Trophic Integration of an Invasive Plant: *Lepidium latifolium*'s Impact on the Suisun Song Sparrow Food Web

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Invasive Plants and Management

- Importance of control and eradication
  - Altered: geomorphology, soil disturbance regimes, hydrology, climate and microclimate, nitrogen cycling, soil chemistry, productivity, decomposition, etc.
- Invasive species can facilitate natives biota
- How to balance multiple management concerns?
  - Understand invasive plant integration into native ecosystems

Dukes and Mooney 2004; Shafroth et al. 2005

Invasive Plants in Wetlands

- Wetlands cover less than 6% of the globe
  - 24% of the most invasive weeds
- Wetland home to numerous rare and endemic species
- Wetland invaders often ecosystem engineers
  - Altered food webs

Crooks, 2002; Grosholz, 2002; Zedler and Kercher 2004; Levin *et al.*, 2006; Whitcraft *et al.*, 2008
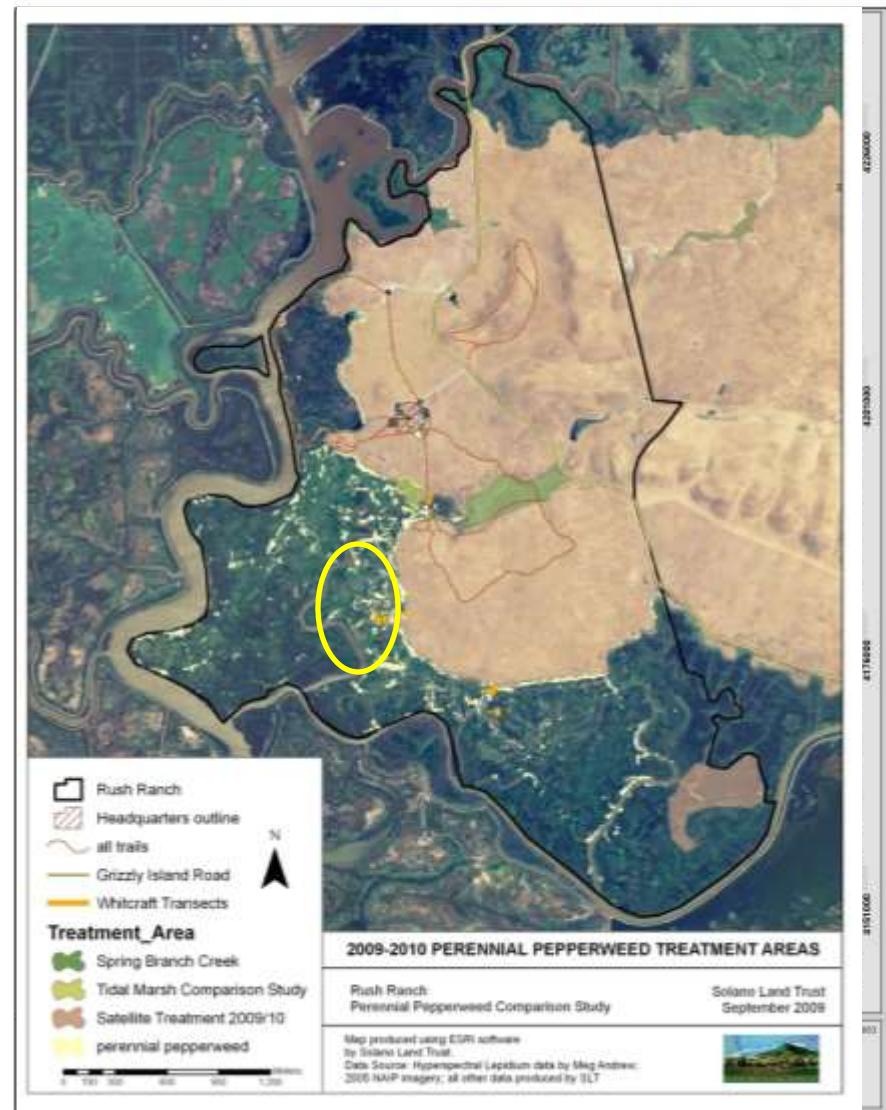
Rush Ranch Open Space Preserve

- Brackish marsh habitat within Suisun Bay

- Largest intact area of fully tidal marsh remaining in Suisun Bay

- Home to many rare and endangered species (Soft-bird's beak, Suisun Thistle, Suisun Song Sparrow, CA Black Rail)

