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

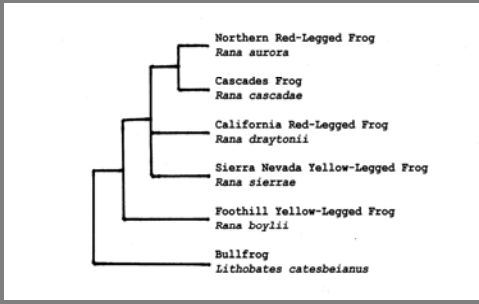
Western Toad
Bufo boreas >> Anaxyrus boreas

Bullfrog
Rana catesbeiana >> Lithobates catesbeianus

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

PHYLOGENY

Rana draytonii Phylogeny
(Shaffer, et. al. 2004)



PHYLOGENY

Phylogeny - looks can be deceiving

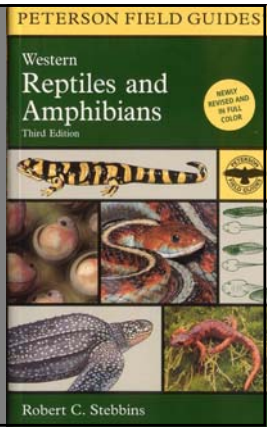
	Rana aurora	*Rana draytonii*
Male size	65 mm	116 mm
Female size	93	138 mm
Calling position	Underwater	Above water surface
Egg position	Below surface	At surface

IDENTIFICATION

Nomenclature

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

IDENTIFICATION



IDENTIFICATION
Frogs and Toads in California

IDENTIFICATION AND DIFFERENTIATION

Critically Important for Protection of Individuals and Populations

WHY?

