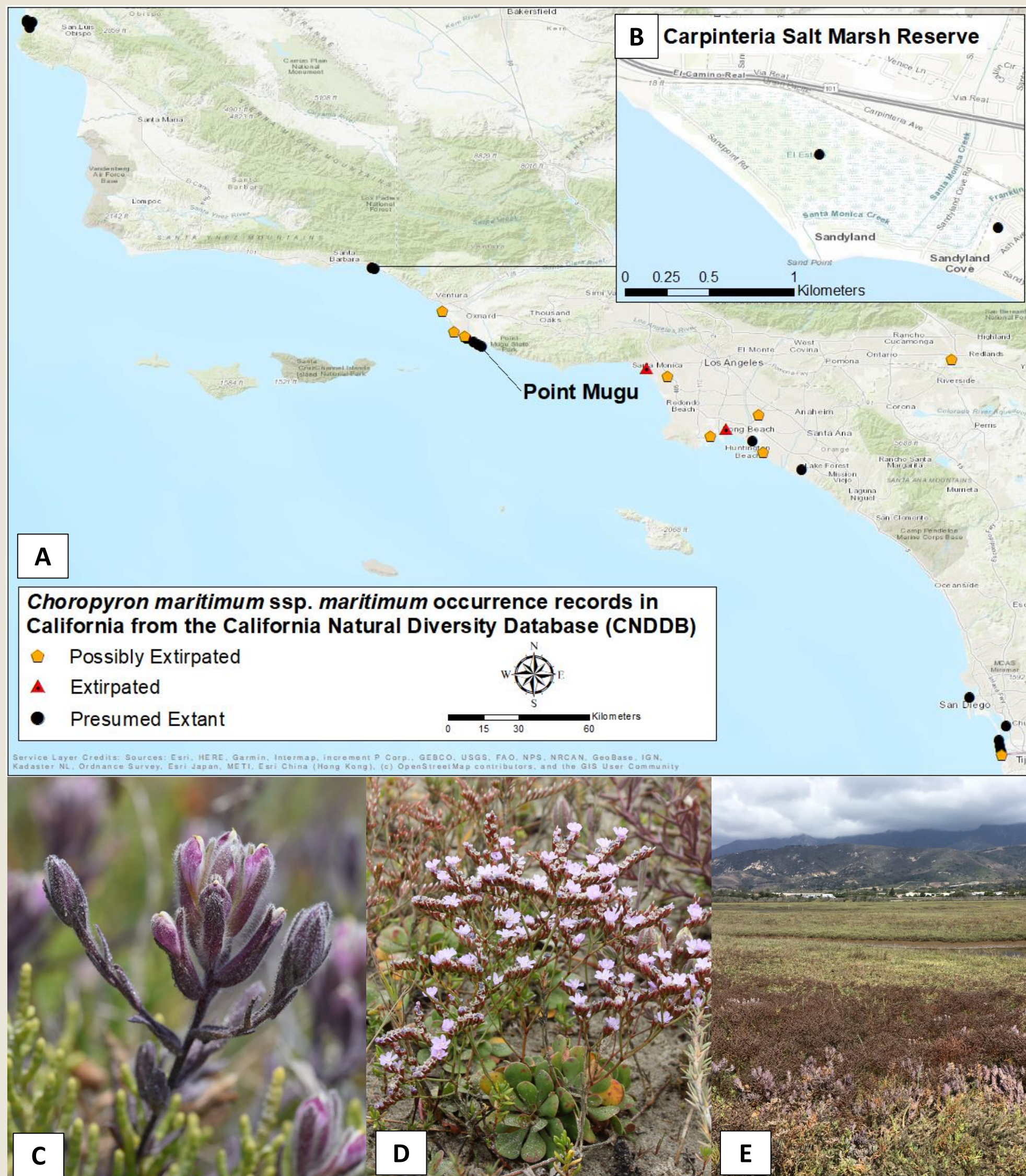


Figure 1. *Chloropyron maritimum* subsp. *maritimum* and *Limonium duriusculum*. A. CNDDB occurrence records of CHMAMA in California. B. University of California Carpinteria Salt Marsh Reserve. C. *Chloropyron maritimum* subsp. *maritimum*. D. *Limonium duriusculum*. E.

