California Tiger Salamander Biology and Conservation

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CTS Pre-Test

Which is the CTS?

- good features for a CTS breeding pond include?
- adult CTS spend ??% of the year in the water?
- where do they live on land?
- most CTS stay within 50 m of water?
- what time of year are breeding migrations?
- what is the best season for larval sampling?

California Tiger Salamander Workshop Topics

- Basics of amphibian biology and conservation
- Tiger salamanders – how is CTS unique
- CTS life cycle and identification of different stages
- Life history, demography, and population dynamics
- Predators and prey
- Habitats and ecology
- Movements, populations, metapopulations, and landscapes
- Threats
- Strategies for avoidance, minimization, conservation and recovery

Things I'd Like to Convince You of:

- The CTS is primarily a terrestrial beast
- Maintaining large areas of continuous or interconnected habitat is what's needed for its conservation
- Upland habitat is not just "aestivation" habitat
- Some CTS are present in uplands year-round
- Many CTS move hundreds of meters from ponds
- Breeding ponds must hold water until at least May
- Large ponds are critical for population sustainability
- Permanent ponds are not ideal CTS habitat
- CTS populations persist alongside many human land uses
- Habitat loss and fragmentation are the main threats

Amphibian Conservation

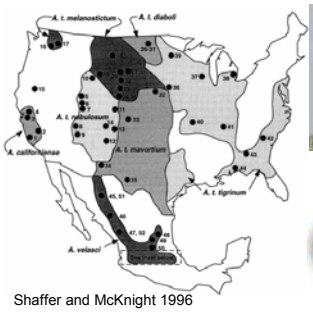
- 6644 described species (as of Mar 3)
  - 32% globally threatened (12% for birds)
  - 42% declining to some degree
- The main threat to most declining species (including the CTS) is habitat alteration
  - most need both aquatic and terrestrial habitat
  - disturbance of either can cause problems

What is a CTS

- **Amphibian**
  - aquatic eggs, thin skin
- **Salamander**
  - four legs and a tail
- **Mole salamander**
  - Family Ambystomatidae
- **Tiger salamander**
  - large terrestrial salamanders and the only group to occupy grasslands

On land, mid-level predator of insects and other invertebrates. Top aquatic predator of vernal pool ecosystems.

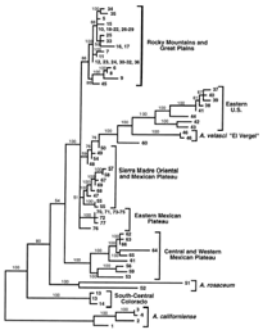
Pattern and Head Shape Differ



Shaffer and McKnight 1996
http://www2.eve.ucdavis.edu/shafferlab/

CTS larvae are smaller and are not known to become sexually mature larvae (paedomorphs)

CTS is Genetically Different



Shaffer and McKnight 1996

CTS Life Cycle and Morphology

CTS Life Cycle

Breeding Migrations
Larvae in Ponds----------
Metamorphosis----------
Juvenile Dispersal

Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep

Identification/Morphology

Get a field guide!

Identification/Morphology

- Embryos
  - Attached to vegetation or other materials
  - Attached singly or in small clusters
  - Each enclosed in an individual membrane
    - Grape-like
  - Whitish to grey to yellow
  - Detectable mainly Dec-Feb

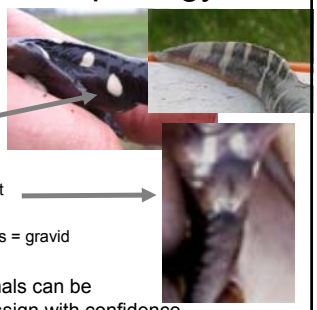
Identification/Morphology

- Larvae
  - Fish-like
  - Four legs
  - Feathery external gills
  - 30 to 150 mm
    - 1 to 6 inches
  - Color variable
  - No stripes or real pattern
  - Potentially detectable year-round

Identification/Morphology

- Breeding Adults
  - Males
    - Massively swollen vent
    - Tail fin
  - Females
    - No/minor swelling at vent
    - No prominent tail fin
    - Many visibly fat with eggs = gravid

Sex of non-breeding animals can be difficult/impossible to assign with confidence