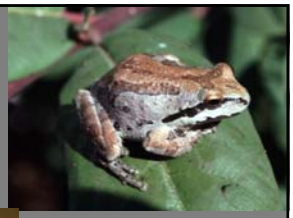
IDENTIFICATION

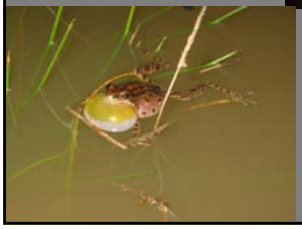
Foothill Yellow-Legged Frog
Rana boylii

IDENTIFICATION

Sierra Nevada Yellow-legged Frog
Rana sierrae

IDENTIFICATION

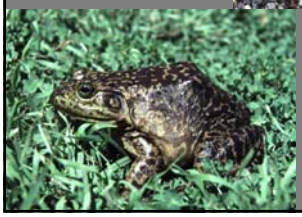


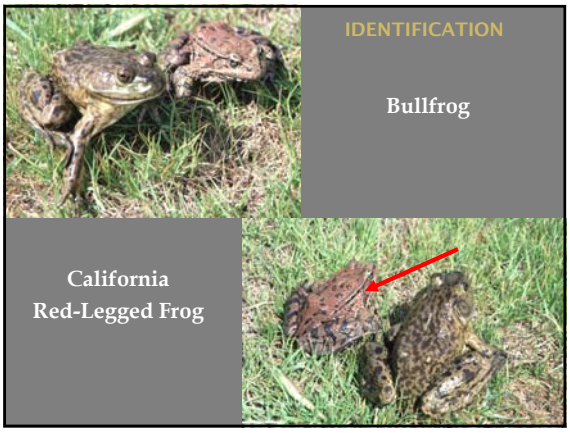


Sierran Treefrog
Pseudacris sierra

IDENTIFICATION

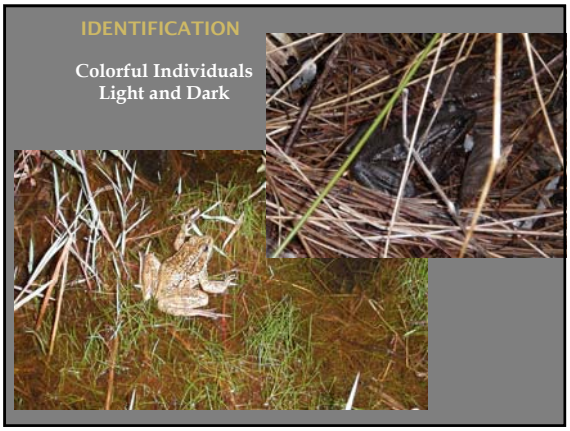
Bullfrog
Lithobates catesbeianus




IDENTIFICATION
Bullfrog
California
Red-Legged Frog


IDENTIFICATION
California
Red-Legged Frog
Rana draytonii


IDENTIFICATION
Variation in
California
Red-Legged
Frogs


IDENTIFICATION
Colorful Individuals
Light and Dark


Colorful With
Minimal Pattern
9/12/2000


IDENTIFICATION
Male vs. Female

DIFFERENTIATING FEATURES Adults

- *Rana draytonii*
- *Lithobates catesbeianus*
- *Rana boylii*
- *Pseudacris sierra*

IDENTIFICATION

CRF Egg Masses

IDENTIFICATION Bullfrog Egg Mass

IDENTIFICATION Bullfrog Egg Mass

IDENTIFICATION Treefrog Egg Mass

IDENTIFICATION Treefrog Egg Mass

IDENTIFICATION

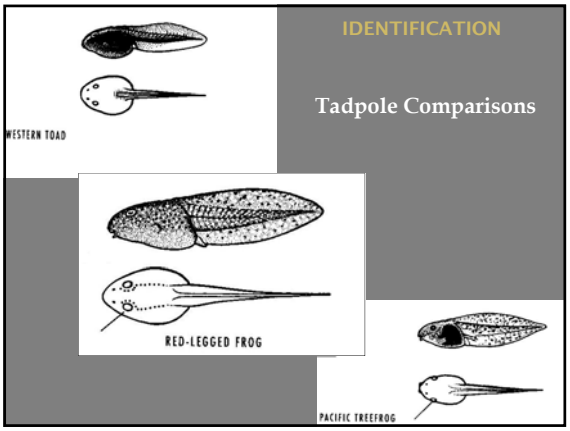
Gosner Embryo/Tadpole Staging System

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

(*Gosner 1960*)

