Landscape-Scale Habitat Restoration Approach

San Diego South County Grasslands Project:
Habitat Restoration BMP Development

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The Nature Conservancy

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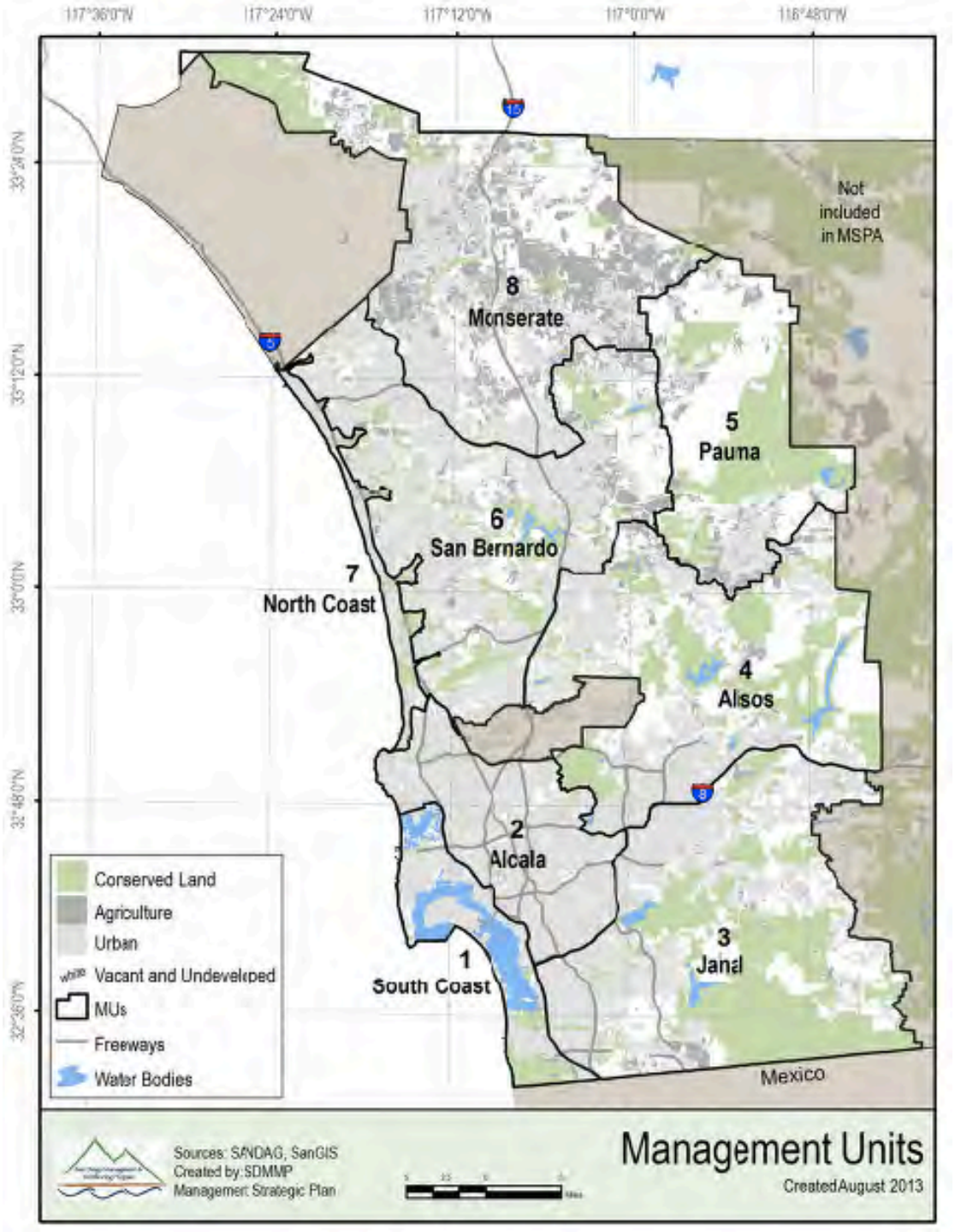
South County Grasslands Project Phases

1
- Development of Management Visions with Land Managers
- Existing Condition Surveys and Identification of Restoration Opportunities