- 27% of the flora at the site are non-native

Whitcraft *et al.*, 2011; Spautz *et al.*, in review

2009-2010 PERENNIAL PEPPERWEED TREATMENT AREAS

Rush Ranch: Perennial Pepperweed Comparison Study

Solano Land Trust September 2009

Treatment_Area
- Spring Branch Creek
- Tidal Marsh Comparison Study
- Satellite Treatment 2009/10
- perennial pepperweed

- Rush Ranch
- Headquarters outline
- all trails
- Grizzly Island Road
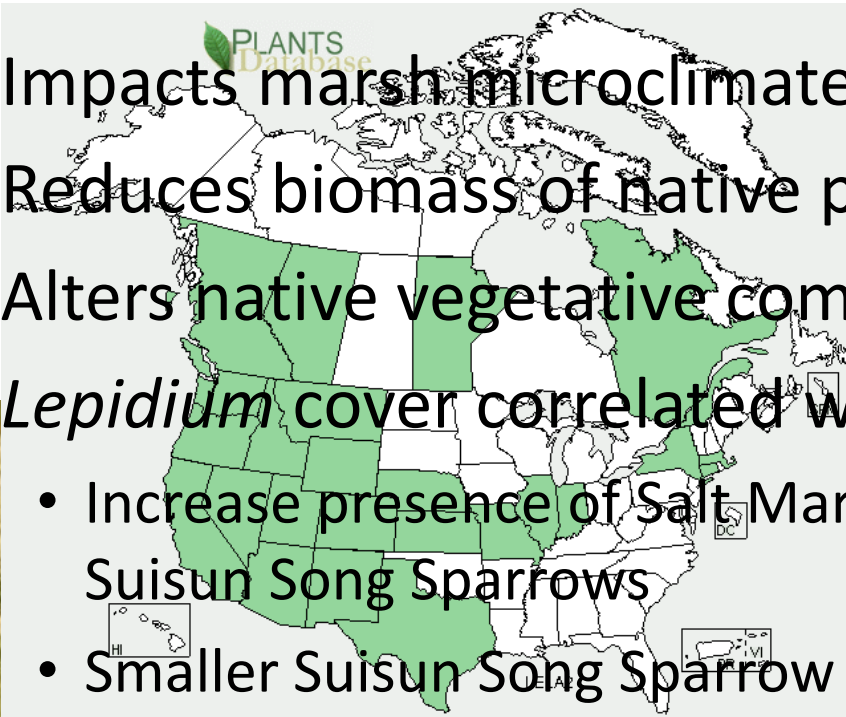- Whitcraft Transects

Lepidium latifolium

Within Rush Ranch:

- Impacts marsh microclimate
- Reduces biomass of native plant species
- Alters native vegetative community composition
- *Lepidium* cover correlated with
  - Increase presence of Salt Marsh Common Yellowthroat and Suisun Song Sparrows
  - Smaller Suisun Song Sparrow territories

Blank and Young, 2002; Blank, 2002; Blank and Young, 2002; Renz and Blank, 2004; Spautz and Nur 2004; Whitcraft *et al.,* 2011; Whitcraft, unpublished data; Grewell, personal communication; Wigginton *et al.*, 2014

Season Alters Arthropod Abundance

Wigginton

Suisun Song Sparrow

- *Melospiza melodia maxillaris*

- California species of special concern

- Breeds early March-July

- Eats within multiple foraging guilds

Marshall, 1948; Grenier, 2004; Spautz and Nur, 2008; Takekawa *et al.*, 2011

Goal and Hypothesis

Goal: Assess the potential impacts of *Lepidium latifolium* on the food web of Suisun song sparrows to further understand how the plant is functioning in the system

Hypothesis: *Lepidium* carbon and nitrogen will be fully integrated into the Suisun song sparrow food web, primarily through elevated arthropod populations

Indirect Trophic Impacts

Stable Isotope Ecology

- You are what you eat!
  - ^{13}C and ^{15}N

- Stable Isotope Terminology:
  - $\delta^{12}C : \delta^{13}C$ and $\delta^{14}N : \delta^{15}N$
  - Ratio of ratios