Materials and Methods

In 2017, we established 29, 2x2 m quadrats across a gradient of LIDU and CHMAMA abundances throughout the CHMAMA population at CSMR in a stratified random fashion. In July and August of 2017 and 2019, we measured the rate of insect visitation to all flowers within each quadrat for three separate five-minute increments, totaling 15 minutes/quadrat and 12 hours of observation. Observations of quadrats were made in three different timeslots: morning, midday, afternoon. Incidental floral visitors occurring outside of study quadrats were noted when possible, but not included in analyses. Representative insects were collected, pinned and identified to the lowest rank possible. We collected vegetation data from each quadrat, including percent cover of all vegetation, and number of flowering CHMAMA inflorescences.

Takeaways

- European sea-lavender shares few floral visitors with salt marsh bird's beak.
- In 2017 and 2019, 98% of floral visitors to European sea-lavender were introduced species and 100% of floral visitors to salt marsh bird's beak were native species.
- We did not find a relationship between European sea-lavender cover and floral visitors at our plot scale ($r^2 < 0.15$).

Frequent floral visitors of salt marsh bird's beak and European sea-lavender in 2017 & 2019 study quadrats

■ Salt marsh bird's beak (2017 & 2019) ■ European sea lavender (2017) ■ European sea lavender (2019)