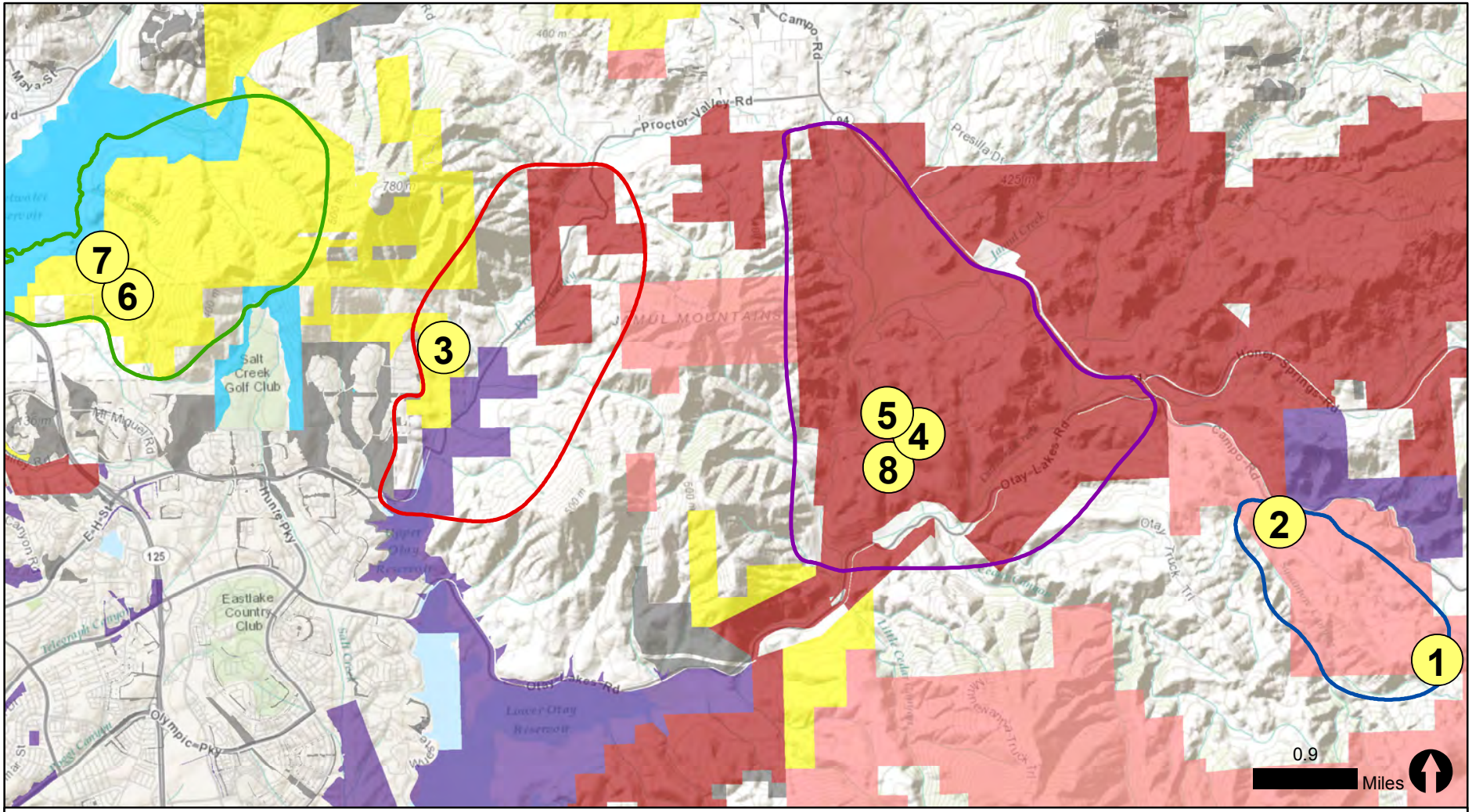
2
- Habitat Restoration Experiment Design to Test Landscape Scale Methods for South County
- Implementation of Site Preparation/Weed Management: 2013-2015

3
- Implementation Continued: Seeding Fall 2015, Maintenance Weeding 2016-2017
- First Year of Establishment Monitoring in Spring 2016
- Interim BMP Development

4
- Potential Future Phase
- Incorporate Additional Management Challenges (e.g. Grassland Livestock Grazing)
- Fifth Year (2020) or Later Establishment Monitoring of Experiment
- Updated BMPs



- Development of Grassland BMPs implements Goals and Objectives of the 2014 Management Strategic Plan for Western San Diego County



1 Restoration Sites

Study Areas

- Sweetwater Reservoir
- Proctor Valley
- Rancho Jamul Ecological Reserve
- Sycamore Canyon

Conserved Land Ownership

- BLM
- City/County
- Forest Service
- Private/Conservancy
- State
- USFWS NWR
- Water District

Landscape-Scale Habitat Restoration Approach

1. Weed Management Strategy and Principles
2. Seed-Based Habitat Restoration
3. Adaptive Management Plan for Weed Management and Habitat Enhancement/Restoration
   - Native Perennial Grasslands
   - Otay Tarplant Habitat
   - Forblands
   - Quino Checkerspot Butterfly Habitat

Habitat Management/Restoration Strategy

"Bradley Method"
Species-Based Targeted Control of Invasive Plants

Weed Management
Site-Based Management of Weed Populations

"Weed Management"

- Contain expansion of new invaders
- Protect sensitive species populations
- Reduce competition in existing plant communities

Plant Material Addition
Seeding

"Site Preparation"

- Reduce weed populations prior to addition of native plant material

Seeding and Maintenance Weeding

- Seed-limited native habitat

South County Grasslands Project Site Preparation Methods

- 2013: Initial Dethatching
- 2014 and 2015 (2-years of Site Prep)
  - Grasslands/OTP Habitat:
    - Mow 2x/yr (Mechanical Mowing)
    - Herbicide 2x/yr (Fusilade then Glyphosate-based Roundup Pro)
  - Forbland
    - Line Trim 2x/yr
    - Herbicide 2x/yr (Glyphosate-based Roundup Pro Only)
  - QCB Habitat
    - Hand Weed/Selective Line Trim 2x/yr
  - Weed Management Buffers
    - Mow 2x/yr with selective herbicide use, as needed

