

## CALIFORNIA RED-LEGGED FROG WORKSHOP



Trish Tatarian, M.Sc. and Greg Tatarian

## BIOGRAPHY *Trish Tatarian*

CRF Researcher - 14 years

- ❖ CRF Radio-telemetry - Sierran and Inland
- ❖ Bd occurrence in Sierran CRF populations
- ❖ Genetic composition of Sierran populations

Biological consultant - 24 years

## BIOGRAPHY *Greg Tatarian*

CRF Research - 6 years

- ❖ CRF Radio-telemetry
- ❖ Bd occurrence in Sierran CRF populations
- ❖ Bat Specialist - banding, telemetry, roosts, mitigation

Biological Consultant - 24 years

## ACKNOWLEDGEMENTS

Norm Scott and Galen Rathbun  
U. S. Fish and Wildlife Service  
U.S. Forest Service  
East Bay Regional Park District  
East Bay Municipal Utility District  
California Department of Transportation  
U. S. Geological Survey  
California State Parks

## ACKNOWLEDGEMENTS

Elkhorn Slough Coastal Training Program  
Grey Hayes

Elkhorn Ranch  
Pedro Rodriguez

San Francisco Bay National Estuarine  
Research Reserve

AND YOU - THE ATTENDEES!

## TODAY'S SCHEDULE

0800-1200 Lecture  
1200-1230 Lunch  
1230-1430 Lecture & Demonstrations  
1530-1800 Field Demonstrations  
1830-2000 Dinner Break  
2000-2400 Nighttime Instruction

## ADDITIONAL INFORMATION

ELKHORNSLOUGHCTP.ORG

Bibliography  
Peer-reviewed papers

## GOALS FOR THIS WORKSHOP?

- ❖ Gain better understanding of CRF biology and ecology
- ❖ Insights into management concerns, techniques and solutions
- ❖ Learn how to conduct Site Assessments
- ❖ All/most: Learn how to conduct Protocol CRF Surveys
- ❖ Some/few: obtain a U.S.F.W.S. individual research permit - 10(A)1(a)
- ❖ Improve field biology skills

## MANAGING EXPECTATIONS

- ❖ This workshop does not present ALL research and management of CRF
- ❖ Use the concepts, biological information, and specific examples to gain broader and deeper understanding, however;
- ❖ Site-specific or project-specific questions by attendees are limited to available time, applicable experience of presenters
- ❖ NOT a CEQA or NEPA permitting workshop, but we can offer experience and insights as consultants

## KEEP IN MIND...

- ❖ Listed species - no take of individuals
- ❖ Manage on a site-by-site basis
- ❖ Information presented here provides some tools for management of species
- ❖ Variations in habitat use by bioregion determines each project analysis

## MAJOR DISCUSSIONS Part One

- Taxonomy, Phylogeny
- Distribution
- Effects of Mediterranean Climate
- Biology
- Population Data
- Habitats

## MAJOR DISCUSSIONS Part Two

- Movements
- Population Biology
- Extinction Sequence
- Threats
- Management
- Regulatory

# TAXONOMY PHYLOGENY IDENTIFICATION NOMENCLATURE

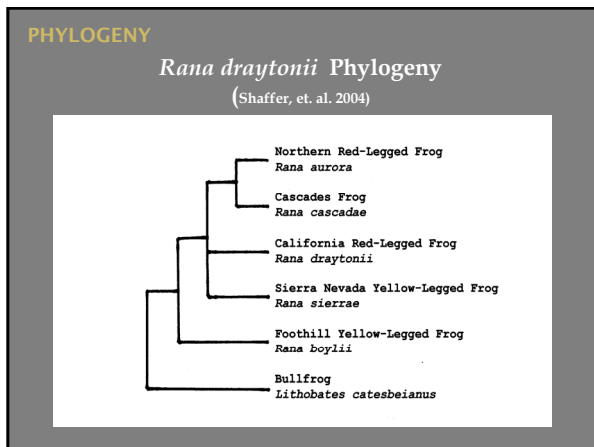
## TAXONOMIC CHANGES

Sierran Treefrog  
*Hyla regilla* >> *Pseudacris sierra*

Western Toad  
*Bufo boreas* >> *Anaxyrus boreas*

Bullfrog  
*Rana catesbeiana* >> *Lithobates catesbeianus*

California Red-legged Frog  
*Rana aurora draytonii* >> *Rana draytonii*

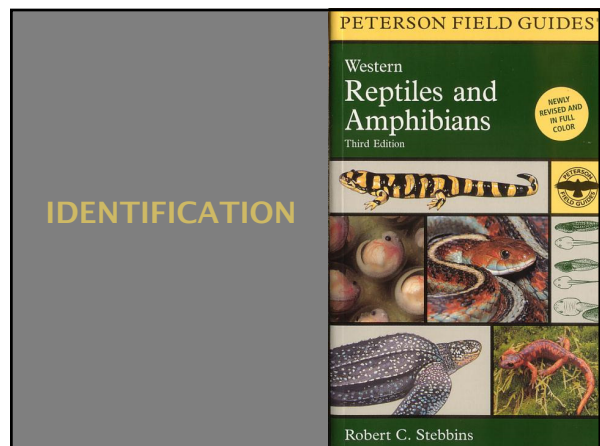


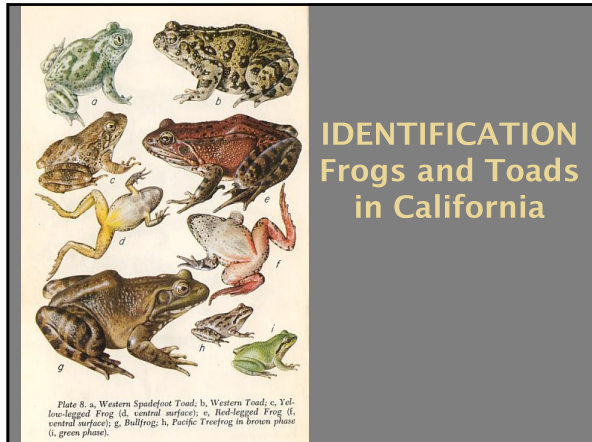
PHYLOGENY

Phylogeny - looks can be deceiving

	<i>Rana aurora</i>	<i>Rana draytonii</i>
Male size	65 mm	116 mm
Female size	93	138 mm
Calling position	Underwater	Above water surface
Egg position	Below surface	At surface

