# *Population Viability and Restoration Potential of Rare Plants Near Solar Installations*

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Photo: www.BLM.gov

# Challenges in the California Deserts

- Meeting CA's ambitious Renewable Portfolio Standard Goal by 2020: 33% of energy from renewable sources

- Managing biodiversity and impacts to special status plants and animals

# Efforts to Mitigate Impacts to Rare Plants

- Carefully selection of sites for energy development and project design
- Permanent protection and management of offsite populations
- On-site protection of subpopulations within energy project footprints
- Seed banking and population restoration

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Each requires understanding of how taxon-specific biology and subpopulation size may influence extinction probability.

# Project Goals

For several species of rare plants potentially impacted by solar development:

- Provide information on population viability
- Estimate extinction threshold population (ETP) sizes based on field data
- Test PVA as a tool for examining sensitivity of life history stages of rare desert plants to impacts

# Population Viability Analysis (PVA)

- A modeling technique that simulates the trajectory of a population over time
- Built on ecological, life history, and demographic data
- Multiple simulations and a long time frame
- Compares how extinction risks vary under different levels of impact or environmental variation

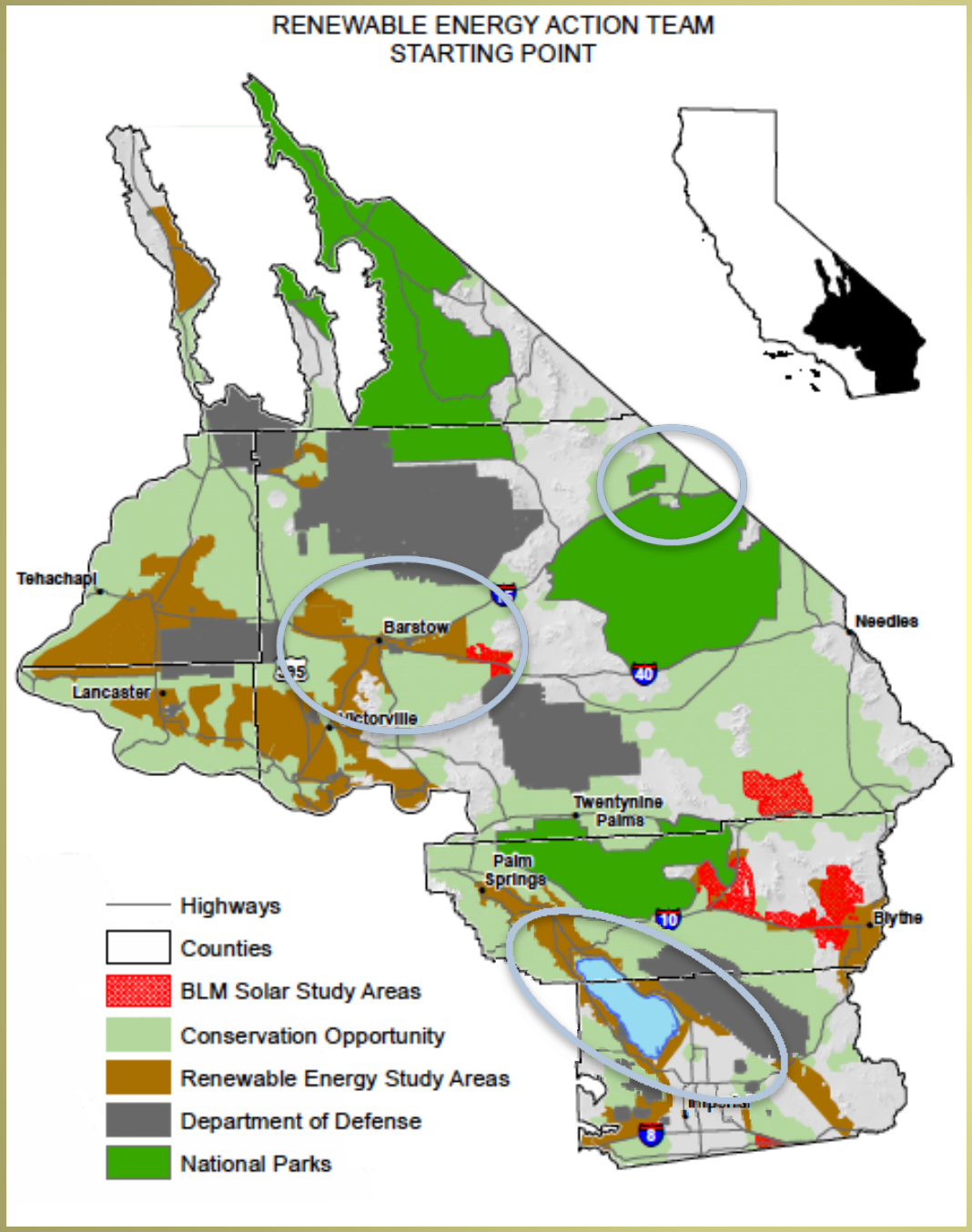
# Project Overview


- 6-8 target rare and 2 common taxa with different life histories (e.g. annuals, perennials)
- 2-3 natural study populations for each taxon
- Collect 4 years of field demographic data
- Develop and interpret PVA models including:
  - Estimation of extinction threshold population size
  - Sensitivity analysis that links population viability to past or potential impacts