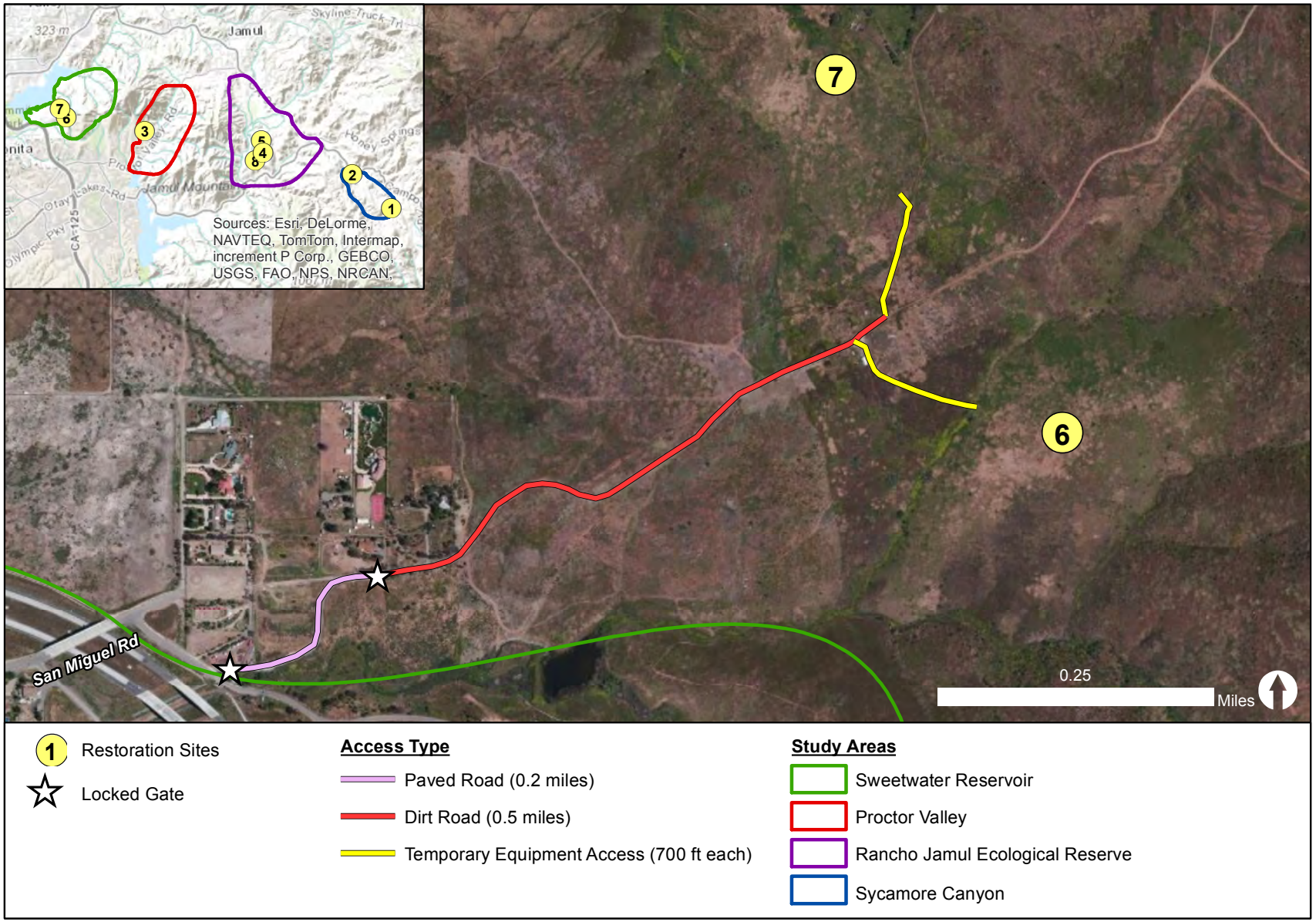
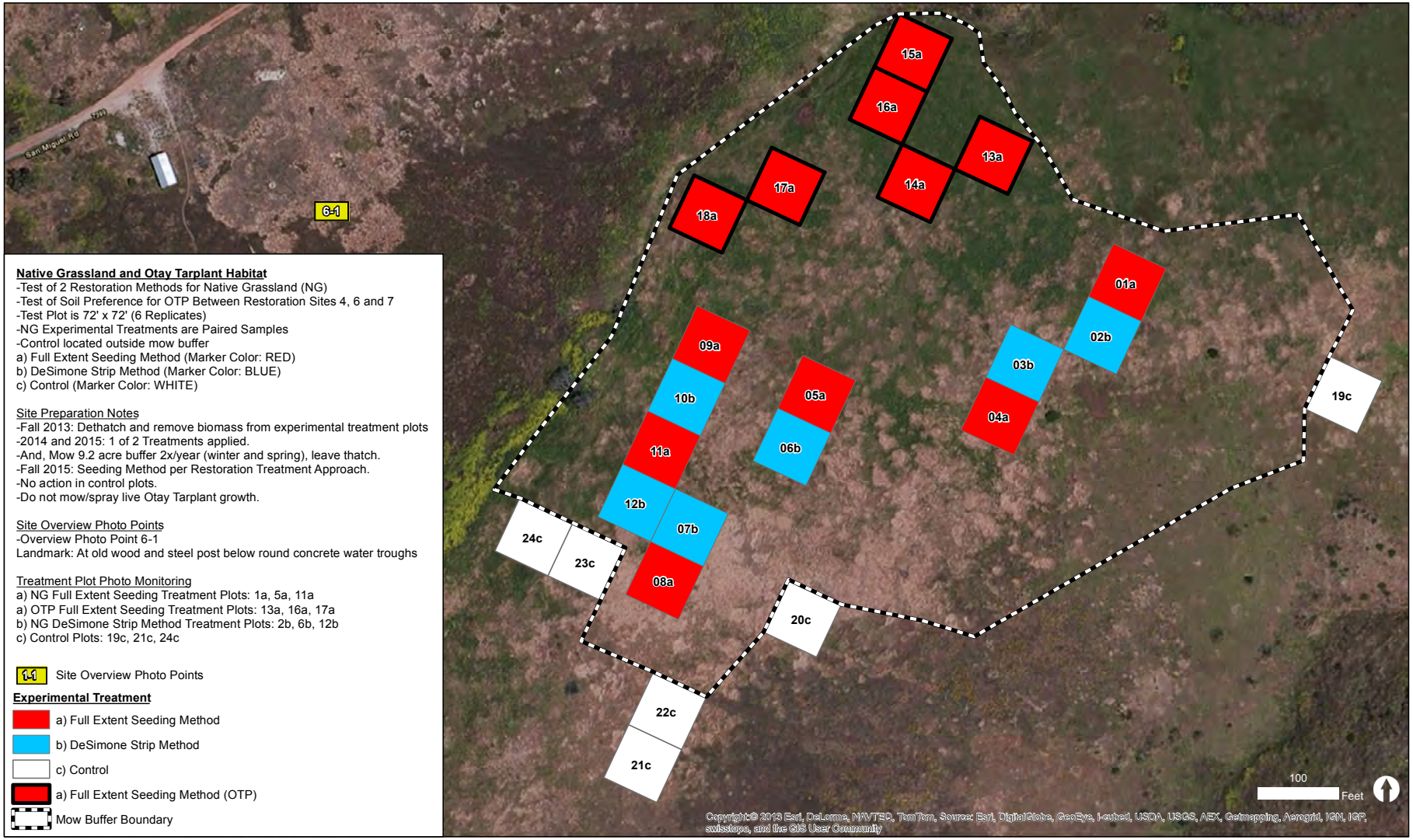