- IDENTIFICATION
- Nomenclature
- ❖ Age
  - ❖ Egg
  - ❖ Embryo
  - ❖ Tadpole (Larva)
  - ❖ Metamorph
  - ❖ Froglet
  - ❖ Juvenile
  - ❖ Adult





**IDENTIFICATION AND  
DIFFERENTIATION**

Critically Important for Protection of  
Individuals and Populations

*WHY?*

**IDENTIFICATION**

Foothill  
Yellow-Legged  
Frog  
*Rana boylei*

**IDENTIFICATION**

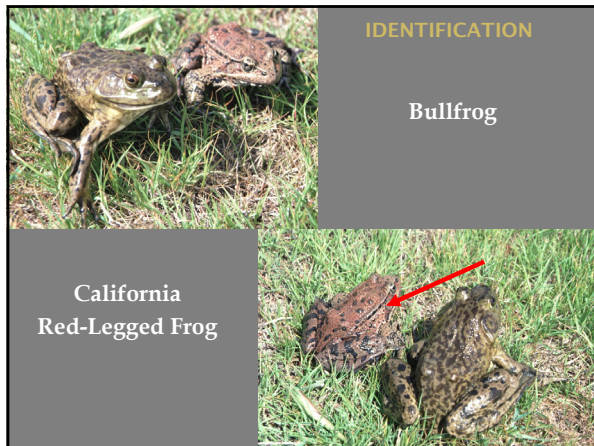
Sierra Nevada Yellow-legged Frog  
*Rana sierrae*

**IDENTIFICATION**

Sierran Treefrog  
*Pseudacris sierra*

**IDENTIFICATION**

Bullfrog  
*Lithobates  
catesbeianus*



## DIFFERENTIATING FEATURES Adults

- ❖ *Rana draytonii*
- ❖ *Lithobates catesbeianus*
- ❖ *Rana boylei*
- ❖ *Pseudacris sierra*



IDENTIFICATION

Bullfrog Egg Mass



IDENTIFICATION

Bullfrog Egg Mass



IDENTIFICATION

Treefrog Egg Mass



IDENTIFICATION

Treefrog Egg Mass



**IDENTIFICATION**

**Gosner Embryo/Tadpole Staging System**

Stage 1= Undivided fertilized egg  
 Stage 26 = Hind leg bud apparent  
 Stage 46 = Metamorphosis complete

*(Gosner 1960)*

**IDENTIFICATION**

California Red-Legged Frog

**IDENTIFICATION**

**Tadpole Comparisons**

WESTERN TOAD

RED-LEGGED FROG

PACIFIC TREEFROG

**IDENTIFICATION**

Western Toad Tadpole

**RELATIVE LOCATION OF EYES**

Treefrog Red-Legged Frog

**IDENTIFICATION**

**BODY PROFILES**

Red-Legged Frog Tadpole

Bullfrog tadpole

**IDENTIFICATION**

**IDENTIFICATION**

## TADPOLE COMPARISONS

	Bullfrog	Red-legged
<b>Hatching period</b>	April - September	December - April
<b>Overwinter</b>	Sometimes	Sometimes
<b>Color</b>	Greenish-yellow with dots, white ventral	Brown dorsal, pinkish ventral
<b>Size</b>	Larger than most, up to 8 in.	Up to 4 in.

**IDENTIFICATION**

## DIFFERENTIATING FEATURES Larvae

- ❖ *Rana draytonii*
- ❖ *Lithobates catesbeianus*
- ❖ *Rana boylei*
- ❖ *Pseudacris sierra*

**IDENTIFICATION**

## Call Comparisons: California red-legged frog vs. American bullfrog

(Davidson 1995)

*R. draytonii*

*R. draytonii*

*L. catesbeianus*

## CALIFORNIA RED-LEGGED FROG BIOLOGY

**BIOLOGY**

### Annual Cycle

*Hatching to Juvenile Stage (0-6 mos.)*

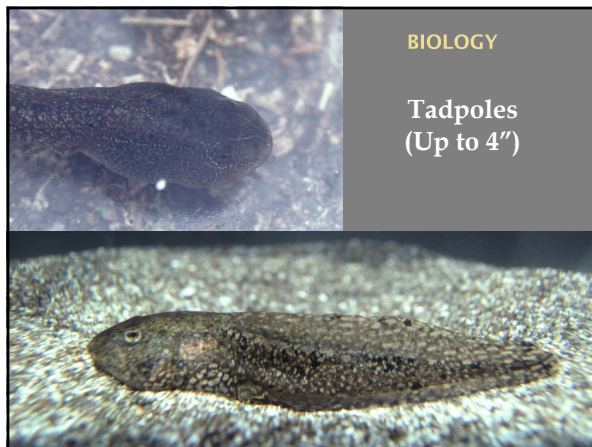
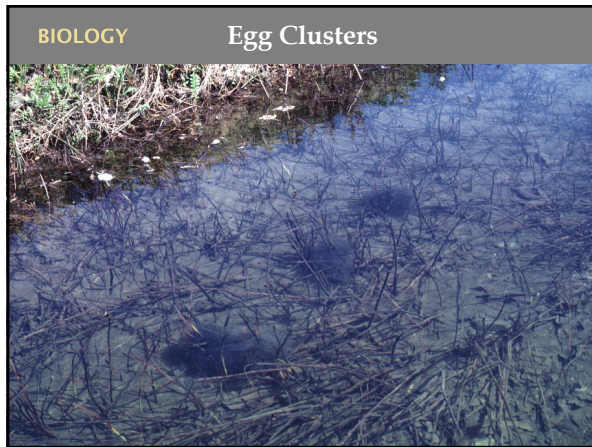
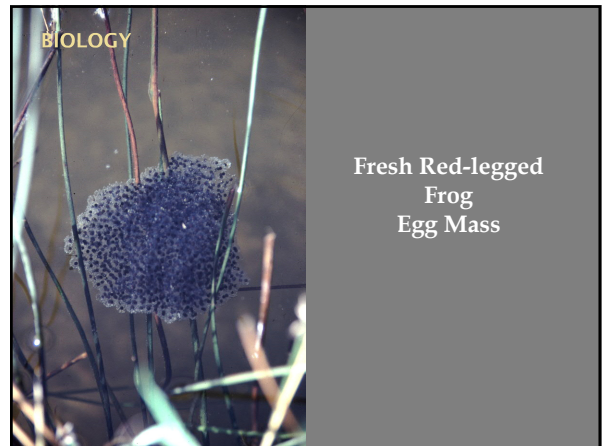
December-April.....Calling and Egg Laying  
 January-September.....Tadpole Stage  
 June-September.....Metamorphs Appear  
 June-December..... Entering Juvenile Period