IDENTIFICATION

California Red-Legged Frog

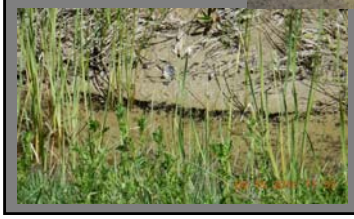


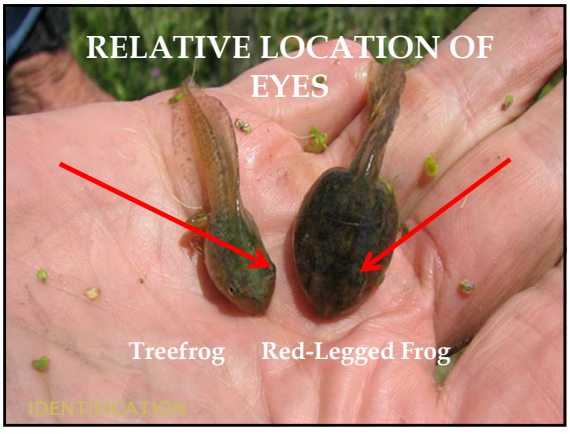
IDENTIFICATION

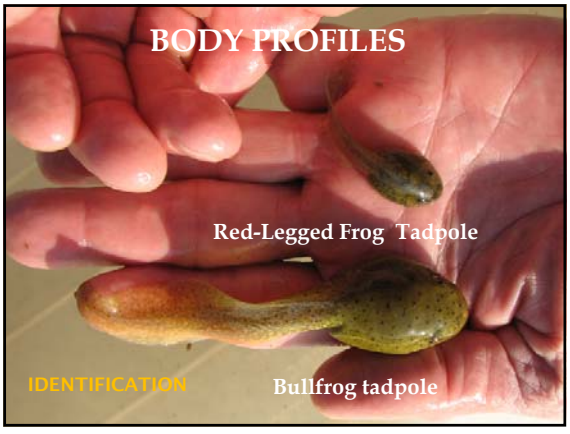
Tadpole Comparisons

IDENTIFICATION

Western Toad Tadpole







IDENTIFICATION

TADPOLE COMPARISONS

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

IDENTIFICATION

DIFFERENTIATING FEATURES Larvae

- *Rana draytonii*
- *Lithobates catesbeianus*
- *Rana boylii*
- *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

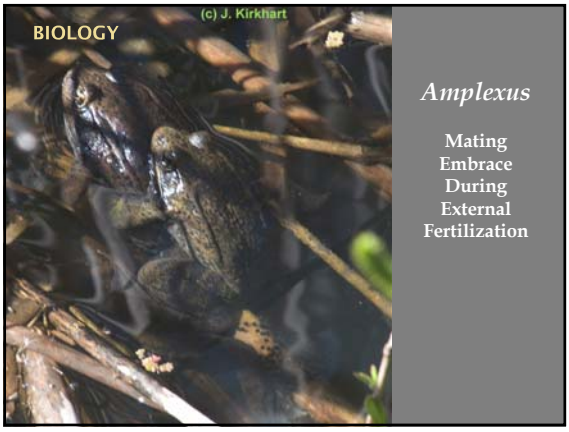
BIOLOGY

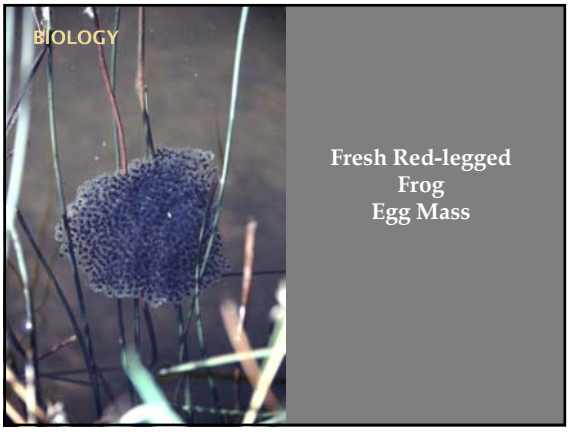
Annual Cycle

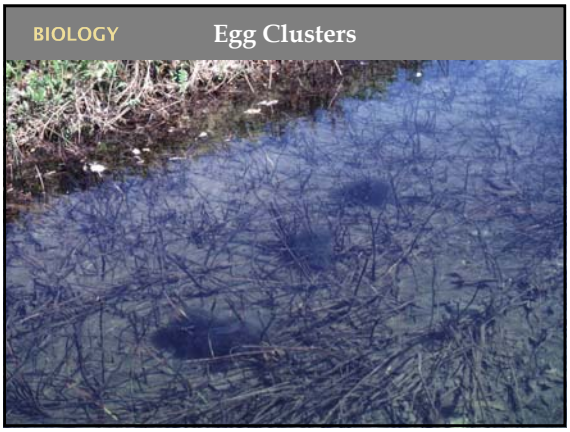
Hatching to Juvenile Stage (0-6 mos.)
December-April.....Calling and Egg Laying
January-September….....Tadpole Stage
June-September.....Metamorphs Appear
June-December..... Entering Juvenile Period