- Mixtures of different sources

http://afsuw.wordpress.com/2012/04/11/stable-isotope-workshop/
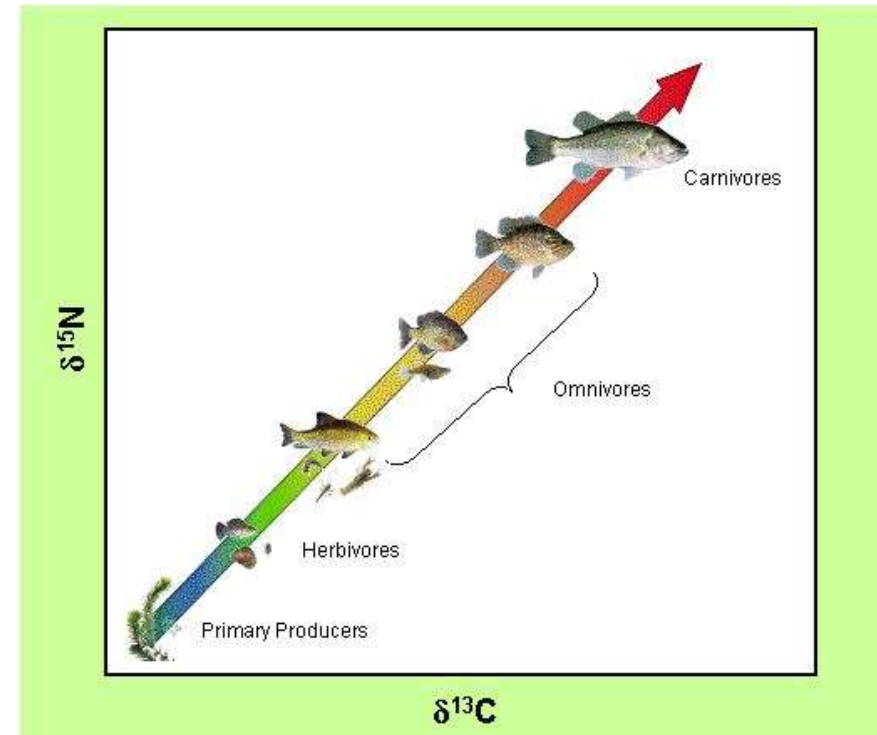
Stable Isotope Methods