Figure 5. Sweetwater Reservoir (USFWS NWR) Access to Restoration Sites 6 and 7.



Native Grassland and Otay Tarplant Habitat
-Test of 2 Restoration Methods for Native Grassland (NG)
-Test of Soil Preference for OTP Between Restoration Sites 4, 6 and 7
-Test Plot is 72' x 72' (6 Replicates)
-NG Experimental Treatments are Paired Samples
-Control located outside mow buffer
a) Full Extent Seeding Method (Marker Color: RED)
b) DeSimone Strip Method (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 9.2 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Seeding Method per Restoration Treatment Approach.
-No action in control plots.
-Do not mow/spray live Otay Tarplant growth.

Site Overview Photo Points
-Overview Photo Point 6-1
Landmark: At old wood and steel post below round concrete water troughs

Treatment Plot Photo Monitoring
a) NG Full Extent Seeding Treatment Plots: 1a, 5a, 11a
a) OTP Full Extent Seeding Treatment Plots: 13a, 16a, 17a
b) NG DeSimone Strip Method Treatment Plots: 2b, 6b, 12b
c) Control Plots: 19c, 21c, 24c

1-1 Site Overview Photo Points

Experimental Treatment
a) Full Extent Seeding Method
b) DeSimone Strip Method
c) Control
a) Full Extent Seeding Method (OTP)
Mow Buffer Boundary

Figure 11. Sweetwater Reservoir Native Grassland and Otay Tarplant Habitat Restoration Site 6.

