

## California Tiger Salamander Biology and Conservation



Pete Trenham  
ptrenham@yahoo.com



## 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

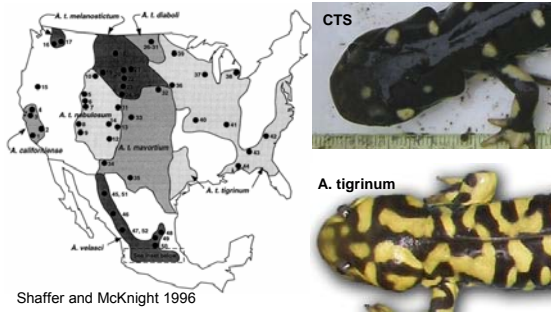
## What is a CTS

- **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

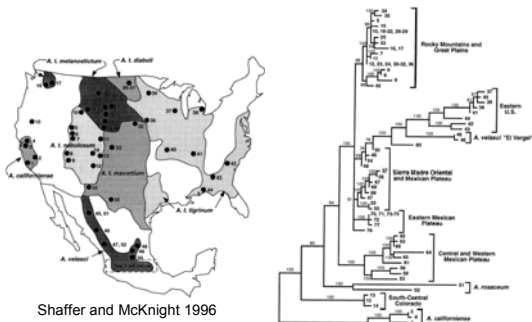


Shaffer and McKnight 1996  
<http://www2.eve.ucdavis.edu/shafferlab/>

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

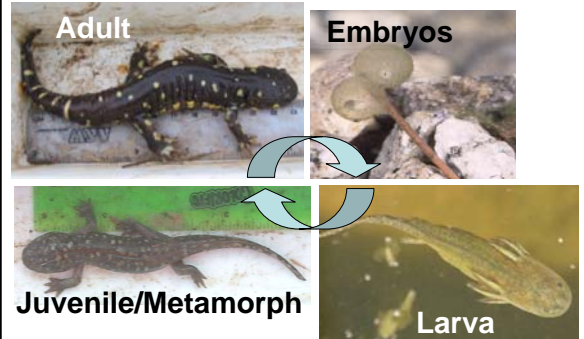


## CTS is Genetically Different

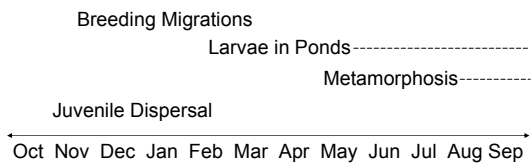


Shaffer and McKnight 1996

## CTS Life Cycle and Morphology



## CTS Life Cycle




## Identification/Morphology




### 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 1<sup>st</sup> summer)
  - Resemble adults, but smaller
  - Adults 6-10 inches




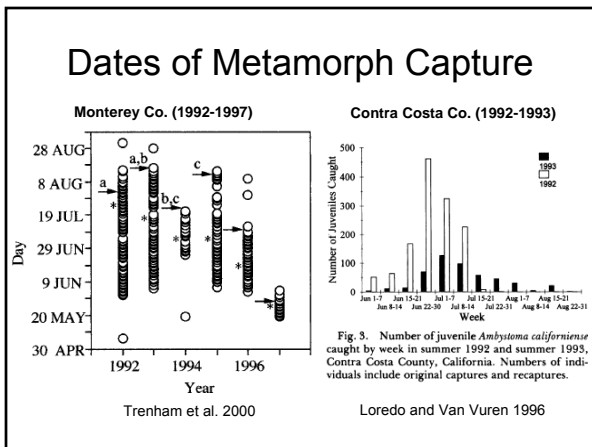
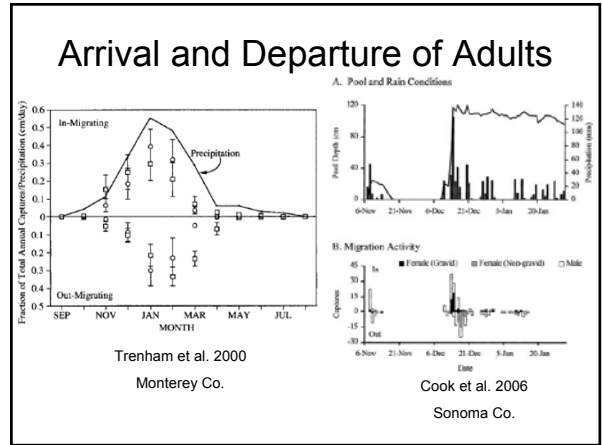
### Hybrids