(6~42 mos. after hatching)  
 Juvenile Period

(~42 mos. after hatching)

December-April.....First Breeding  
 (males and some females)







**BIOLOGY**

### Physiology of Anurans

Majority of water loss is through the skin.

Reabsorption through the ventral pelvic region.

The larger the size the greater the distance travelled between aquatic sites.

Small amphibians have proportionately more surface area and, therefore, have higher rates of evaporative loss.

*(Duellman and Trueb 1994)*



**BIOLOGY**

### Tadpole Food

“Aufwuchs” (Slime!)

Algae, fungi

Microscopic animals

Carriion

**BIOLOGY**

### Frog Food

Arthropods

Molluscs

Annelid worms

Largest frogs eat fish, other frogs, mice

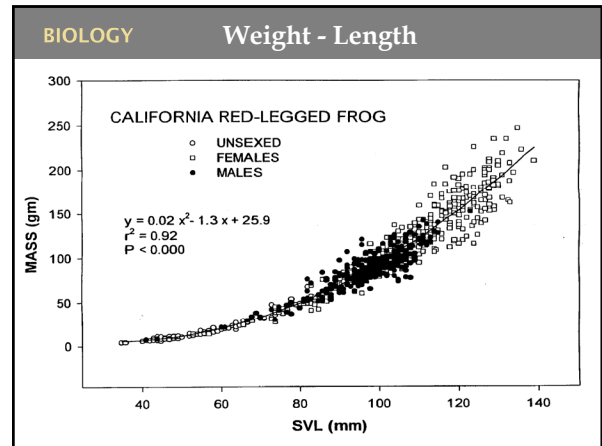
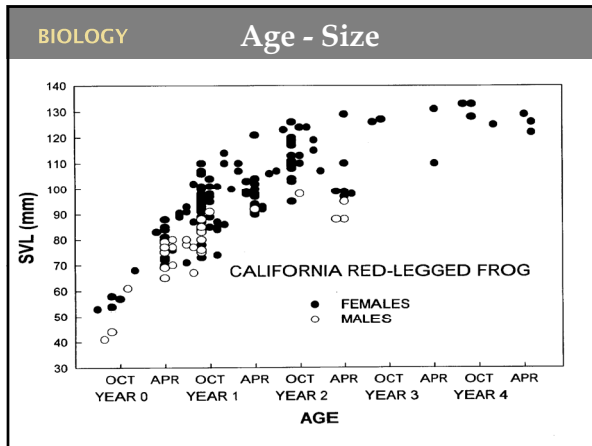
Terrestrial prey = 90% of total prey items

*(Bishop 2011)*

**BIOLOGY**

### SIZE AND WEIGHT

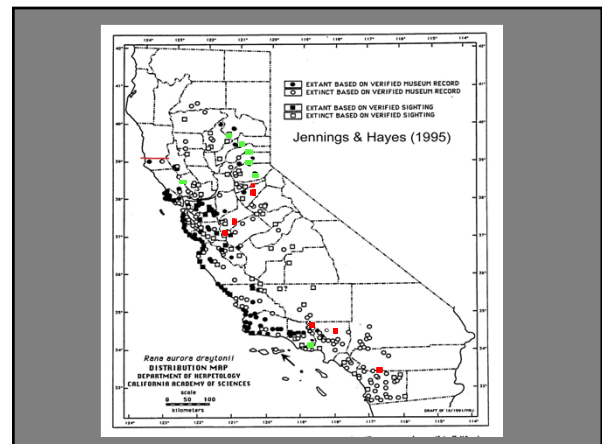
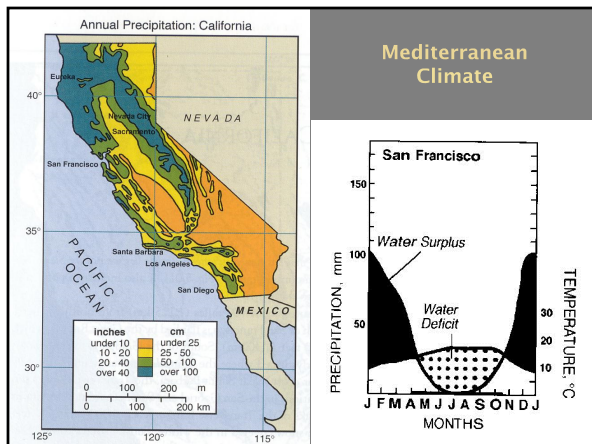
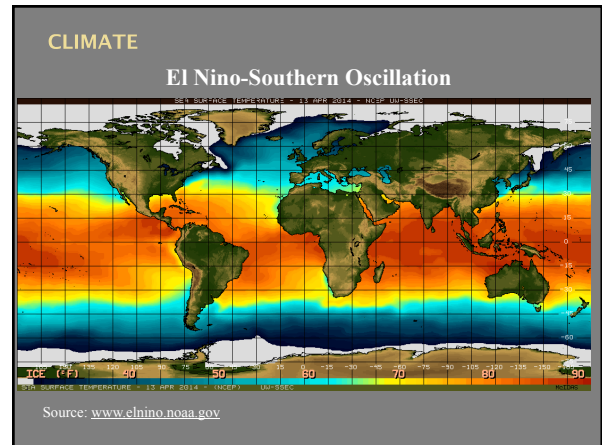
### Sexual dimorphism