(6~42 mos. after hatching)
Juvenile Period

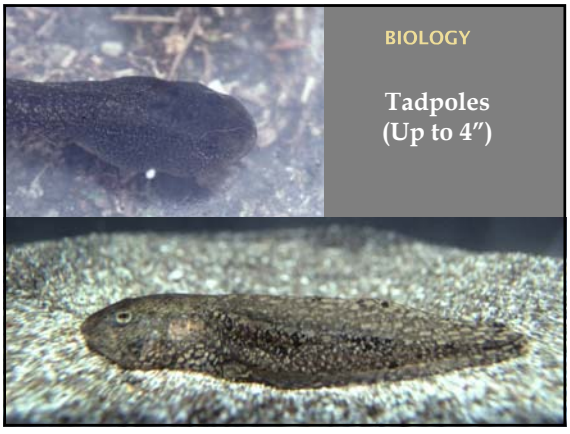
(~42 mos. after hatching)
December-April.....First Breeding
(males and some females)


BIOLOGY
(c) J. Kirkhart
Amplexus
Mating
Embrace
During
External
Fertilization


BIOLOGY
Fresh Red-legged
Frog
Egg Mass


BIOLOGY
Egg Clusters


BIOLOGY
Newly Hatched Tadpoles


BIOLOGY
Tadpoles
(Up to 4″)


BIOLOGY
Metamorphosis

BIOLOGY

Juvenile

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.

(*Wells 2007*)

BIOLOGY

Adult

BIOLOGY

Tadpole Food

"Aufwuchs" (Slime!)
Algae, fungi
Microscopic animals
Carrion

BIOLOGY

Frog Food

Arthropods
Molluscs
Annelid worms
Largest frogs eat fish, other frogs, mice

Terrestrial prey = 90% of total prey items
(*Bishop 2011*)

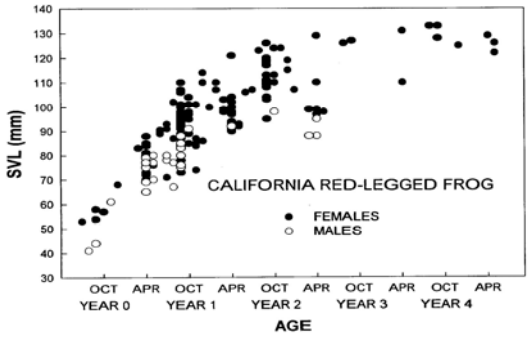
BIOLOGY

SIZE AND WEIGHT

Sexual dimorphism

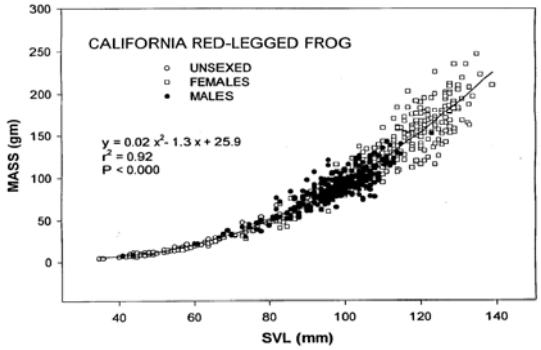
BIOLOGY

Age - Size



BIOLOGY

Weight - Length



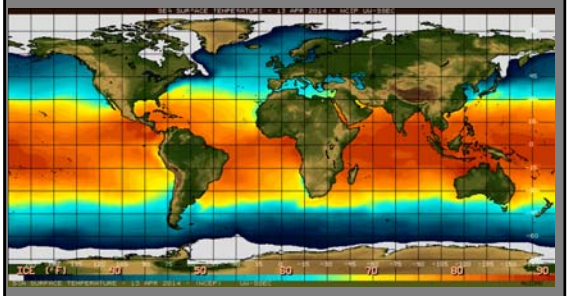
CALIFORNIA'S MEDITERRANEAN CLIMATE

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

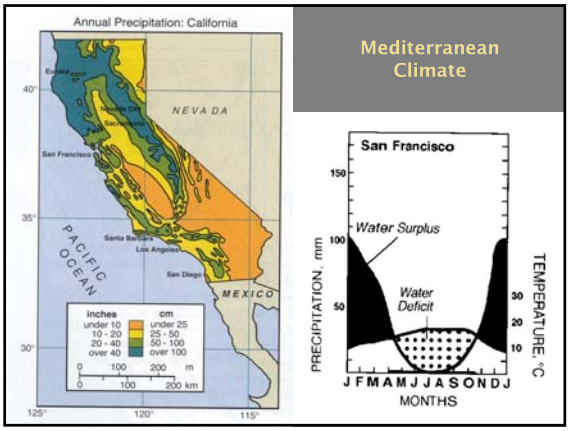
Dramatically impacts where CRF are found and how they move within different habitats