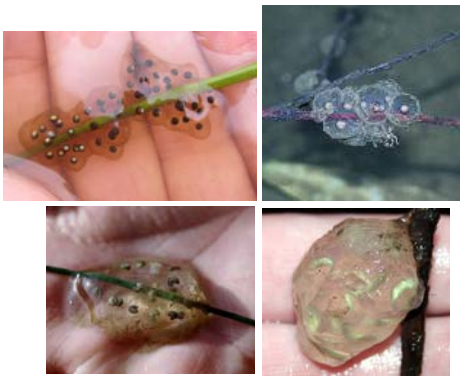
Identification/Morphology

- Metamorphs
  - Muddy color patterns
  - Remnant gill stubs
  - 100 to 150 mm long
    - 4 – 6 inches
  - Fat
- Juveniles (after 1st summer)
  - Resemble adults, but smaller
  - Adults 6-10 inches

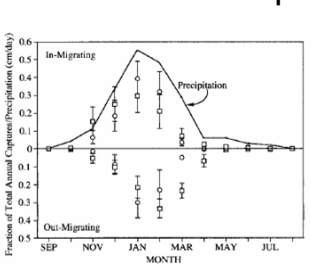
Hybrids

- Genetic test needed for conclusive ID
  - Adults with barring are suspicious
  - Giant larvae are suspect also (CTS larvae usually <6" total length)

CTS versus Hybrids

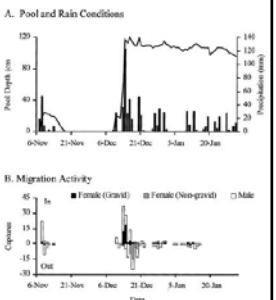


Arrival and Departure of Adults



Trenham et al. 2000

Monterey Co.

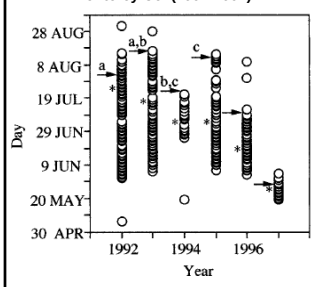


Cook et al. 2006

Sonoma Co.

Dates of Metamorph Capture

Monterey Co. (1992-1997)



Trenham et al. 2000

Contra Costa Co. (1992-1993)

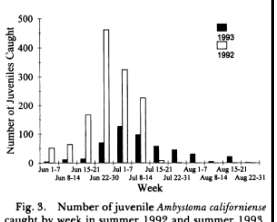


Fig. 3. Number of juvenile *Ambystoma californiense* caught by week in summer 1992 and summer 1993, Contra Costa County, California. Numbers of individuals include original captures and recaptures.

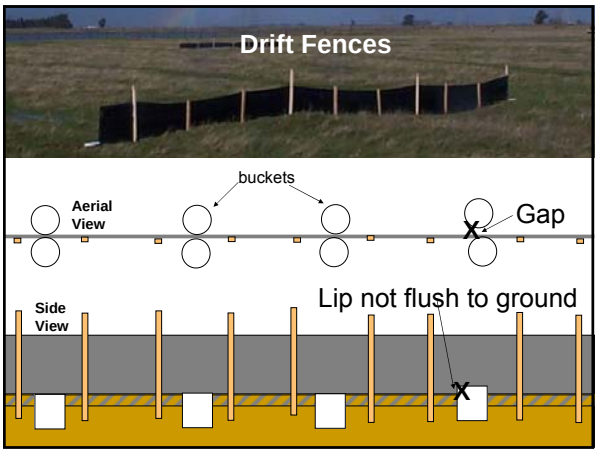
Loredo and Van Vuren 1996

Life Cycle and Morphology – Main Points

- Adults migrate to ponds during fall and winter rains
  - Present at ponds relatively briefly
- Embryos potentially detectable Nov-March
  - Eggs attached singly or in small groups
- Larvae mainly detectable March-August
  - Too small to catch before March
  - Coloration extremely variable, but no stripes
- Metamorphosis begins in May
  - Metamorphs vary wildly in color and size
  - Some present in many ponds through summer

Aquatic Sampling

- Dip nets
- Minnow Seine
- 1/8" mesh or smaller
- Move through the water quickly
- Neither works well in deep ponds



Alternate CTS Survey Methods

- Minnow traps
- Egg surveys
- Walking surveys

Sampling for CTS – The USFWS Way

- 1) Site assessment – assess upland and aquatic habitat onsite and in surrounding areas
- 2) If upland habitat only…
  - Two seasons of upland drift fence sampling
  - ≥ 1 ft tall drift fence w/ pitfalls ≥ 90% site perimeter
  - Pitfall buckets <33 ft apart, ≥ 2 gallon buckets
  - Traps opened for rain events Oct. 15 – Mar. 15
- 3) If potential breeding habitat present
  - One season upland sampling as above
  - Drift fences around potential breeding habitat
  - 2 seasons aquatic sampling for CTS larvae
    - Sample >10 days apart in March, April and May
    - Sample using dipnets and seines (if none detected in dipnets)