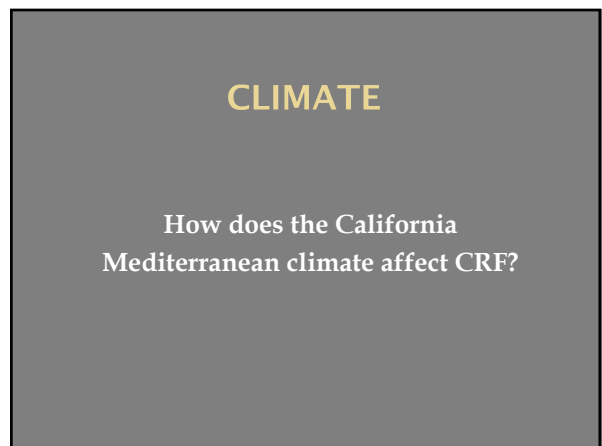
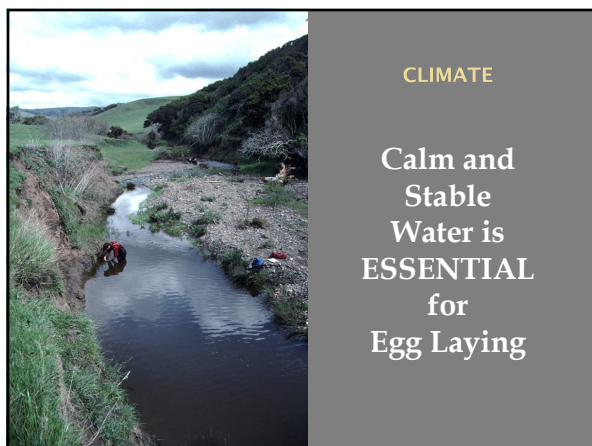
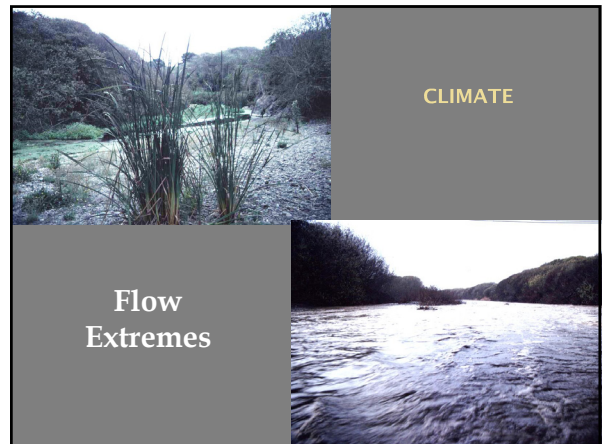
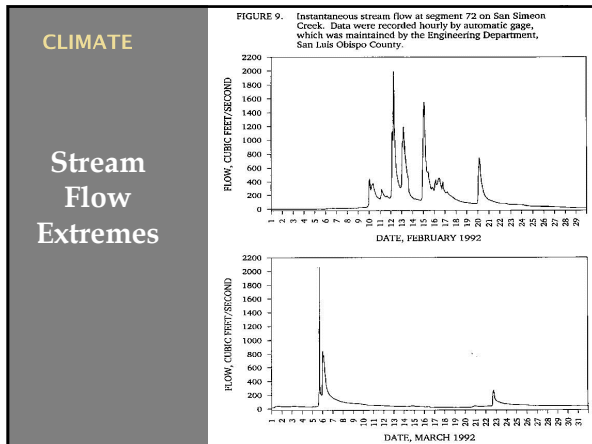


## CALIFORNIA'S MEDITERRANEAN CLIMATE

HOT AND DRY IN SUMMER, WET AND COLD IN WINTER!

*Dramatically impacts where CRF are found and how they move within different habitats*





# HABITATS

## 3 BIOREGIONS


COASTAL - e.g., Marin, Santa Cruz, San Luis Obispo, Sonoma Counties

INLAND - e.g., Alameda, Contra Costa, Santa Clara Counties

SIERRAN - e.g., Butte, Yuba, Plumas, Calaveras Counties

### HABITATS

### Characteristics



### HABITATS

### Ponds - Coastal



### HABITATS

### Stream Pools - Inland




### HABITATS

### Ponds - Inland



### HABITATS


### Ponds - Sierra



**HABITATS**

Other

- Seeps
- Spring boxes
- Cement wells
- Sewage basins



**HABITATS**

Aquatic Habitat Use



**HABITATS**

Aquatic Habitat Use



**HABITATS**



**HABITATS**

Riparian Upland Use



**POPULATION ECOLOGY**

MANAGEMENT IMPLICATIONS!