CLIMATE

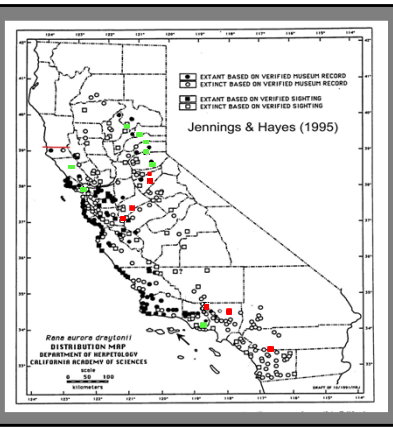
El Nino-Southern Oscillation



Source: www.elnino.noaa.gov

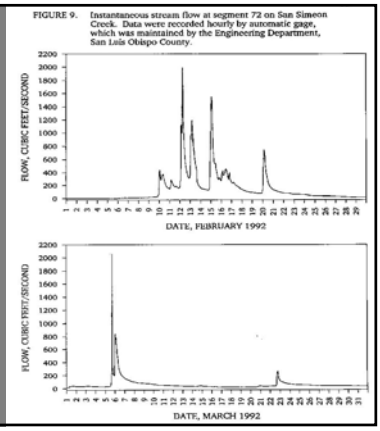


Mediterranean Climate



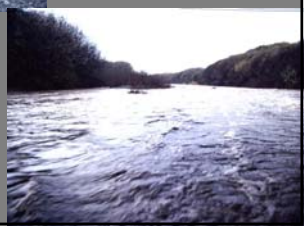
CLIMATE

Stream Flow Extremes



CLIMATE

Flow Extremes



San Simeon - Spring

San Simeon - Summer

CLIMATE

Calm and Stable Water is ESSENTIAL for Egg Laying

CLIMATE

How does the California Mediterranean climate affect CRF?

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

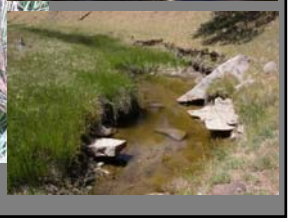
HABITATS Characteristics

HABITATS

Ponds - Coastal

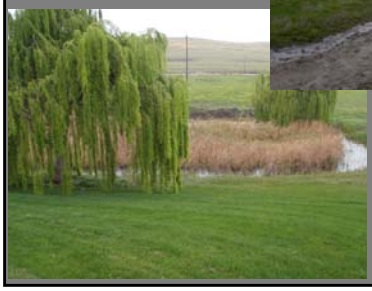
HABITATS

Stream Pools – Inland



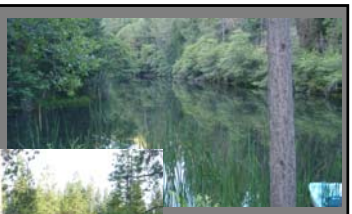
HABITATS

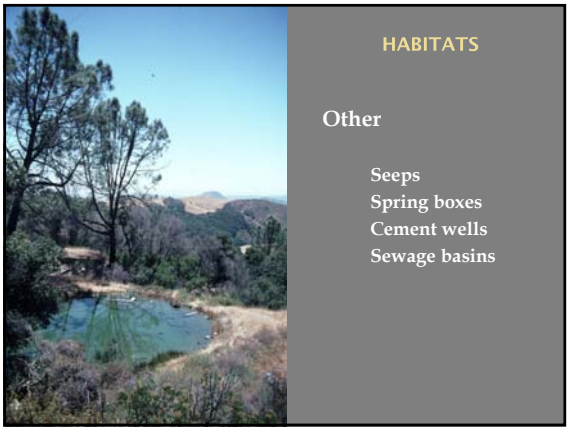
Ponds - Inland



HABITATS

Ponds - Sierra





POPULATION ECOLOGY

MANAGEMENT IMPLICATIONS!