# Rare Taxa Selection


~361 CNPS-tracked rare plant taxa in the CA desert region

- Threshold number of occurrences
- Elevations suitable for solar installations
- Locations/habitats prioritized for development
- Focused on taxa listed as CA Rare Plant Rank 1B
- Range of life forms and life histories
- Feasibility for both projects




## Currently:

Potential target rare taxa list ~15

Field reconnaissance of subpopulations and assessing feasibility

Establish 2-3 long-term study sites for each taxon this season

# Common Taxa

- Select an annual and a perennial
- Use as baseline for rare plant PVA models
- Provides “typical” demographic responses to rainfall quantity and timing
- Less likely to be idiosyncratic

# Demographic Data Collection

At each subpopulation, in each year:

-Number of individuals

-Stage distributions

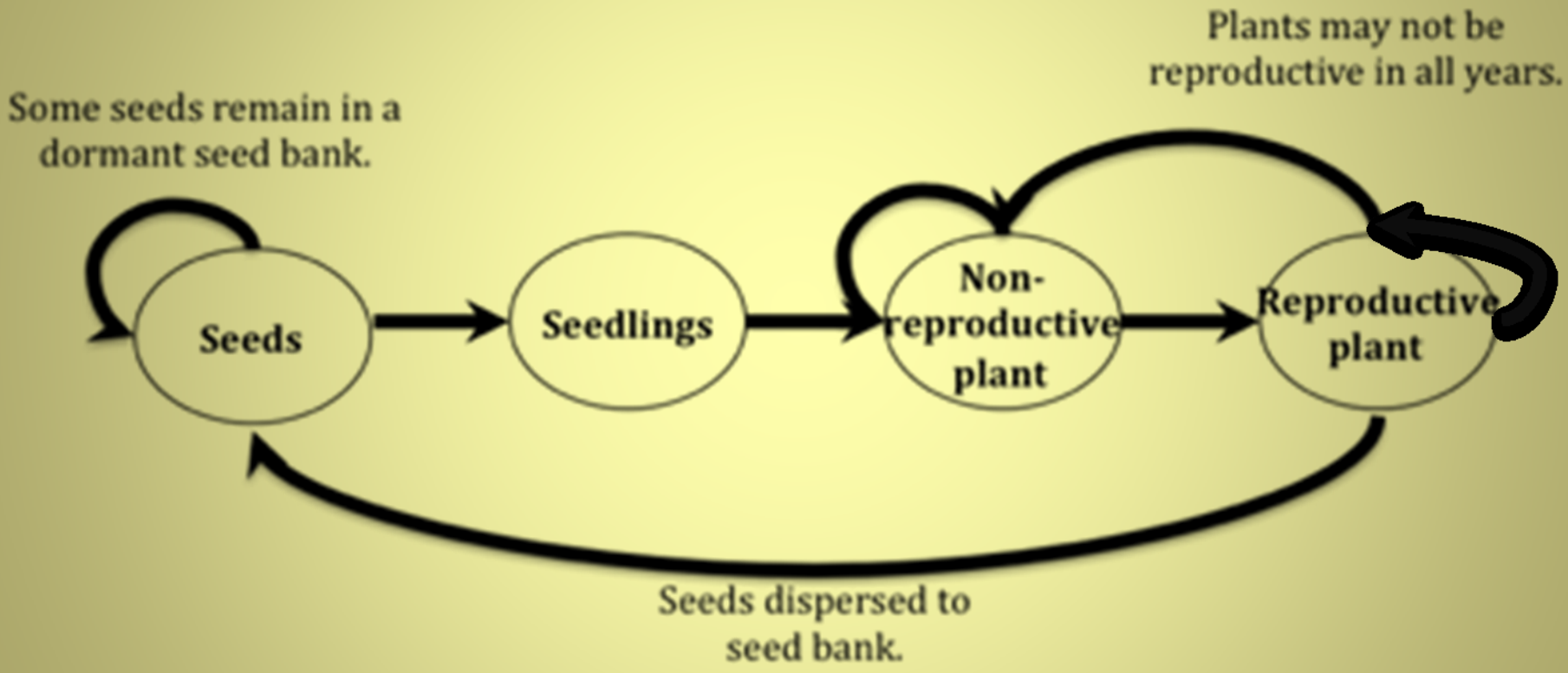
-Seedling emergence

-Plant survivorship

-Fecundity (seed output)