POPULATION ECOLOGY

## EIGHT-YEAR STUDY

*(Scott, et. al., 2001)*

Populations in four coastal streams

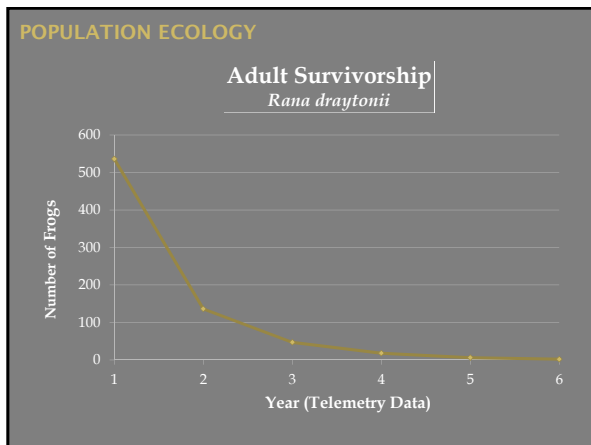
San Luis Obispo County

> 700 marked frogs

POPULATION ECOLOGY

## Survivorship

Stage	Age (months)	Survival Rate	Number of Individuals
<i>Egg&gt;&gt;metamorph</i> <i>(assume 2,500/mass)</i>	0-5	1-5%**	125
<i>Metamorph&gt;&gt; juvenile</i>	5-12	10%	12.5
<i>Juvenile&gt;&gt;adult</i>	12-24	25%	~ 3.12
<i>Adults</i>	24-80	~33%/yr	1



POPULATION ECOLOGY

## *Roughly Speaking...*

The average female (~66%) only breeds  
*once/year*  
*and*

One egg mass (2,000-4,000 eggs) will  
produce ~1 breeding pair

## OUR RECOMMENDATION


*Manage for Tadpoles and Juveniles*

## CRF MOVEMENTS

Why?  
Where?  
When?

**MOVEMENTS**

Breeding, Dispersal, and Avoiding Adversity



**MOVEMENTS**

**RESEARCH STUDIES**

*Scott and Rathbun* (Observations 1993-1999)  
San Luis Obispo Co.

*Bulger, et al.* (2003)  
Santa Cruz Co.

*Fellers & Kleeman* (2007)  
Marin Co.

*Tatarian* (2008)  
Contra Costa Co.  
Butte Co. (Observations 2007- 2009)

**MOVEMENTS**

**INTERPRETING MOVEMENT STUDIES**

Climatic Regime

Length & Seasonality of Study

Habitat Characteristics

**MOVEMENTS**

**Inland Habitat Movement Comparisons**

	Round Valley	San Pablo Watershed	Plumas Nat. Forest
<b>Breeding Timing (Male vocalizations)</b>	December	December	February
<b>Sample Size</b>	n = 49	n = 22	n = 13
<b>% of Sample Moved</b>	42%	50%	100%
<i>Terrestrial</i>	26.5%	18%	1%
<i>Aquatic</i>	24.4%	36%	100%
<b>Duration of Terrestrial Movements</b>			
<i>Average</i>	1-4 days	1-6 days	1-7 days
<i>Maximum</i>	50 days		
<b>Greatest Distances</b>			
<i>Terrestrial</i>	91 m	215 m	10 m
<i>Aquatic</i>	661 m	643 m	152 m

**MOVEMENTS**

**Coastal Habitat Movement Comparisons**

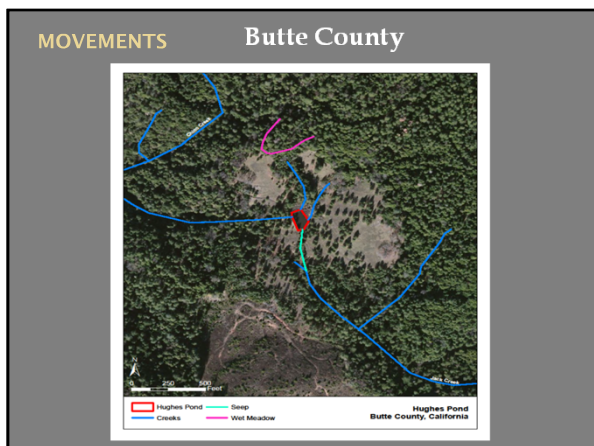
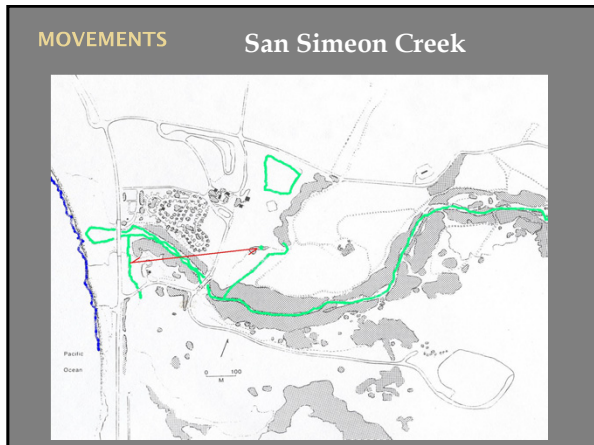
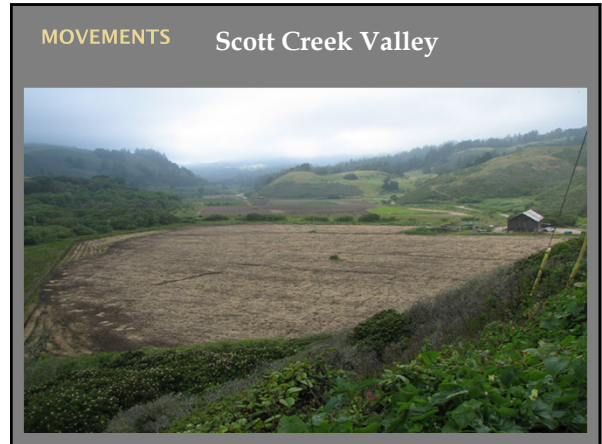
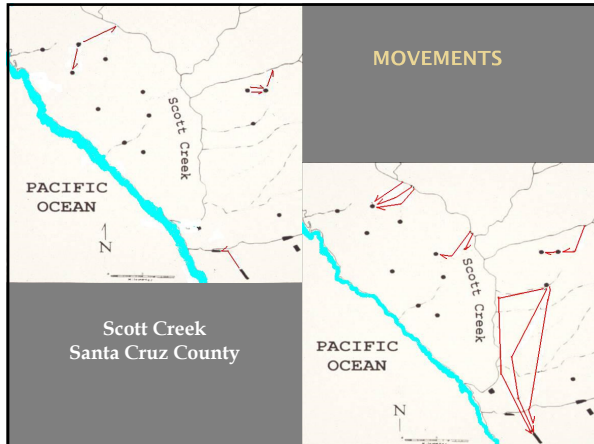
	Santa Cruz Co	Marin Co
<b>Breeding Timing (Male vocalizations)</b>	November	December
<b>Sample Size</b>	n = 56	n = 123
<b>% of Sample Moved</b>	14-32%	29%
<i>Terrestrial</i>	10-23%	2%
<i>Aquatic</i>	16%	27%
<b>Duration of Terrestrial Movements</b>		
<i>Average</i>	23-30 days	4 days
<i>Maximum</i>	63 days	6 days
<b>Greatest Distances</b>		
<i>Terrestrial</i>	1,200 m	430 m
<i>Aquatic (riparian)</i>	2,800 m	1,400 m