- 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





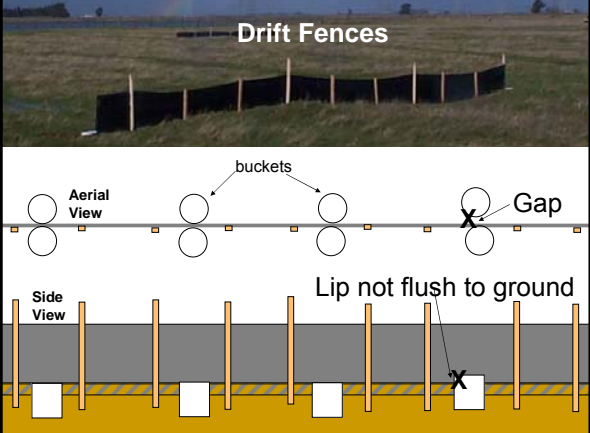
- ### Life Cycle and Morphology – Main Points
- Adults migrate to ponds during fall and winter rains
    - Present at ponds relatively briefly
  - Embryos potentially detectable Nov-March
    - Eggs attached singly or in small groups
  - Larvae mainly detectable March-August
    - Too small to catch 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

### Drift Fences



The diagram illustrates the setup of drift fences. The top part shows an aerial view of a line of buckets connected by a fence, with a 'Gap' indicated by an 'X'. The bottom part shows a side view of the fence posts, with a label 'Lip not flush to ground' and an 'X' indicating a problem with the fence's contact with the ground.

### Alternate CTS Survey Methods



- Minnow traps
- Egg surveys
- Walking surveys

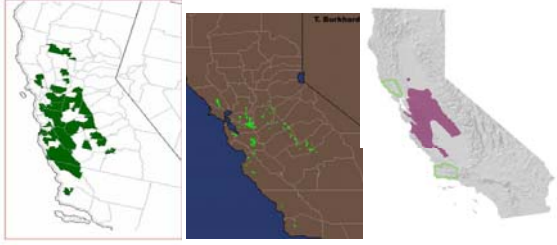
### Sampling for CTS – The USFWS Way

- 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
  - $\geq 1$  ft tall drift fence w/ pitfalls  $\geq 90\%$  site perimeter
  - Pitfall buckets  $< 33$  ft apart,  $\geq 2$  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

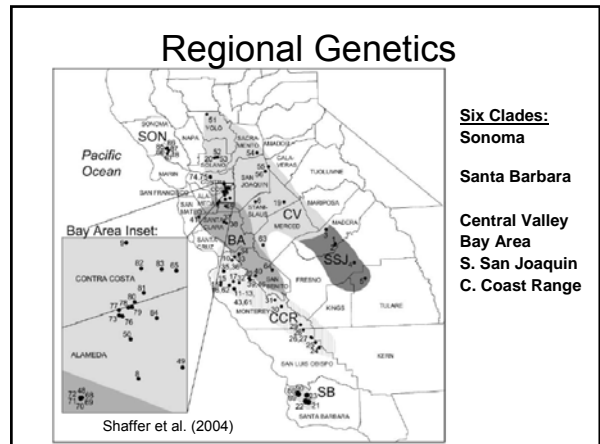
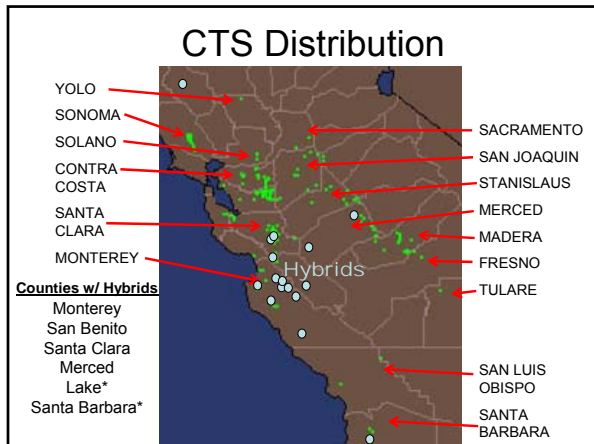
- Provide Complete Information
  - Dates and times sampled
  - Rainfall/temperature data for area during study period
  - Records of all animals captured
  - Photographs of representative specimens
  - Photographs of sampling apparatus
  - Records of all communications with FWS
  - For aquatic sampling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

### CTS Distribution



The maps show the distribution of CTS in California. The first map (USGS ARMI Atlas) shows green dots in the northern and central regions. The second map (CaliforniaHerps.com) shows a more detailed distribution with green dots and a shaded area. The third map (CA Dept. of Fish and Game) shows a shaded area in the northern and central regions.