FWS Reports

- Provide Complete Information
  - Dates and times sampled
  - Rainfall/temperature data for area during study period
  - Records of all animals captured
  - Photographs of representative specimens
  - Photographs of sampling apparatus
  - Records of all communications with FWS
  - For aquatic sampling calculations of the total effort expended/area covered each time

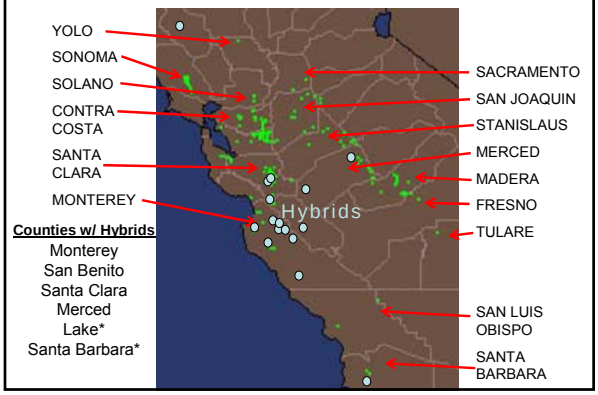
CTS Distribution

USGS ARMI Atlas

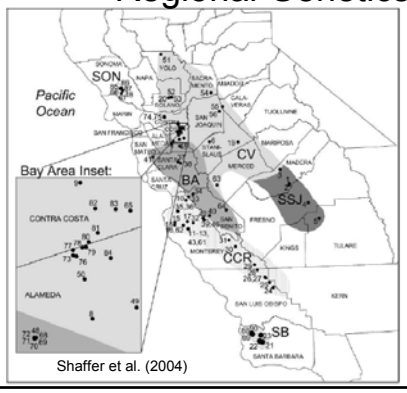
CaliforniaHerps.com

CA Dept. of Fish and Game

CTS Distribution



Regional Genetics



Shaffer et al. (2004)

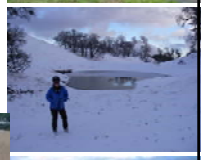
Six Clades:
Sonoma

Santa Barbara

Central Valley
Bay Area
S. San Joaquin
C. Coast Range

Habitat Basics

- Aquatic Habitat
  - Ponds*
  - Vernal Pools*
  - Ditches
  - NOT streams
- Upland Habitat
  - Grassland*
  - Oak savanna*
  - Oak woodlands
  - Sometimes chaparral and shrublands
  - NOT forest


Aquatic Habitat – Important Issues

- Vernal pools/sag ponds (natural habitat)
  - Constructed ponds (more common today)
- Hydroperiod
  - Must persist into May (July or August better)
  - Permanent ponds often unsuitable due to predators
- Pool area and depth
  - Bigger pools = more metamorphs
  - Deeper pools = >hydroperiod
- Vegetation? Water quality?
  - Little is known
- Prey and predators

Aquatic Prey and Predators

- Prey
  - Zooplankton
  - Crustaceans
  - Insect larvae
  - Chorus frog tadpoles
  - Newt larvae
  - CTS larvae
- Predators
  - Herons
  - Avocets
  - Terns
  - CTS larvae
  - Insect larvae*
  - Adult newts*
  - Fish*
  - Crayfish*
  - Bullfrogs*
  - *the problem with permanent ponds!