-Seed dormancy

# Stage-based Model



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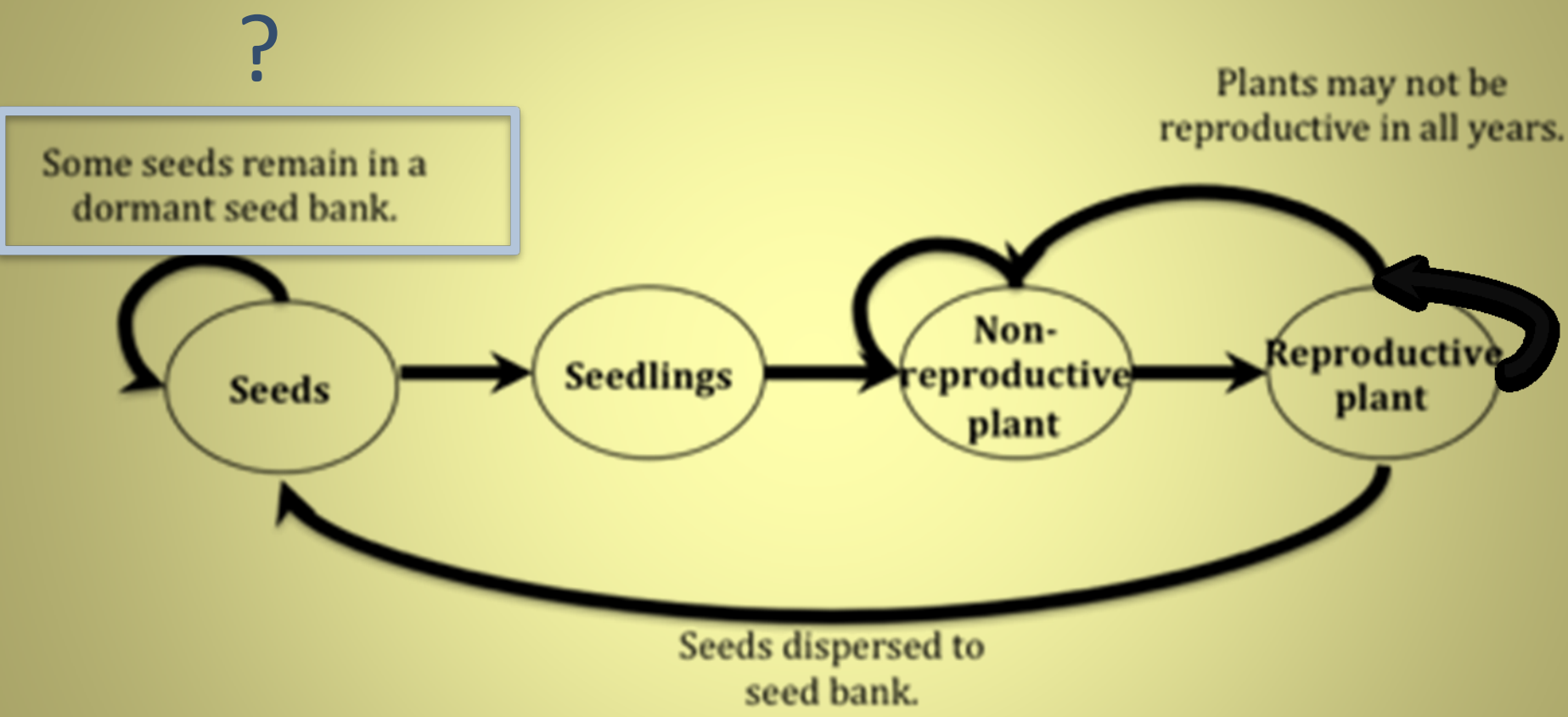

# Seed Demography

- Field dormancy experiment
  - Bury seeds at study sites
  - Determine dormancy and mortality annually
- Laboratory assessment of germination
  - Germination trials

# Model Development

- RAMAS Stage and RAMAS Metapop
  - Stage-structured PVA platform
  - Relatively straightforward
  - Has been applied successfully to both annual and perennial plants
- Leslie matrix is generated based on the mean and variance of survivorship and fecundity data for each stage and year.

# Project Challenges

- PVA models must include data on all stages of life history
  - Dependent on annual weather conditions
  - Ongoing site access and security
  - Buffer against herbivore impacts when possible
- Study time span must capture the range of variability in demographic responses
  - Ideally including wet and dry years

# Model Outcomes

- Estimated extinction threshold probability (ETP) with confidence intervals
- Assessment of the vulnerability of subpopulations of different sizes
- Identification of sensitive population parameters

  e.g. life stages that may have important effects on the probabilities of extinction or recovery.

# Interpretation of Findings

- Data will be assessed and analyzed following each field season
  - evaluate and interpret annual demographic data and its implications
- Final recommendations given after 4 years of data collection and PVA
  - Including ETP and sensitivity analysis

# Extinction threshold probability (ETP)

- Population size with less than 5% chance of further decline (towards extinction)
- Varies with factors affecting survivorship and fecundity (e.g. rainfall, simulated impacts)
- An upward shift of ETP over the project period might signal, for example:
  - Simulated impacts (e.g. shading) are a benefit and thus fewer individuals are necessary for maintaining the population
  - A given mitigation action (e.g. protection from herbivores) increases survivorship, thus fewer individuals are necessary

# Innovations and Applications

- Identify life history stages sensitive to impacts
- Compare responses of rare and common taxa
  - Evaluation of the use of PVA on desert taxa
- Provide information on cryptic life-history stages
- Inform mitigation and management strategies
- Develop synergy between PVA and habitat modeling projects

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