Site 6: Pre-Restoration in 2013

Site 6: Initial Mow/Dethatch in Fall 2013

Site 6: After 1st Treatment and Before 2nd Treatment in March 2014

Site 6: Beginning of Year 2, January 2015, Early emergence of grass; Before Treatment

Site 6: February 2015, 1st Herbicide Treatment, Year 2 (Red Plots)

Site 6: March 2015, After 1st Mow of Year, Year 2 (Blue Plots)

Site 6: March 2015, Flail Mower, 1st Mow of Year, Year 2 (Blue Plots)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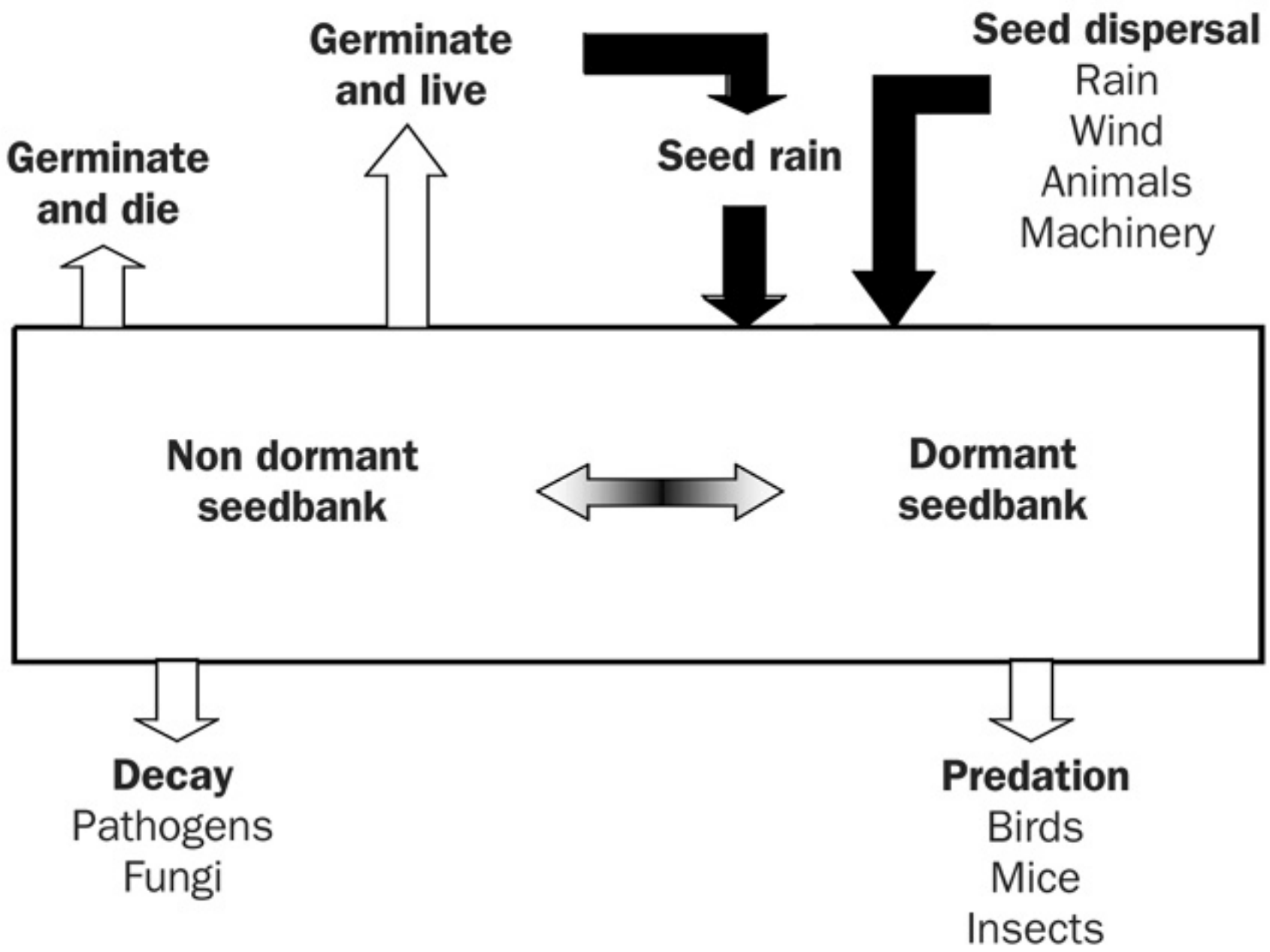
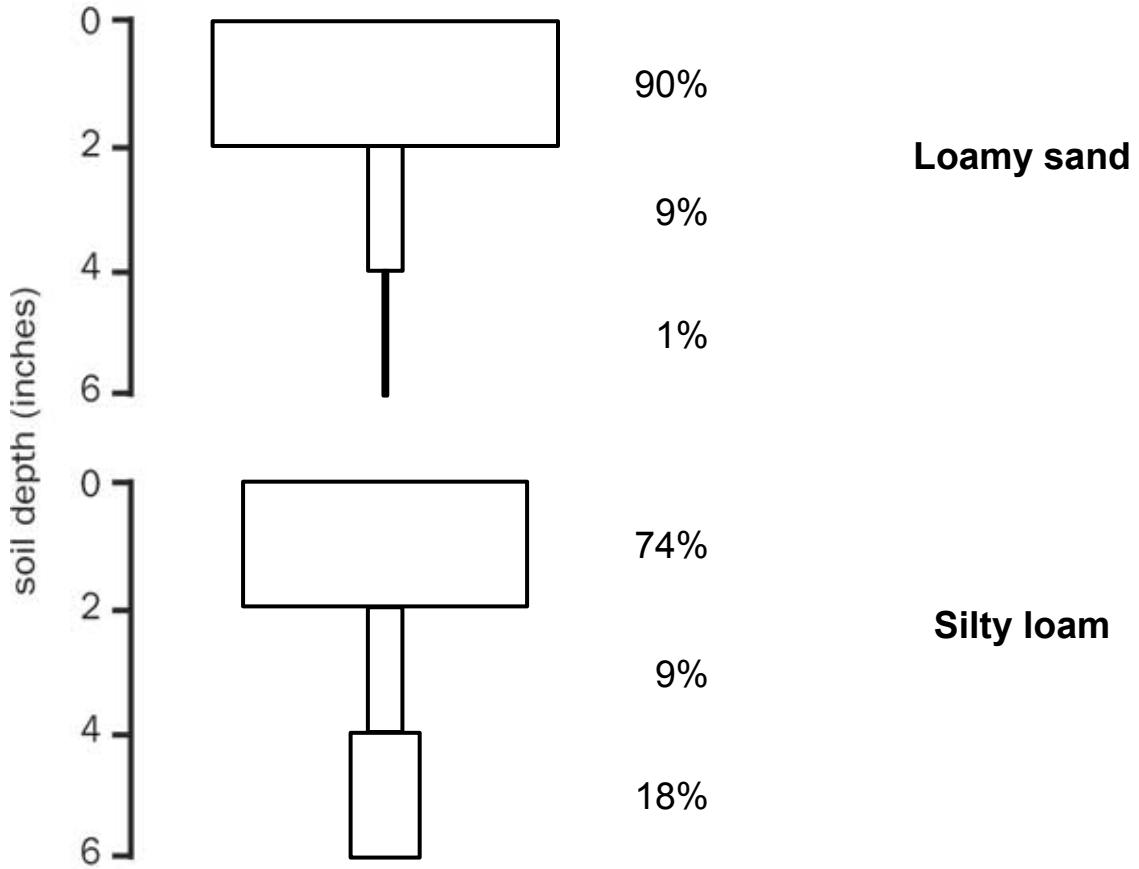
Weed Management Principles