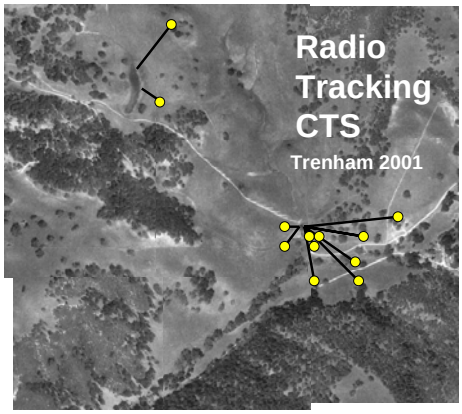
CTS and Small Mammal Burrows

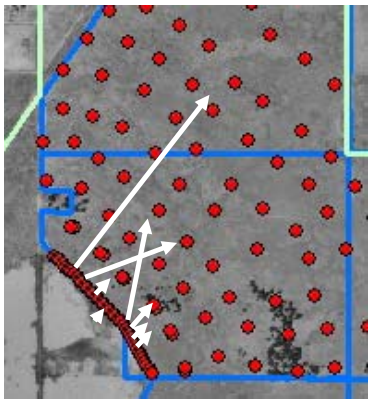



FIBER-OPTIC VIDEO
courtesy of Michael Van Hattem

Upland Habitat Basics

- After metamorphosis, CTS are almost always underground
- Occupy mainly ground squirrel and gopher burrows
  - Emerge to move to pond or another burrow
  - Emerge only at night, usually when raining
- Aestivation has not been documented
- Most do not remain near edge of pond



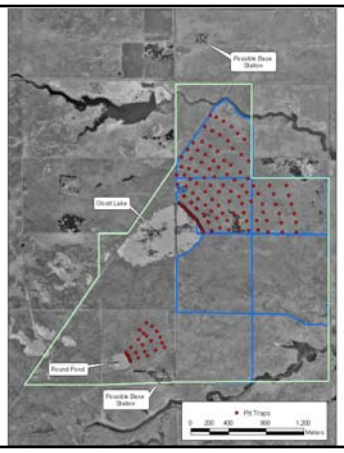


Jepson Prairie
Solano County

CTS Study Area

2008 Radio Tracking

Adult males tracked after leaving pond

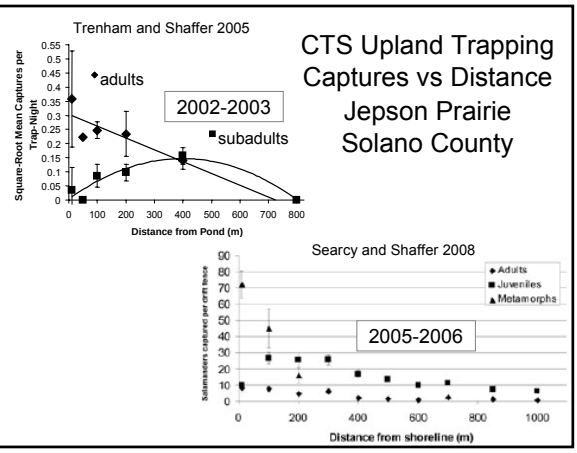


Jepson Prairie
Solano County

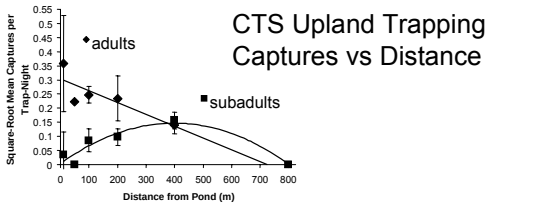
CTS Study Area

Trapping Studies

2002-2008

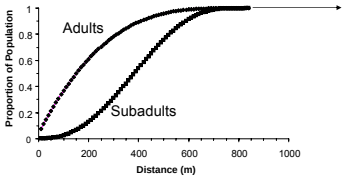


CTS Upland Trapping Captures vs Distance
Jepson Prairie
Solano County

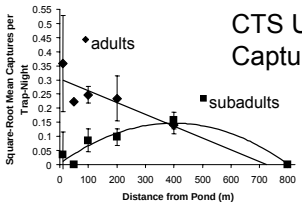


CTS Upland Trapping Captures vs Distance

Predicted Upland Distributions



Trenham and Shaffer 2005



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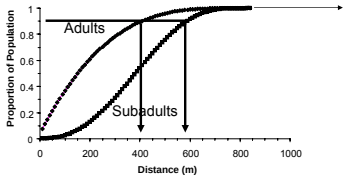
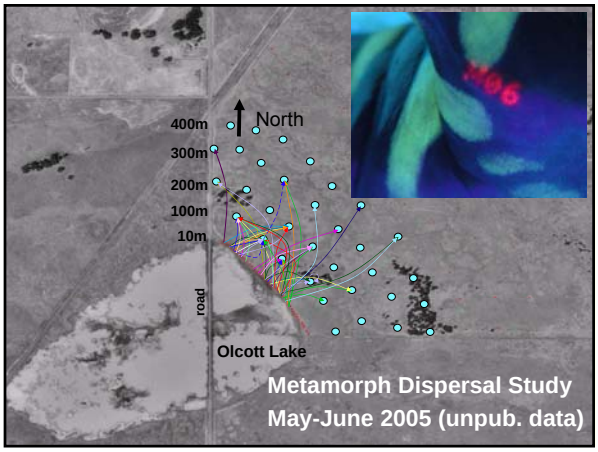
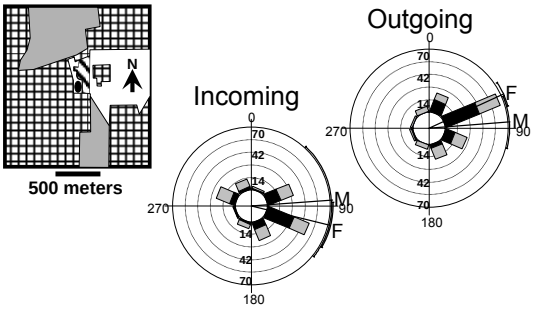