**MOVEMENTS**

**Generalities**

- ✦ Most do not move far
- ✦ Movement between aquatic habitats
- ✦ Escape adversity
- ✦ Move in damp conditions (first rains)
- ✦ Move at night
- ✦ Rarely use corridors





MOVEMENTS

*Juvenile Frogs - Dispersal*

Constrained by physiology  
Lack of knowledge of landscape and environmental conditions

## Studies of Adult CRF Movements

- ❖ Name 3 regions of studies
- ❖ Were movements alike in all regions?
- ❖ Why or why not?
- ❖ What are some appropriate generalities of CRF movements?

## POPULATION DYNAMICS

### POPULATION DYNAMICS

## Terminology

**LOCAL POPULATION** - Frogs in habitats linked by the regular exchange of individuals

**METAPOPULATION** - Two or more local populations rarely linked by migrating individuals

**ISOLATED POPULATION** - A local population not exchanging individuals with any other local population

### POPULATION DYNAMICS

### POPULATION DYNAMICS

## European Pool Frog (*Rana lessonae*)

- ❖ 155 permanent ponds in Sweden
- ❖ 60 local frog populations
- ❖ All 24 ponds >4 km from another population had no frogs
- ❖ 70% of ponds <1 km from another population had frogs
- ❖ 33% of ponds 1-4 km from another had frogs

(Sjögren 1991)

Jennings and Hayes, Species of Special Concern 63

**THE GEOGRAPHY OF EXTINCTION**  

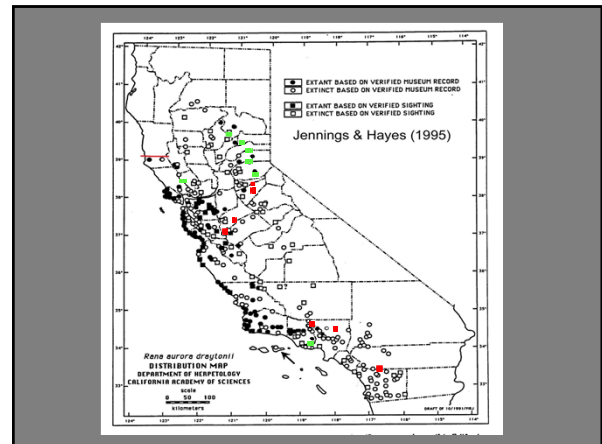
 Rana aurora dringoides  
 DISTRIBUTION MAP  
 DEPARTMENT OF HERPETOLOGY  
 CALIFORNIA MUSEUM OF SCIENCES  
 1988

Figure 17. Historical and current distribution of the California red-legged frog (*Rana aurora dringoides*) in California based on 162 localities from 1329 museum records and 291 records from other sources.

**POPULATION DYNAMICS**

### Extinction Sequence

1. Metapopulation linkages are broken, creating isolated local populations
2. Local populations lose mosaic of local habitats
3. Local populations go extinct



**POPULATION DYNAMICS**

### “Isolated populations will not persist without management.”

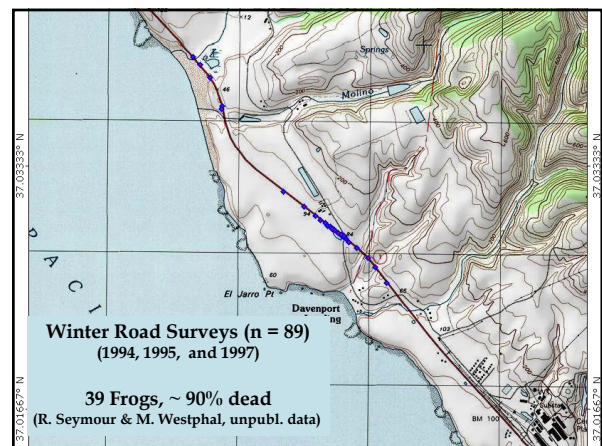
*(Hanski and Gilpin 1997)*

### THREATS

NAME A FEW

**THREATS**

- Roadways
- Urban Influences
- Agricultural Influences
- Exotic Predators
- Natural Predators
- Disease
- Climate Change



**THREATS**

### Roadways – Barriers and Mortality

Canadian study (*Carr and Fahrig 2001*): Significant negative effect on leopard frog (*Lithobates pipiens*) abundance due to vehicular traffic density within 1.5 km radius of pond (i.e., greater impact because of increased traffic density).

German study (*Andrews and Jochimsen 2007*) - Zero to 50% survival rate of toads (*Bufo bufo*) crossing roads with traffic densities of 24-40 cars per hour.