- Natural rainfall driven “grow-and-kill” is cost-effective and necessary in many sites
  - At mercy of weather, so allow for multiple control events over several years (1-3 treatments per year).
- Control (eradicate) highly invasive species in the management area
- Weed and native seed bank population diversity and densities are unknown and variable in the landscape
- Manage weed populations, most of which are in the soil seed bank (not readily visible)
  - For example, treat non-native annuals grasses prior to “milk stage”



Source: Menalled, F and Schonbeck, M. Manage the Weed Seed Bank – Minimize "Deposits" and Maximize "Withdrawls"

Vertical Distribution of Weed Seeds



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Weed Management Principles

- What part of the weed soil seed bank can we manage?
  - Reduce germination of weed seed bank
    - Avoid significant soil disturbance during weed management
  - Reduce seed inputs from weed species
    - **Chemical control:** after germination and before seed production
    - **Mechanical control:** after germination, but large enough to be hand pulled or cut—but, before seed set
      - Hand weeding
      - Mowing
      - Line trimming

Weed Management Principles

- Selection of weed management technique from available options is site-specific
  - Land manager constraints (e.g herbicide restrictions, labor/equipment available)
  - Site-specific factors influencing weed density and composition
  - Year-specific weather factors influencing timing and expression of seed bank
- Timing is critical
  - Optimize timing of treatments guided by plant phenology and weather-driven/site-specific conditions
    - Timing in warmer and drier locations will generally occur earlier than in cooler and moister locations.
  - Weed species also differ in the seasonal timing of their germination and emergence (1-3 treatments per year; Year-specific weather):
    - Winter rain driven non-native annual grasses
    - Spring broadleaf weeds
    - Summer weeds, as needed
  - Qualitative monitoring to guide timing of treatments

Example of mowing to reduce seed inputs from non-native annual grasses

- Must grow tall enough to mow or line trim and after it begins to flower
- Must cut grass seeds before the "Milk Stage" (*Noted by the Letter M, approx. 1-2 weeks after flowering*) to ensure viable seed isn't returned to the weed seed bank.
  - If seeds reach milk stage, most of the cut grass seed will still mature (e.g 80%)