Trenham and Shaffer 2005



Southwest Park Study – Urban CTS



Trenham and Cook (2008)

Habitat Main Points

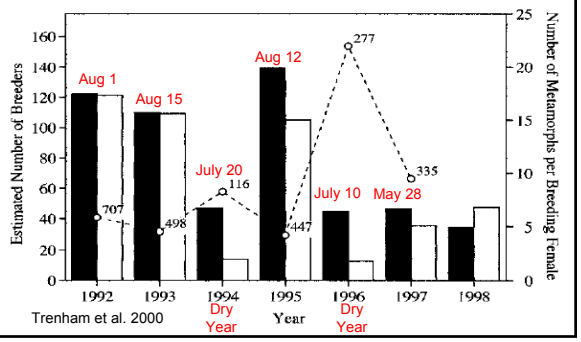
- Breeding habitat is ponds
  - Ponds must hold water until at least May
  - Permanent ponds are not good habitat
  - Small ponds produce fewer metamorphs
- Uplands are the primary CTS habitat
  - Live underground in mammal burrows
  - Come to surface rarely
  - They do not stay at the edge of the pond

Demography

- Embryos = 800 per female
- Embryonic survival = 0 - 5%
  - also limited by density
  - Max <5 per square meter
- Post-metamorphic survival
  - Year 1 ~ 50%
  - Later ~ 70% per year

Monterey Study

Breeding Adults: M=black; F=white
Metamorphs per Female = line

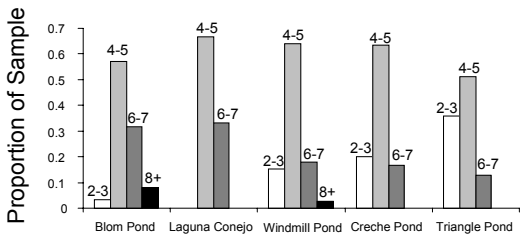


Trenham et al. 2000

Pond Size Influences Productivity

- Blom Pond, Monterey County
  - 116 to 707 metamorphs (average = 400)
- Loredo Study Pond, Contra Costa County
  - 1248, 481, and 3 metamorphs (average = 571)
- Jepson Prairie, Solano County
  - Olcott Lake ~2400 – ~3200 captured in 400 m fence
  - Round Pond ~200 – ~2700 captured in 100 m fence
- All other factors equal – larger pools support larger populations! – but hydroperiod is key!

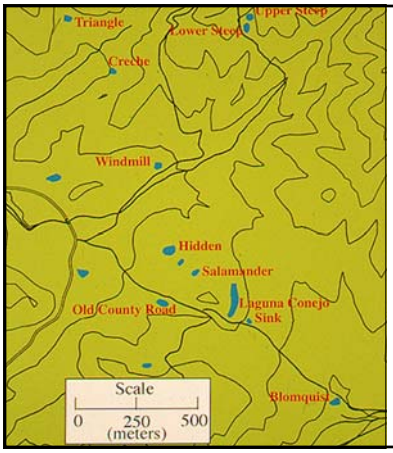
Age of Adults Varies Between Ponds
-5 ponds in Monterey County-



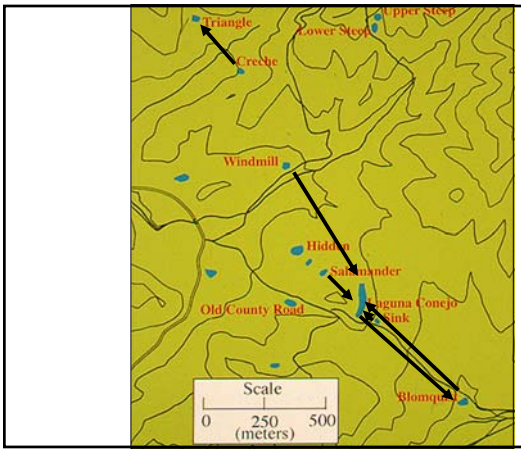
Trenham (unpub. data)