- Consumer sources
  - Bird blood (winter N=17, summer N=11)
- Food sources
  - Plant samples
  - Sediment-dwelling macrofauna: **SDM**
  - Canopy-dwelling arthropods: **CDA**
- Mass spectrometry & elemental analyzer
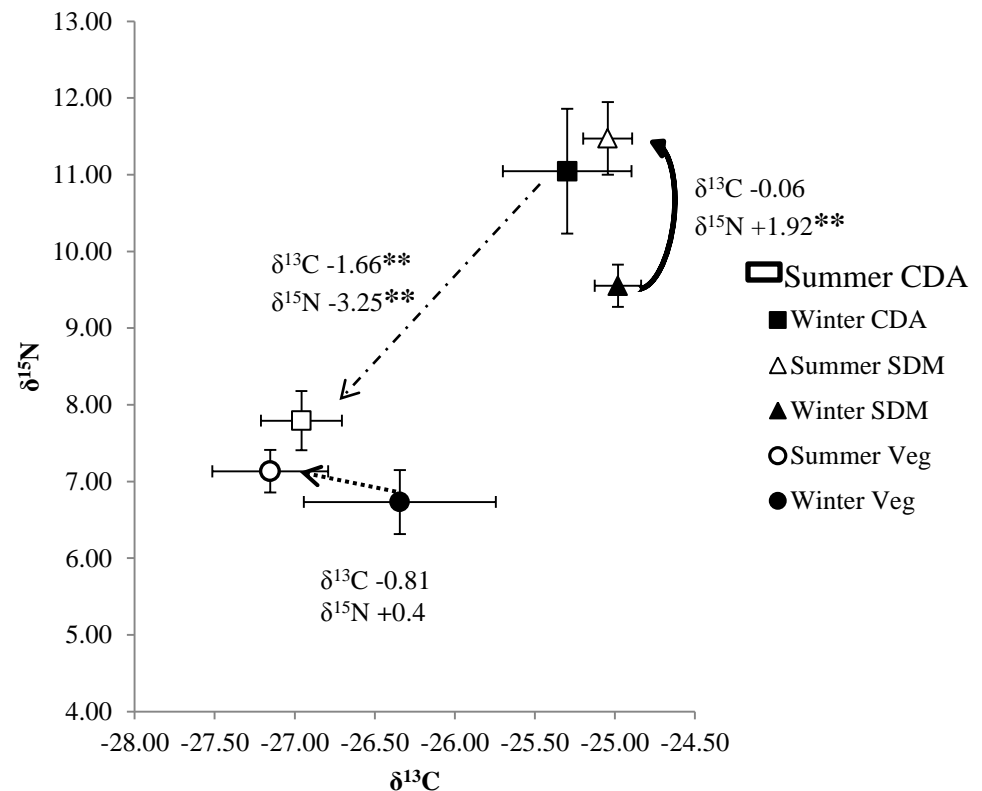
Shifting Stable Isotope Values
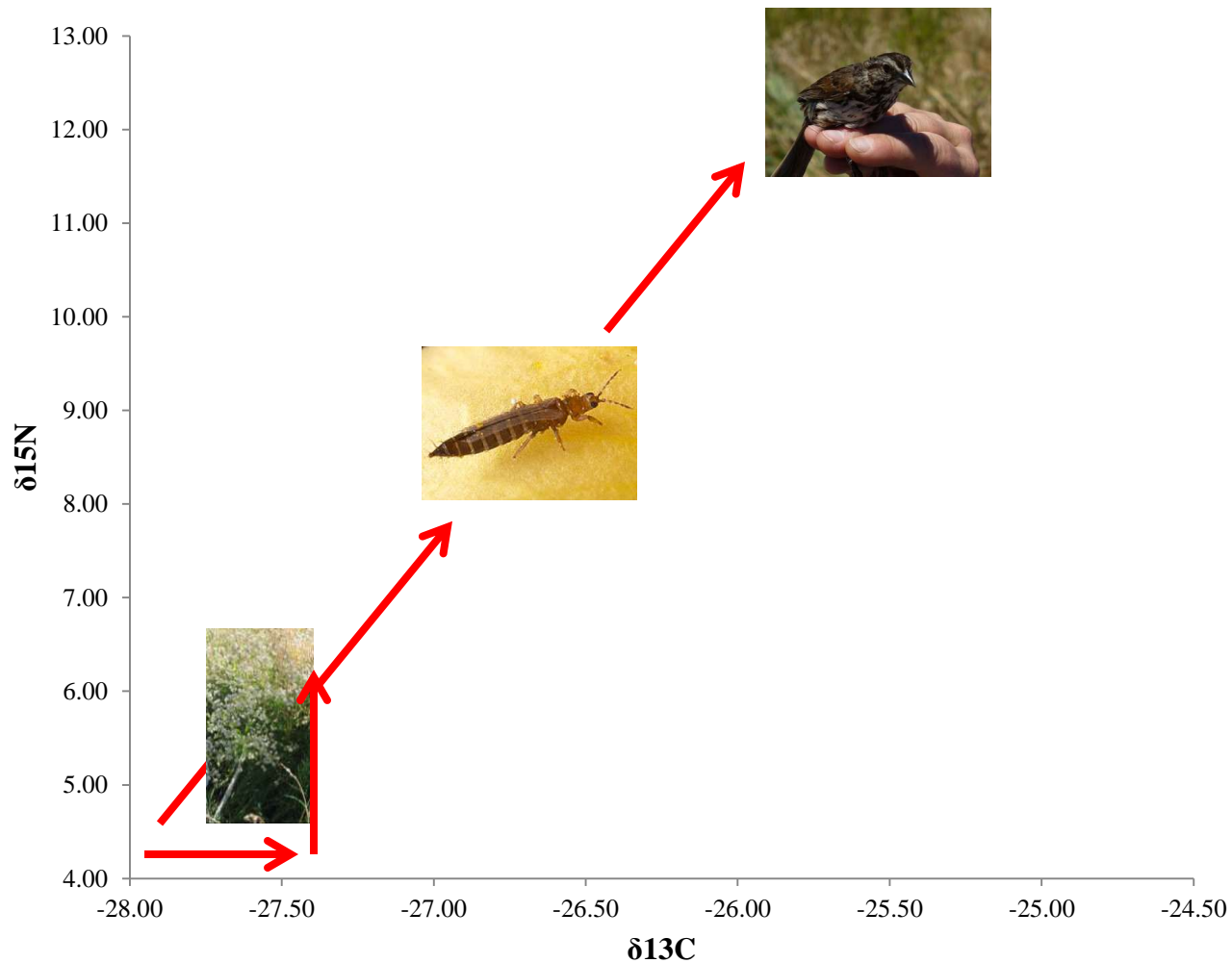