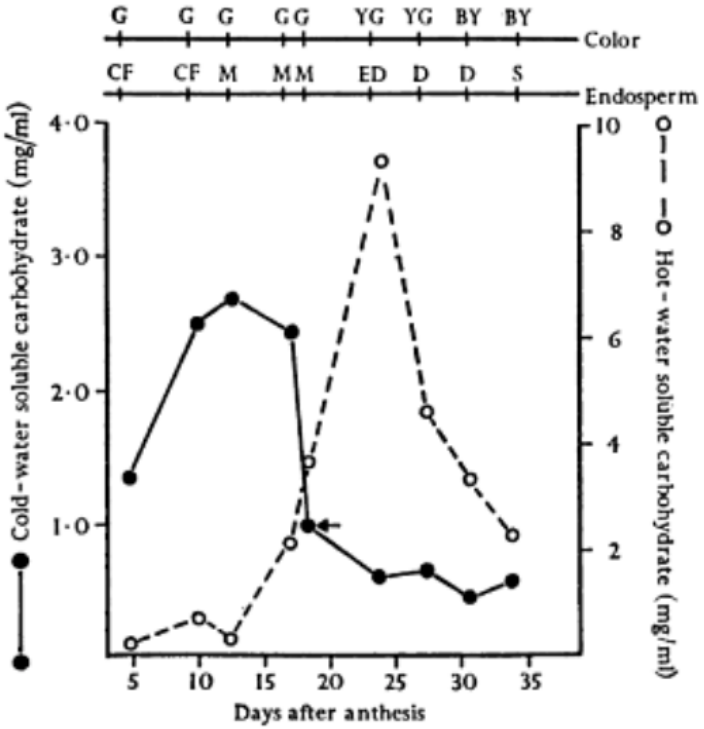


FIG. 5. Changes in cold-water soluble and hot-water soluble carbohydrates during ripening of seeds of *Lolium temulentum* L.; G, green seed coat; YG, yellow-green seed coat; BY, brown-yellow seed coat; CF, clear fluid endosperm; M, milk-stage endosperm; ED, early dough-stage endosperm; D, dough-stage endosperm; S, granular endosperm; ←, point of maximum seed viability. [From Stoddart (1966).]

Source: Stoddart, J. L. 1966. Studies on the Relationship between Gibberellin Metabolism and Daylength in Normal and Non-flowering Red Clover (Trifolium pratenseL.). J. Exp. Bot: 17 (1): 96-107.

Weed Management Principles

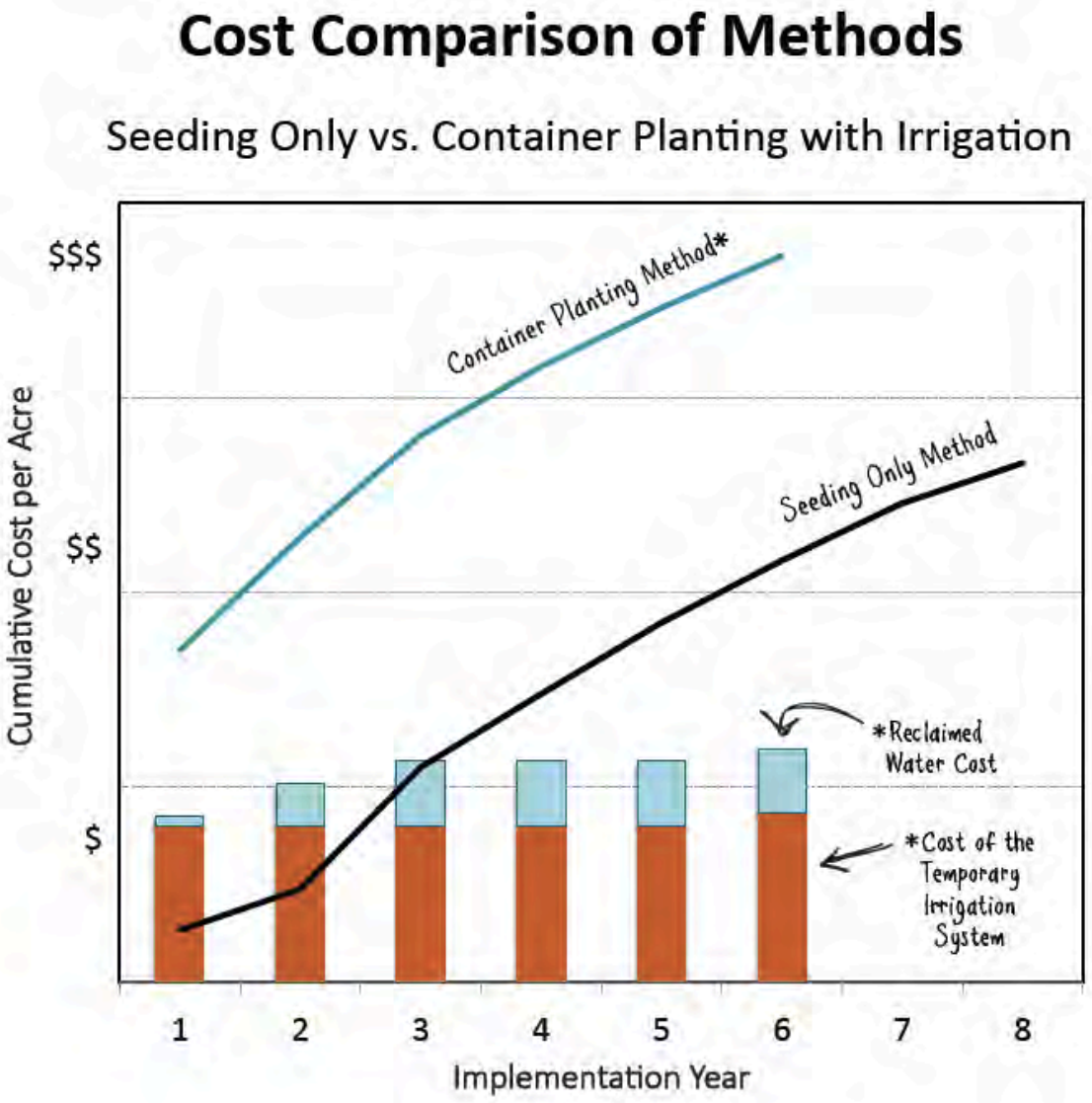
- Long-term (3+ year) commitments to weed management are most cost-effective and highest value to habitat
  - One or two year efforts are unlikely to provide sustainable benefits
  - As non-native annual grass populations and litter are controlled, they will be replaced by expression of other parts of the weed seed bank, especially broadleaf weeds
  - Weed seeds, including annual Mediterranean grasses, have longer dormancy and soil seed bank viability than reported in the literature
    - More than the 1-2 year soil viability reported in agricultural studies
  - Seed addition may be necessary to sustain benefits of weed management
  - Exceptions include stimulating sensitive annual plant species with dormant seed banks, like Otay Tarplant, by reducing thatch/litter cover in a 1 or 2 year effort
- More effective site preparation (if seeding) reduces total cost of project
  - Weeding after seeding is more labor intensive and difficult, but may be necessary if weed load is high