USGS ARMI Atlas      CaliforniaHerps.com      CA Dept. of Fish and Game



### 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\*

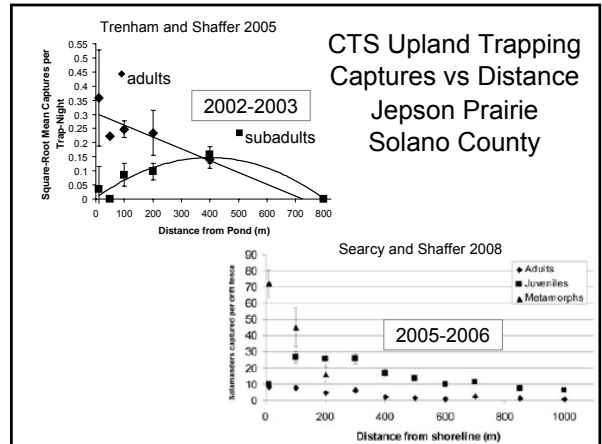
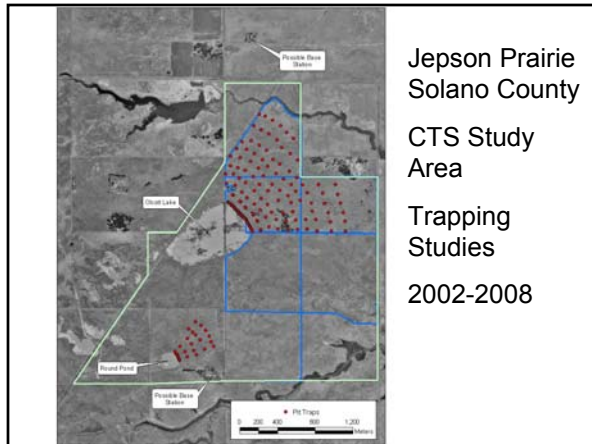
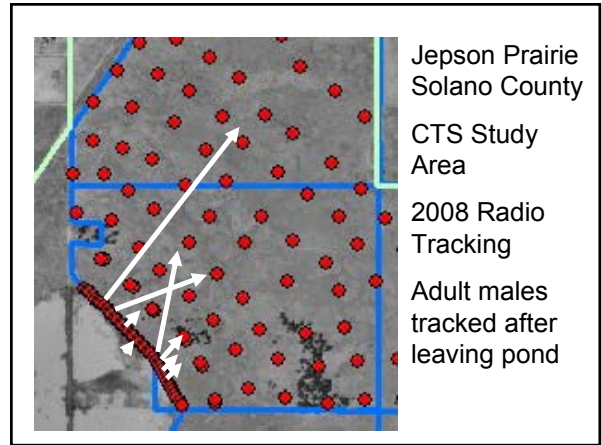
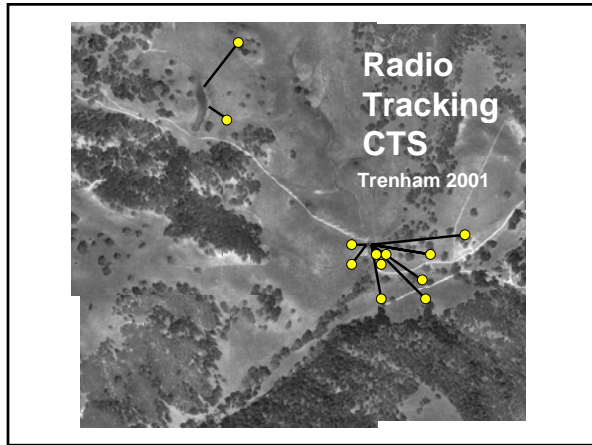
\*the problem with permanent ponds!