**THREATS**

### Urban Impacts

- ❖ Loss/Modification of Wetlands
- ❖ Loss of Terrestrial Habitats
- ❖ Loss of Habitat Connectivity
- ❖ Toxins – pesticides, pharmaceuticals, heavy metals

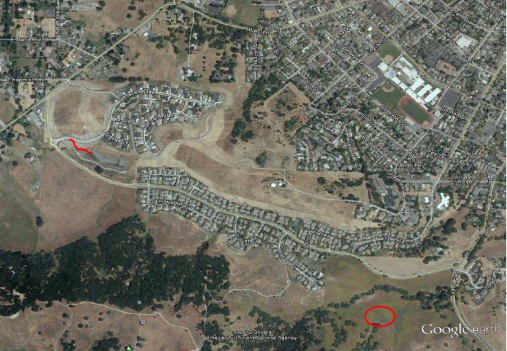
**THREATS**




Modification of wetlands



**THREATS**      **Urbanization**



**THREATS**      **Cattle and Vegetation**



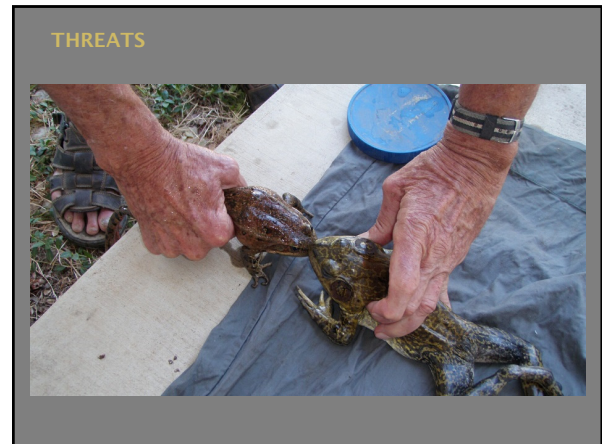
**THREATS**      **Agricultural Impacts**



THREATS

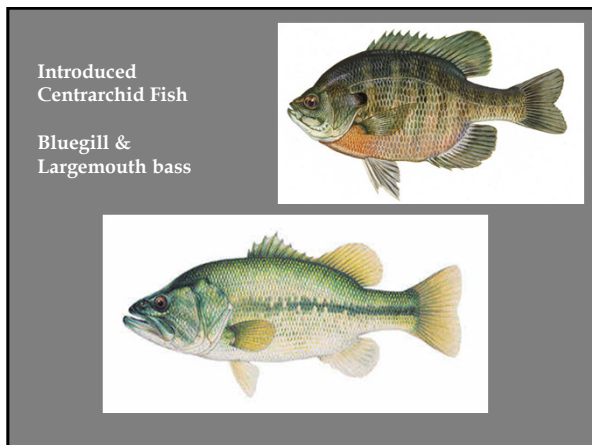


Exotic Predators



Introduced  
Centrarchid Fish

Bluegill &  
Largemouth bass



THREATS



Native Predators

THREATS

Agricultural Chemicals

[www.epa.gov/espp/litstatus/  
effects/redleg-frog/](http://www.epa.gov/espp/litstatus/effects/redleg-frog/)

THREATS

Emerging Diseases

*Batrachochytrium dendrobatidis* genome sequenced and even most recently evolved clade contained more genetic variation than previously reported. Important to consider Bd in broader evolutionary context and identify mechanisms that led to shift in virulence.  
(Rosenblum, et al. 2013)

**THREATS**

## Emerging Diseases

Ranavirus – Highly infective to a range of animals and detected in frogs and salamanders , U.K., U.S.A and Canada

(Dazak, et al., 2003)

**THREATS**

## Climate Change

- ❖ Decrease in cold days and nights and frost occurrences
- ❖ Increase in hot days and nights
- ❖ Increase in heat waves
- ❖ Stronger storm events
- ❖ Wildfires
- ❖ Emerging pathogens and invasive species

*(Intergovernmental Panel on Climate Change (IPCC) Synthesis Report 2013)*

**THREATS**

## Climate Change Potential Effects

<i>Biology</i>	<i>Deluge</i>	<i>Drought</i>
<i>Breeding habitat</i>	Increases	Decreases
<i>Egg survival</i>	Stays the same	Stays the same or decreases
<i>Larval survival</i>	Stays the same or decreases	Decreases
<i>Metamorph survival</i>	Dependent on larval stage	Decreases
<i>Adult</i>	Stays the same	Decreases

# MANAGEMENT

**MANAGEMENT**

## Management Tools

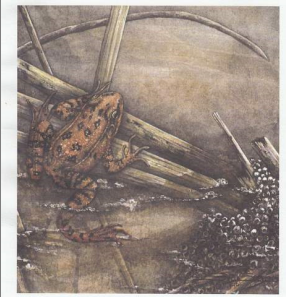
- ❖ Control of exotic predators
- ❖ Pond construction
- ❖ Vegetation and silt removal
- ❖ Buffer zones
- ❖ Translocation
- ❖ Population re-establishment

**MANAGEMENT**

U.S. Fish & Wildlife Service

### Recovery Plan for the California Red-legged Frog

*(Rana aurora draytonii)*





MANAGEMENT

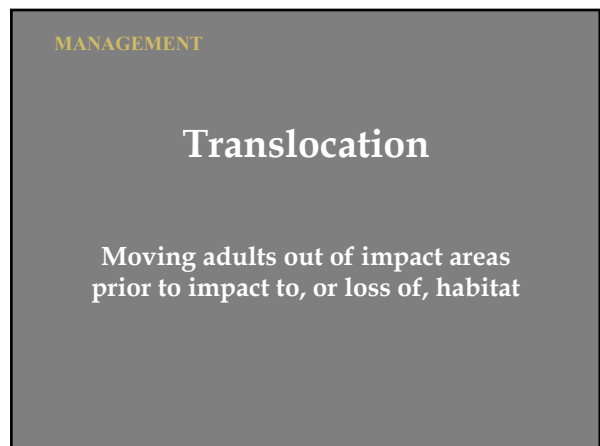
Use of Stock Ponds to Manage  
CRF Populations  
(Caution: rarely maintenance free)

- ❖ Manage for soil accretion/aquatic biomass accumulation, even with weirs for water control
- ❖ Prevent individual loss

MANAGEMENT

Creating  
Good  
Frog Ponds







MANAGEMENT


## Translocation

- ❖ Success dependent on many factors - not appropriate for all projects
- ❖ Requires USFWS concurrence