Seed-Based Habitat Restoration

- Why seeds?
  - Durable, storable and transportable form of plants
  - More economical than transplanting
  - Establishment from seed at restoration site can sort and screen plant species for adaptedness/suitability
- For goal of enhancing or recovering native habitat:
  - Diverse seed palettes added at appropriate densities of Pure Live Seed (PLS) per unit area (acre) facilitate greater native plant establishment
- Maximize “passive restoration” opportunities from existing seed bank sources
  - Adjust planned seed mix rates and species diversity according to what is observed during the site preparation process
  - Observe both native and non-native germination and growth as proxies for site conditions and suitable seed mixes
- Many areas are native seed-limited due to site history
  - For example, high frequency of fires, high intensity fires, high livestock grazing pressure, and competition from non-native plants

Seed-Based Habitat Restoration

- Natural rainfall driven restoration is cost-effective and feasible in many landscapes
  - Compared to temporary irrigation systems, which are a hard cost, and water costs, which are increasing and water may not be available
  - Exceptions for plants that are highly desirable and only readily introduced by transplantation



Seed-Based Habitat Restoration

- Sourcing Seeds
  - Determine biophysical region suitable for collection
  - Consider commercially grown seed to augment rates and plant functional group diversity
  - Consider seed bulking for rare species
  - Consider impact of existing populations for rare and sensitive plant species
- Seed cleaning and storage
- Seed testing
  - Purity, germination and viability
  - Adjust seeding rates to desired PLS
- Sowing
  - Drill seeding preferred, but not exclusive method
    - Imprint and Hydroseeding options
  - Hand seeding

Seed-Based Habitat Restoration

- Good seed-soil contact is important for moisture uptake to initiate germination
  - Therefore, hand seeing techniques should insure this (e.g. hand racking or cultipacker)

Site 2: November 2015

Site 2: March 2016

HABITAT RESTORATION ADAPTIVE MANAGEMENT PLAN

Site Selection

Weed Management / Site Preparation

"Restoration"

Identify seed sources

Seed collection

Seed bulking

Commercial grown seed

Seed cleaning and storage

Seed testing* and mix adjustments

**when feasible*

Fall Seed Sowing

Develop Seed mix

Ecologically appropriate site selection

- *"Know your site"*
- *Conceptual ecological niche model*
- *Habitat proxies (soil/weeds)*

Release entire site or Phased subareas with <10% weed cover (pre-control)

3-5+ years of natural rainfall "grow-and-kill"
(at least 2 non-drought years), & then annually decide if/when seed addition is necessary to meet management goal

Winter
1. Grass-specific herbicide
2. Mow (flail, rotary)
3. Line Trimmer
4. Hand Weed

+

Spring
1. Broad-spectrum herbicide
2. Mow (flail, rotary)
3. Line Trimmer
4. Hand Weed

+

Summer (as necessary)
1. Grass-specific herbicide
2. Hand Weed

Initial Dethatch
1. Mow/Mechanical
2. Goats
3. Prescribed Fire
4. Opportunistic Wildfire

1. Drill
   - *a. 2-way Full Extent*
   - *b. 1-way in Strips*
2. Hand Seed
   - *a. Hand Rake in*
   - *b. Cultipacker*
3. Seed balls
4. Hydroseed
5. Imprint

Avoid sensitive resources

Track weed phenology and cover; & native recruitment

Invasive species control and remedial weeding

Monitoring of Vegetation and Wildlife

CNPS COVER DIAGRAMS