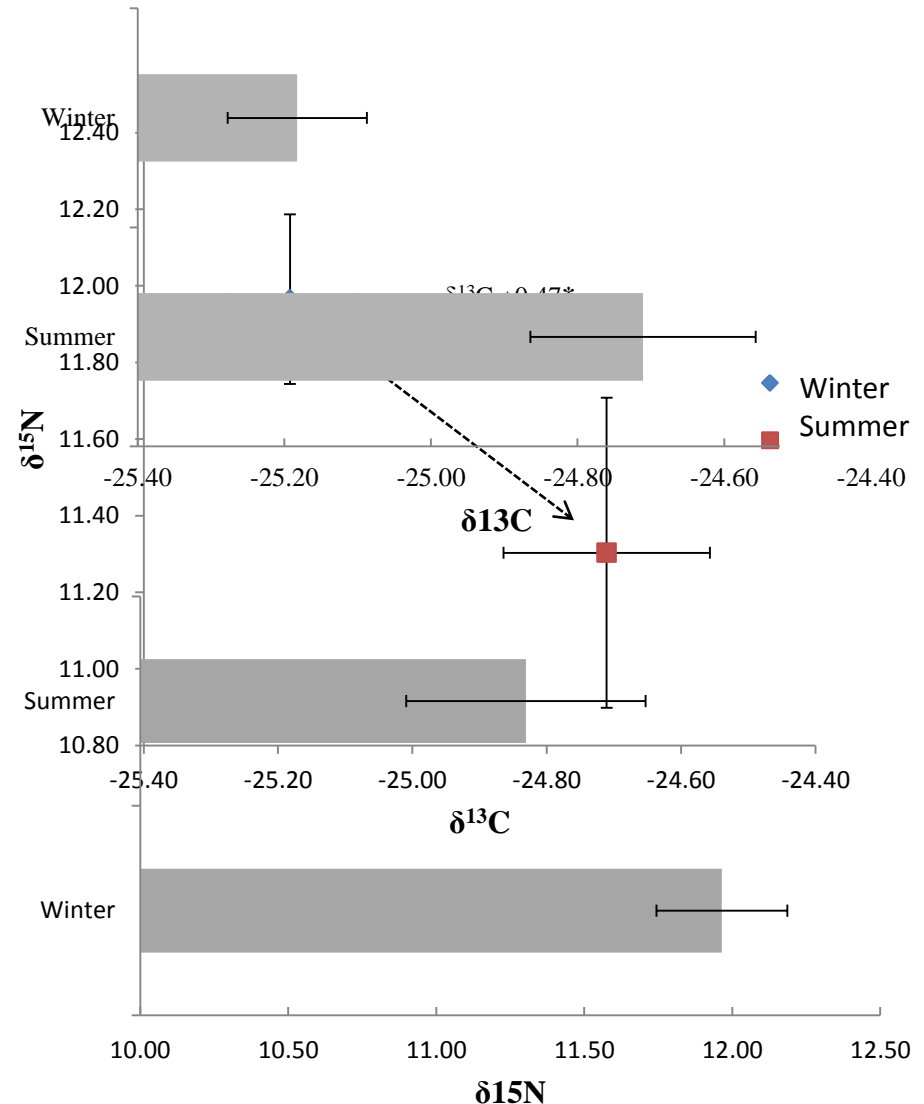
Average Isotopic Sources
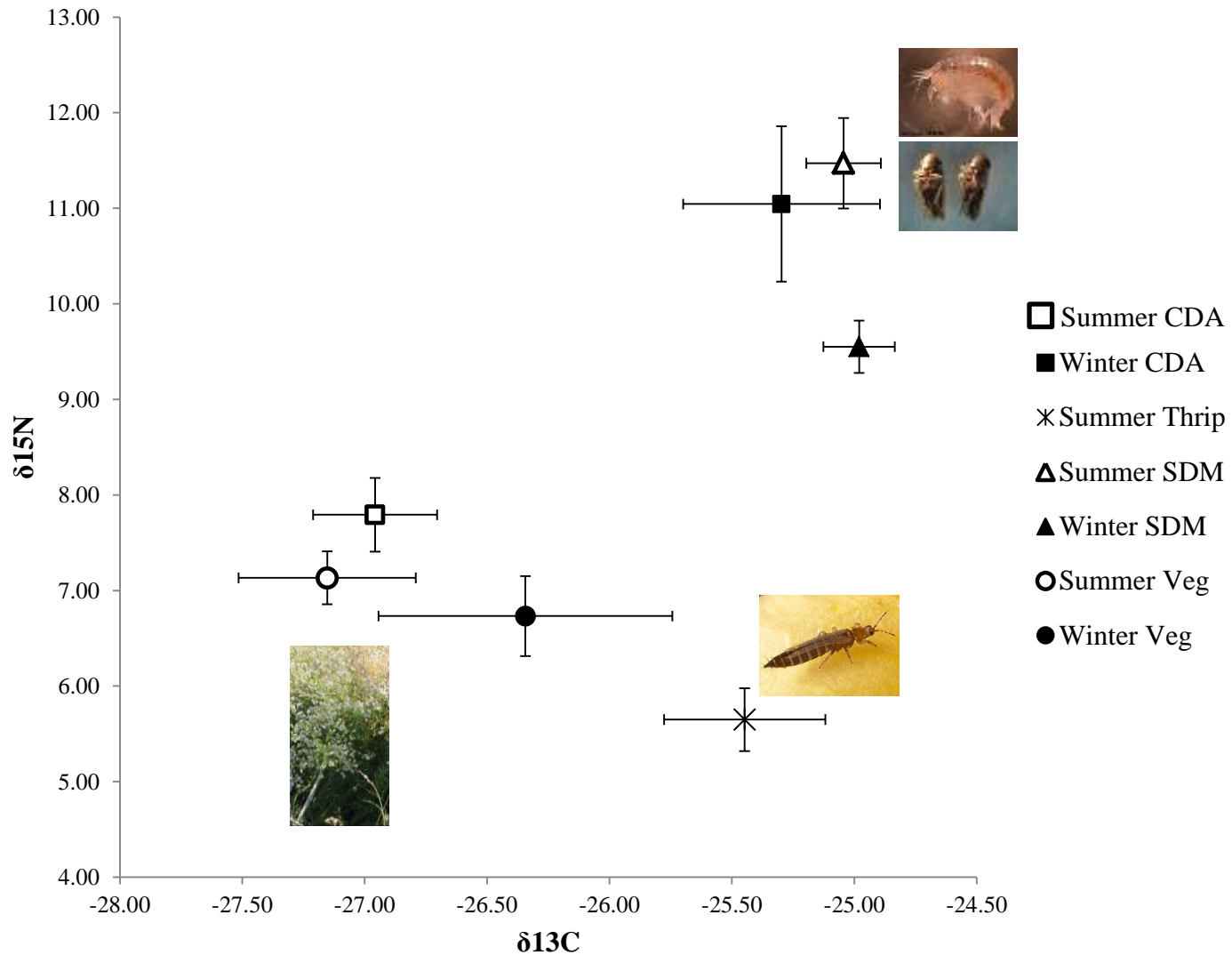
Seasonal Source Isotopic Shifts