MANAGEMENT

## Translocation - successful

San Pablo Dam



April Creek Barn

MANAGEMENT

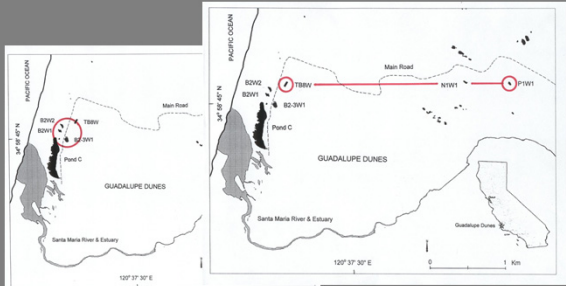
## Translocation - Egg Deposition



- March 3 - Frog mass: 148g
- March 18 - Egg mass observed
- March 26 - Frog mass: 106g

MANAGEMENT

## Translocation - Guadalupe Oil Field Unsuccessful



MANAGEMENT

## Headstarting

(Population reestablishment)

Moving egg masses from a self-sustaining, stable population, to a different location to establish a new population

MANAGEMENT

## Headstarting

- ❖ Success dependent on many factors - not appropriate for all projects
- ❖ Requires USFWS concurrence

**POPULATION RE-ESTABLISHMENT**

**PINNACLES NATIONAL MONUMENT (2001)**

**BEAR GULCH RESERVOIR HISTORY**

- 1934 Reservoir completed
- 1960's-70's Red-legged frogs present
- ~1980 Catfish introduced
- 1985 Drained, catfish removed
- 1987-2000 Frogs absent
- 2001 Re-establishment started

**POPULATION RE-ESTABLISHMENT**

**CHALONE CREEK**  
**Wet Season**

**POPULATION RE-ESTABLISHMENT**

**Chalone Creek Headstarting Program**

- ❖ Collection - 20% of egg masses from Chalone Creek
- ❖ Headstart - held tadpoles in mesh boxes in reservoir
- ❖ Release - placed tadpoles into reservoir

**POPULATION RE-ESTABLISHMENT**

**NUMBER OF EGG MASSES AND TADPOLES RELEASED**

Year	Egg Masses	Tadpoles Released	Metam.	Adults/Juv.
2001	5	116+	17	0
2002	9	914	154	12
2003	3	841	427	29
2004			485	20
2005			317	12
2006			329	22
2007			68+	15+
2008			206	14

**Headstarting a Population**

**Upper Las Virgenes Canyon Open Space Preserve, Los Angeles - 2012**

**POPULATION RE-ESTABLISHMENT**

**Monitoring**

**Additional Sites Added**

## RECAP

### Management Tools

## WHAT WE'VE COVERED

### BIOLOGICAL FACTORS

- Mediterranean climate - water regimes
- Habitat types used by frogs
- Population dynamics
- Threats
- Population-level management
- Clear objectives for species management

## REGULATORY PROCESS

**REPORTING (Consider impacts: temp. vs. perm., indiv. vs. pop.)**

- ❖ Site Assessment (*USFWS 2005*)
- ❖ Habitat Assessment
- ❖ Biological Assessment
- ❖ Habitat Conservation Plan

## REGULATORY

### PERMITTING

**Project Permits:**

- ❖ Section 7 - federal nexus
- ❖ Section 10 - no federal nexus

**Research Permit:**

- ❖ 10(A)(1)(a) Permit issued to Individual

*Note: Individual Permit is NOT required for:*


- ❖ Site Assessment
- ❖ Focused surveys for adults
- ❖ Construction monitoring

## REGULATORY

### PERMITTING

*Individual 10(A)(1)(a) Permit IS required for capture/handling*

Entire pond must be dip-netted to prevent a false negative of occurrence in a pond



## REGULATORY

### INDIVIDUAL 10(A)1(A) PERMIT

Minimum requirements to obtain a permit:

See: Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog (*USFWS 2005*)

Minimum requirements for Service-approval

**REGULATORY**

**SITE ASSESSMENT AND FOCUSED SURVEYS**

Results are valid for two (2) years, unless the following has occurred:

- ❖ Appropriate Service Fish and Wildlife Office was not contacted to review the results of the site assessment prior to field surveys being conducted;
- ❖ Field surveys were conducted in a manner inconsistent with the Guidance or with survey methods not previously approved by the Service;
- ❖ Field surveys were incomplete;
- ❖ Surveyors were not adequately qualified to conduct the surveys;
- ❖ Reporting requirements, including submission of CNDDDB forms, were not fulfilled.

**REGULATORY**

**SITE ASSESSMENT**

1. Is the site within the current or historic range of the CRF?
2. Are there known records of CRF at the site or within a 1.6-km (1-mi) radius of the site?
3. What are the habitats within the project site and within 1.6 km (1-mi) of the project boundary?

**REGULATORY**

**SITE ASSESSMENT**

**Site Evaluation:**

- ❖ Ponds - size, max. depth, vegetation components, substrates, hydrologic duration
- ❖ Streams - bank full width, max. depth, stream gradient, pools present, depth of pools, characteristics of non-pool habitat, vegetation components, substrate, hydrologic cycle, hydrologic connectivity

**REGULATORY**

**PROTOCOL SURVEYS**

	Surveys	
	Diurnal	Nocturnal
<i>Non-breeding</i>	1	1
<i>Breeding</i>	2	4
<i>Intervals (min.)</i>	7 days	7 days

Decontamination guidelines must be used between each separate hydrologic site for all equipment.  
(USFWS 2005)

**REGULATORY**

**PROTOCOL SURVEYS**

- ❖ Stop, listen
- ❖ Visual scan (Visual Encounter Survey)
- ❖ Day survey
- ❖ Night survey
- ❖ Lights and binoculars

**REGULATORY**

**SURVEY EQUIPMENT**

*MOST SURVEYS:*

- Decontamination supplies
- Chest waders
- Headlamps and Lights
- Binoculars
- Dip nets (permit required)

*SPECIAL CIRCUMSTANCES:*

- Float tubes or boat