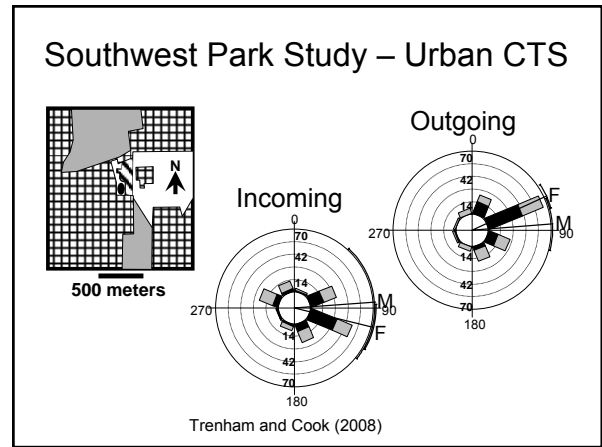
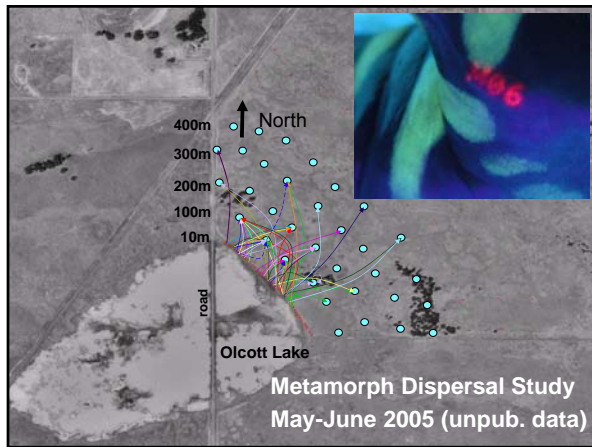
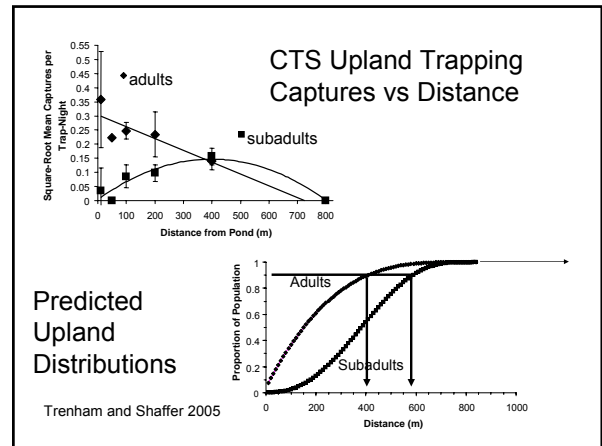
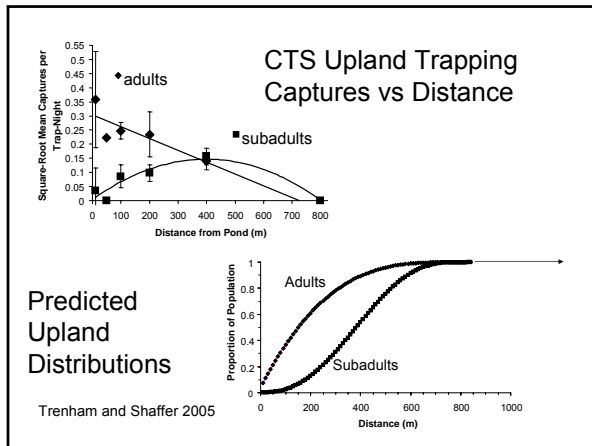
### CTS and Small Mammal Burrows