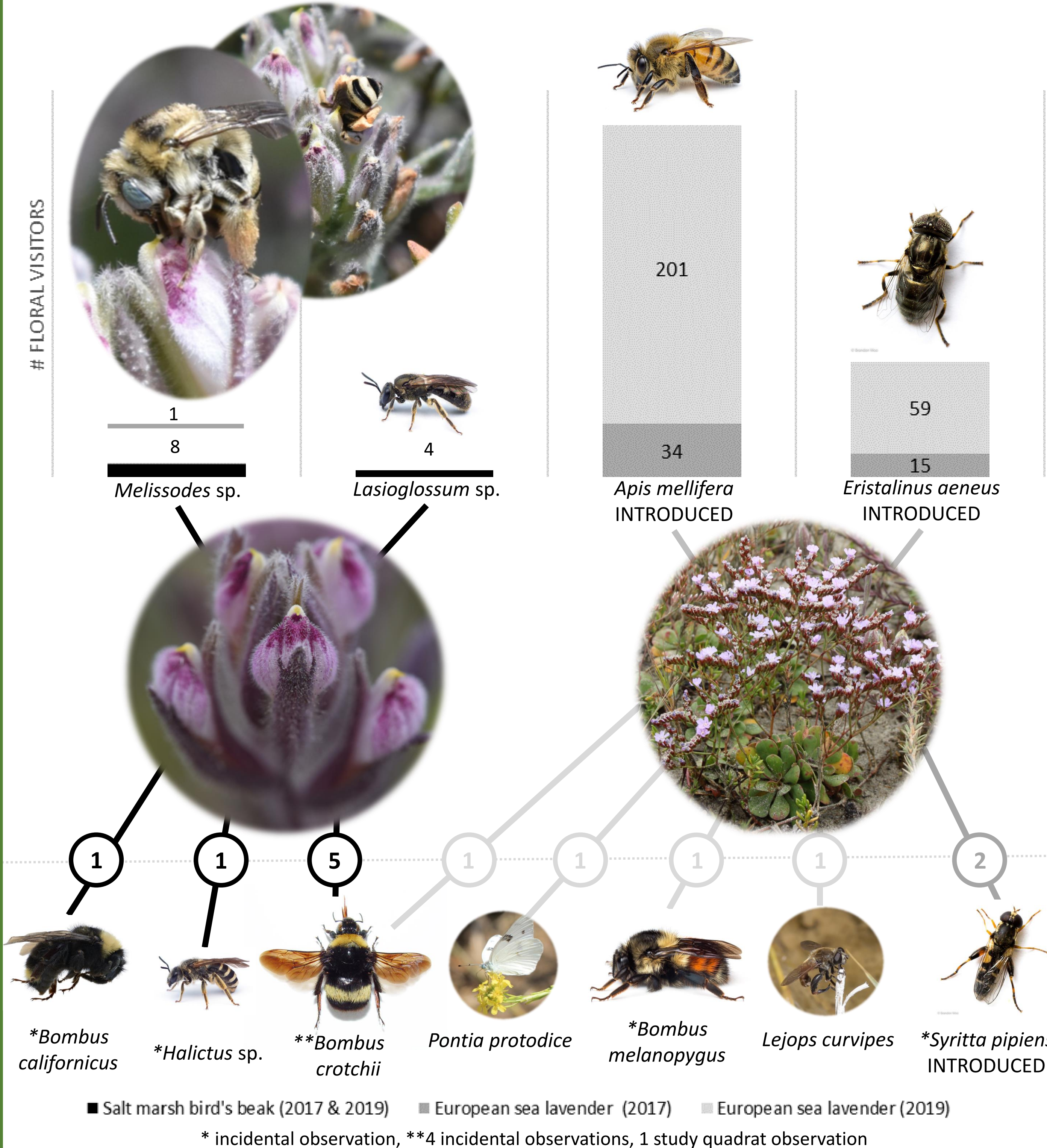


Figure 2. Floral visitor abundance of salt marsh bird's beak and European sea-lavender in 2017 & 2019 study quadrats and incidental observations.

Species	Native?		Total Responses
	No	Yes	
Salt marsh bird's beak	0%	100%	12
European sea-lavender	98%	2%	50

Pearson ChiSquare =56.09, $p < 0.0001$, $n=30$ plots

Figure 3. Origin of flower visitors by focal plant, Carpinteria Salt Marsh, 2017. Data from 2019 were not included because only 1 floral visitor was observed using salt marsh bird's beak.

Discussion

- Floral visitors of LIDU and CHMAMA overlapped only twice, once each with *Bombus crotchii* and *Melissodes* sp. The most frequent floral visitors to LIDU were introduced species from Europe. The most frequent floral visitor of CHMAMA was *Melissodes* sp. (likely *Melissodes tepidus* var. *timberlakei*). Overall, there is a lower diversity of taxa and fewer individuals visiting CHMAMA than has been documented in the past (Lincoln 1985). *Anthidium edwardsii* was noted as the most important pollinator of CHMAMA and we observed it only 5 times (Lincoln 1985).
- We observed the endangered Crotch's bumblebee, *Bombus crotchii* (IUCN Redlist) using CHMAMA five times. Given their high floral constancy and pollen loads consisting purely of CHMAMA pollen, it is possible that even a few *Bombus* individuals may play an important role in pollination (Lincoln 1985). *Bombus crotchii* could be playing an important role at CSMR, which could have important implications for both of these rare taxa if one of them is lost.
- There is a lower diversity of taxa and fewer individuals visiting CHMAMA than has been documented in the past (Lincoln 1985; Knapp & Schneider 2017).
- European pollinators could be contributing to an invasional meltdown in this system by increasing the fitness and competitive advantage of LIDU. Invasional meltdowns occur when the negative impacts of one introduced species are exacerbated by its interaction with other introduced species (Simberloff & Von Holle 1999).
- Removing LIDU not only has the potential to reduce direct competition to CHMAMA, but also to increase CHMAMA pollinator abundance.

A Scan to watch a video of the endangered *Bombus crotchii* foraging on salt marsh bird's beak



Figure 4. Floral visitors of salt marsh bird's beak. A. QR link to *Bombus crotchii* video., B. *Lasioglossum* sp., C. *Melissodes* sp., and D. *Bombus crotchii*

Future Directions

The Santa Barbara Botanic Garden hopes to perform experimental LIDU removal at CSMR. We plan to measure the effectiveness of different treatments, including manual removal and potential herbicide use.

Acknowledgements

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Photographs: *Apis mellifera*, *Bombus californicus*, *Bombus melanopygus*, *Dialictus*, *Halictus* - Thomas Shahan; *Bombus crotchii* specimen - Robyn Waayers; *Bombus crotchii* video - Heather Schneider; *Pontia protodice* - Andrea Kreuzhage, iNaturalist.org; *Eristalinus aeneus*, *Syrirta pipiens* - Brandon Woo; *Lejops curvipes* - Kristie Nelson, iNaturalist.org; *Limonium duriusculum* - R.J. Adams, iNaturalist.org