Demography – Main Points

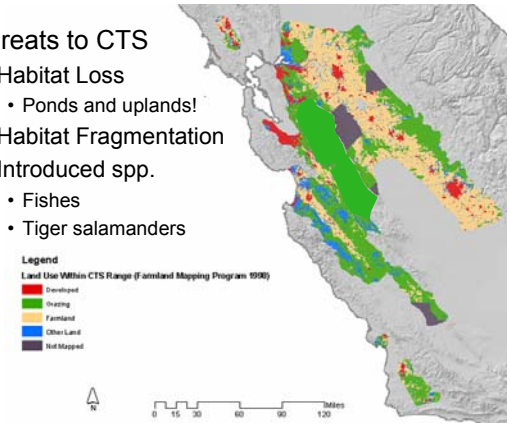
- CTS are capable of producing large numbers of offspring, given the right habitat conditions
- Some individuals can live 10+ years
  - Most don't ever make it to metamorphosis
- Population size is much more sensitive to upland survival than to larval survival
- Given good habitat, even single breeding ponds may be able to support viable populations, but is this what we want?



- Landscape Ecology
  - Most move <600 m
  - Dispersers appear to go 1-2 km
  - ~20% dispersed between ponds



- Threats to CTS
  - Habitat Loss
    - Ponds and uplands!
  - Habitat Fragmentation
  - Introduced spp.
    - Fishes
    - Tiger salamanders



The Livermore example
- Livermore Valley historically had abundant habitat
- Now reduced and extremely fragmented
- Nearby quality occupied habitat remains
- Opportunities for meaningful conservation

- Los Vaqueros (20k acres)
- East Bay Parks (98k acres)
- Henry Coe SP (87k acres)
- Fort Ord BLM (7k acres)
- Palo Corona (10k acres)
- San Luis NWR (>100k acres)
- UC Merced (5k acres)
- Howard Ranch (12k acres)
- Sonoma Co (<1k acres)
- Santa Barbara Co (<1k acres)

Conservation Strategies

- Protect occupied landscapes
  - Ideally >>1000 acre blocks; minimally 100 acres
- Maintain/promote habitat connectivity
  - Minimize effects of new or improved roads
  - Potential barriers: aqueducts and canals, agricultural fields, landfills, other ideas?
- Other approaches
  - Creating/enhancing habitats
  - Compensation through conservation banks
  - Barriers or tunnels to keep them off roads
  - Salvage/translocation (disease is a BIG concern)

Avoidance and Minimization

- Habitat Management Issues: disking, mowing, burning, trenching, herbicides, mammal control, pond repair, road maintenance, irrigation, etc.
- Upland habitats
  - Avoid mammal burrows if possible
  - Limit activities to daylight hours
  - Limit activities to dry season
  - Disturb only part of site at a time
  - Do not poison small mammals
- Aquatic habitats
  - Only conduct work after pond has dried
- Develop the beneficial effects of projects

Managing Habitat for CTS

- Aquatic
  - Create additional ponds
  - Eliminate predators by drying
  - Modify/manage pond to make long lasting, but ephemeral
  - Maintain existing berms/remove excessive siltation
  - Allow livestock grazing (esp. vernal pools)

Managing Habitat for CTS

- Uplands
  - Maintain habitat connectivity
  - Maintain natural habitat near breeding ponds
  - Maintain burrowing mammal populations
  - May be able to enhance mammal habitat (e.g., creating mounds)
  - Effects of grazing unknown, but likely positive

CTS Basics - Review

- Aquatic Habitat – breeding
  - Ponds should be temporary (Why?)
  - Bigger longer lasting ponds are better
- Upland Habitat – the rest of their lives
  - On land occupy small mammal burrows
  - 3-5 year subadult phase (Where do they live?)
  - Move hundreds of meters from ponds
- Landscape Considerations
  - More ponds = more security against local extinction
  - Ideally want ponds separated by <1-2 km
- Weather/Rainfall
  - drives migrations and population dynamics

Additional Issues – Discussion Topics

- Monitoring CTS populations
- Metapopulation dynamics
- Geographic variability
- Climate variation
- Hybrids
- Mosquitofish
- Species range
- CNDDB records