FIBER-OPTIC VIDEO  
courtesy of Michael Van Hatten

### 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

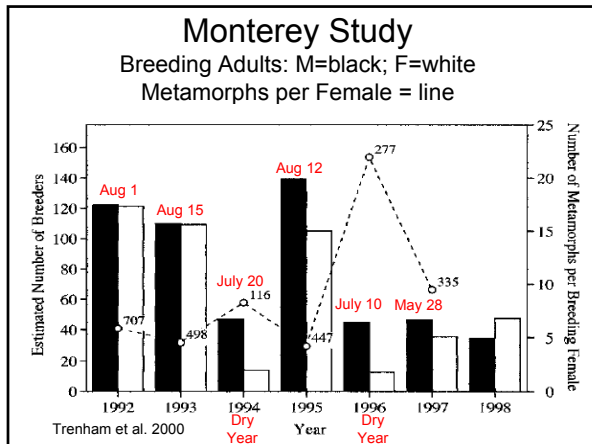




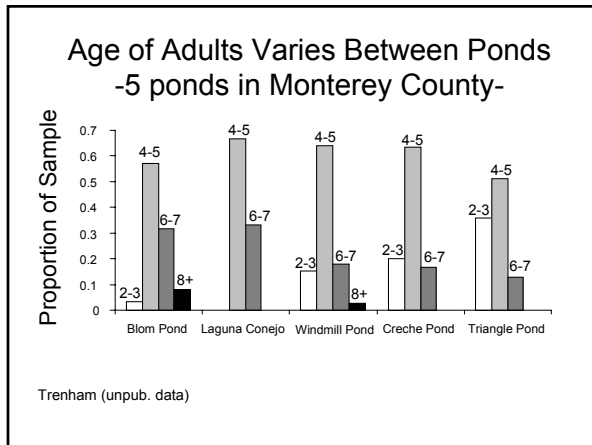
- ### Habitat Main Points
- Breeding habitat is ponds
    - Ponds must hold water until at least May
    - Permanent ponds are not good habitat
    - Small ponds produce fewer metamorphs
  - Uplands are the primary CTS habitat
    - Live underground in mammal burrows
    - Come to surface rarely
    - 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

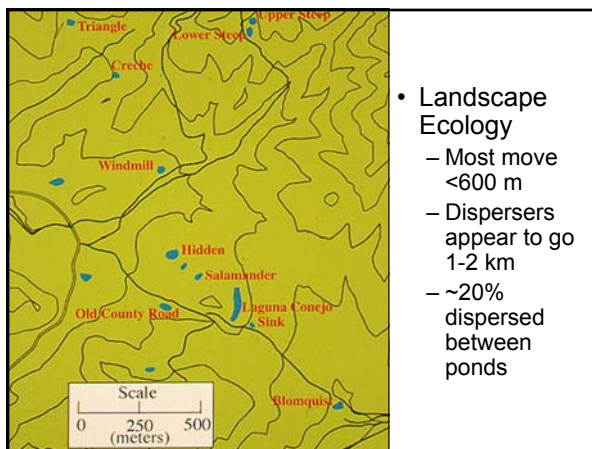




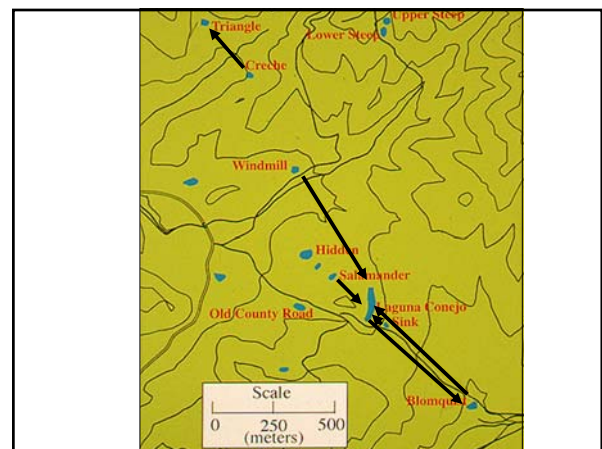
- ### Pond Size Influences Productivity
- Blom Pond, Monterey County
    - 116 to 707 metamorphs (average = 400)
  - Loredo Study Pond, Contra Costa County
    - 1248, 481, and 3 metamorphs (average = 571)
  - Jepson Prairie, Solano County
    - Olcott Lake ~2400 – ~3200 captured in 400 m fence
    -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

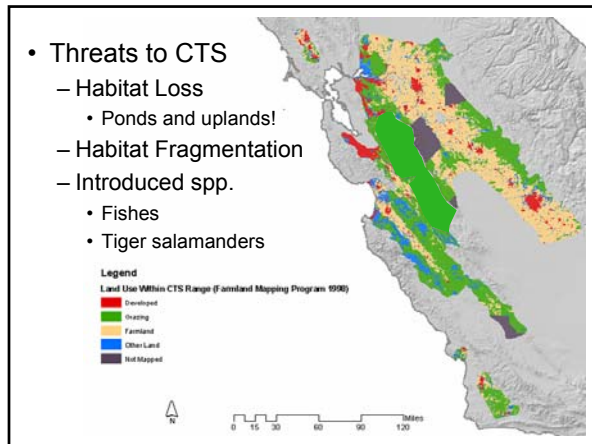


- ### Demography – Main Points
- CTS are capable of producing large numbers of offspring, given the right habitat conditions
  - Some individuals can live 10+ years
    - Most don't ever make it to metamorphosis
  - Population size is much more sensitive to upland survival than to larval survival
  - 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





### 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
- CNDDDB records