- Invertebrates isotopically distinct between seasons
  - ANOSIM, CDA, Global R=0.208, p=0.018; SDM, Global R=0.031, p=0.026

- Vegetation not isotopically distinct between seasons
  - ANOSIM, Global R=0.037, p=0.092

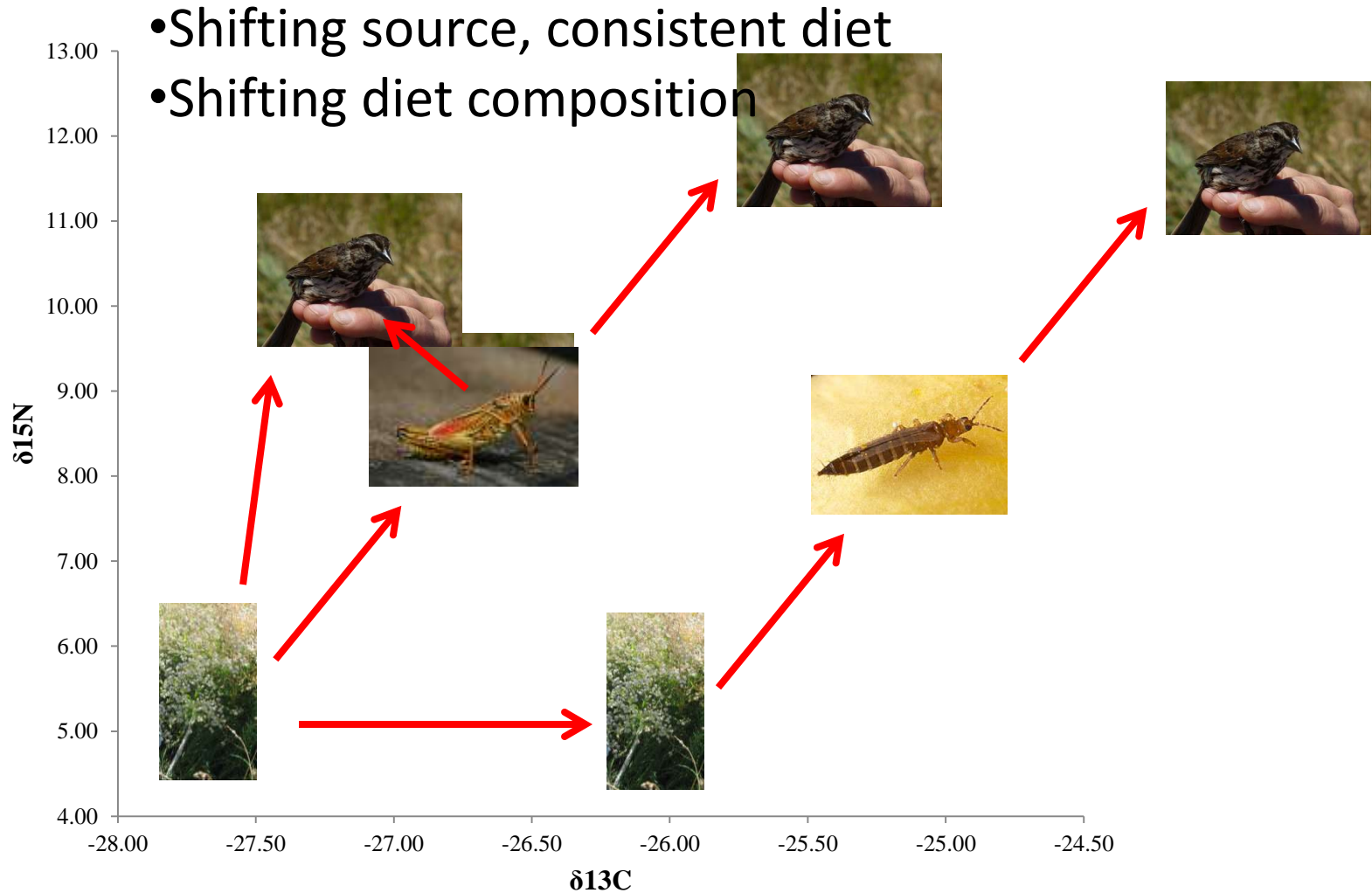# Consumer Isotopic Shifts

- $\delta^{13}C$ is enriched in the summer
  - ANOVA, F=7.65, p=0.01
- $\delta^{15}N$ not significantly altered between seasons
  - ANOVA, F=2.43, p=0.131

Shifts in Consumer Signatures

- Shifting source, consistent diet
- Shifting diet composition

δ15N (y-axis: 4.00 – 13.00)

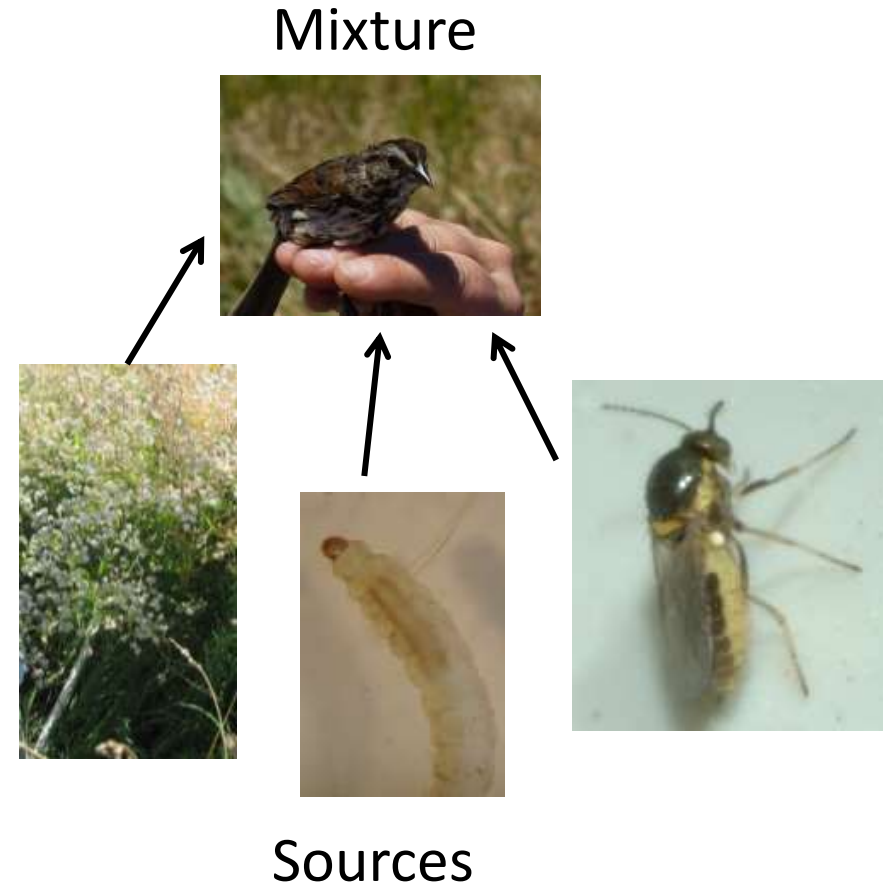δ13C (x-axis: -28.00 – -24.50)

Mixing Model

- 3 source

- Concentration dependent

$$1 = f_X + f_Y + f_Z$$

$$\delta^{13}C_M = f_X\, \delta^{13}C_{X'} + f_Y\, \delta^{13}C_{Y'} + f_Z\, \delta^{13}C_{Z'}$$

$$\delta^{15}N_M = f_X\, \delta^{15}N_{X'} + f_Y\, \delta^{15}N_{Y'} + f_Z\, \delta^{15}N_{Z'}$$
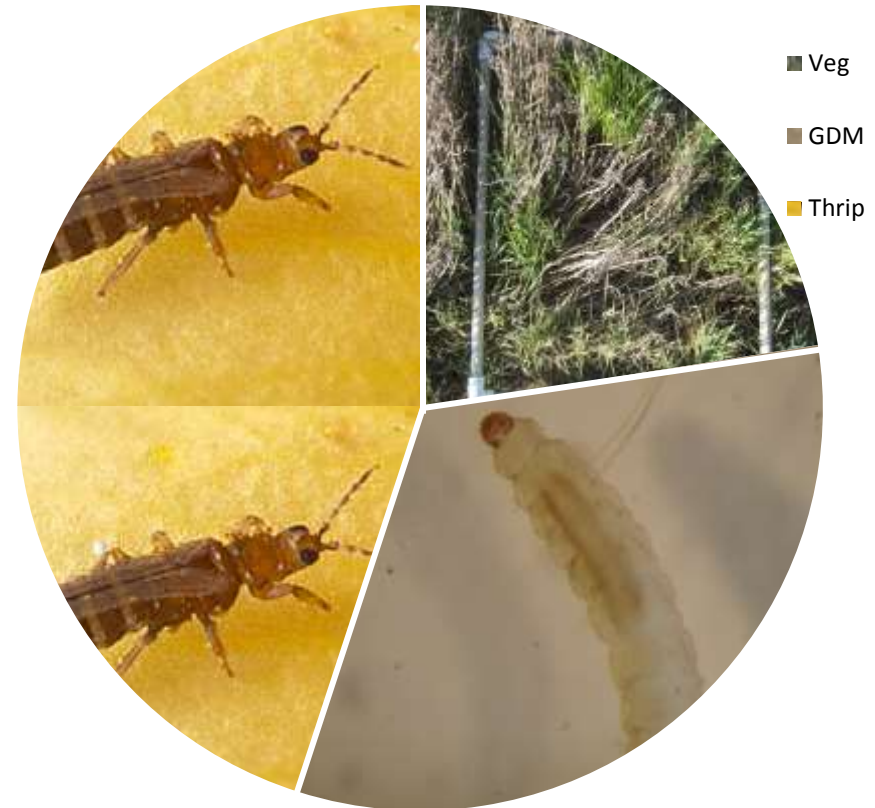
Mixture

Sources

Winter Sparrow Diet

- 12 of 17 individuals have resolved models

- General diet model
  - Seeds (44.7$\pm$5.7%)
  - "Plant matter" (25.9$\pm$4.5%)
  - Canopy dwelling arthropods (29.4$\pm$4.5%)

- Seeds
- Plant Matter
- CDA

Summer Sparrow Diet

- 11 of 11 individuals have resolved models

- General diet model
  - "Plant Matter" (22.5$\pm$5.9%)

  - Soil-dwelling macrofauna (32.4$\pm$5.9%)

  - Thripidae (45.1$\pm$5.3%)

■ Veg

■ GDM

■ Thrip

Impacts on the Food Web?

Lepidium Impacts Sparrow Diet

- Winter: 10 of 17 models resolved
  - non-*Lepidium* : 9 resolved models
  - ***Lepidium* only**: 1 resolved model

- Summer: 8 of 11 models resolved
  - non-*Lepidium* only: 2 resolved models
  - ***Lepidium* only**: 6 resolved models

vs

Return to Hypotheses

Lepidium carbon and nitrogen will be fully integrated into the Suisun song sparrow food web, primarily through elevated arthropod populations

→ Seasonal and individual variation

Diet Impacts of *Lepidium* are Seasonal

- ## Winter
  - CDA abundance higher in non-*Lepidium* marsh

- ## Summer
  - CDA abundance higher in *Lepidium* marsh

Conclusions

- *Lepidium* integrated into food web
  - Evidence for impacts of *Lepidium* on diet in breeding season
- Invasion eradication must take place in a ecosystem context
- Eradication paired with native species replanting
- Future Directions:
  - Multi-source mixing model
  - Application of MixSIR to tri-trophic system

Acknowledgements

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Questions?