POPULATION ECOLOGY

EIGHT-YEAR STUDY
(*Scott, et. al., 2001*)

Populations in four coastal streams

San Luis Obispo County

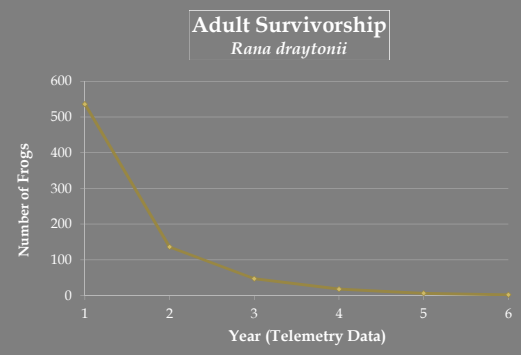
> 700 marked frogs

POPULATION ECOLOGY

Survivorship

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

POPULATION ECOLOGY



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
Breeding Timing (Male vocalizations)	December	December	February
Sample Size	n = 49	n = 22	n = 13
% of Sample Moved	42%	50%	100%
Terrestrial	26.5%	18%	1%
Aquatic	24.4%	36%	100%
Duration of Terrestrial Movements			
Average	1-4 days	1-6 days	1-7 days
Maximum	50 days		
Greatest Distances			
Terrestrial	91 m	215 m	10 m
Aquatic	661 m	643 m	152 m

MOVEMENTS

Coastal Habitat Movement Comparisons

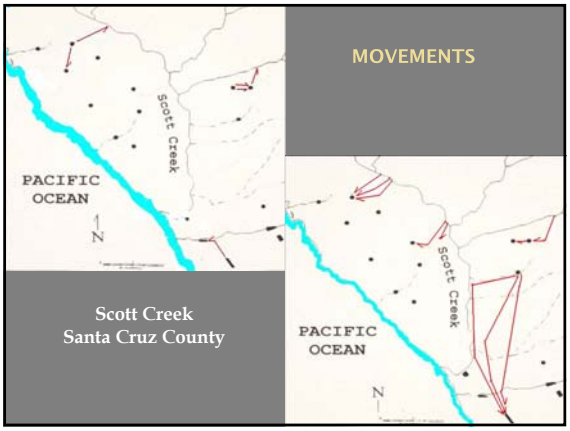
	Santa Cruz Co	Marin Co
Breeding Timing (Male vocalizations)	November	December
Sample Size	n = 56	n = 123
% of Sample Moved	14-32%	29%
Terrestrial	10-23%	2%
Aquatic	16%	27%
Duration of Terrestrial Movements		
Average	23-30 days	4 days
Maximum	63 days	6 days
Greatest Distances		
Terrestrial	1,200 m	430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

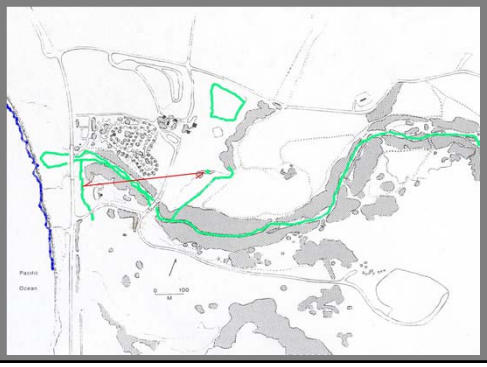
MOVEMENTS



Scott Creek
Santa Cruz County

MOVEMENTS Scott Creek Valley

MOVEMENTS San Simeon Creek



MOVEMENTS Round Valley Contra Costa County

MOVEMENTS

Hughes Pond
Butte County

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

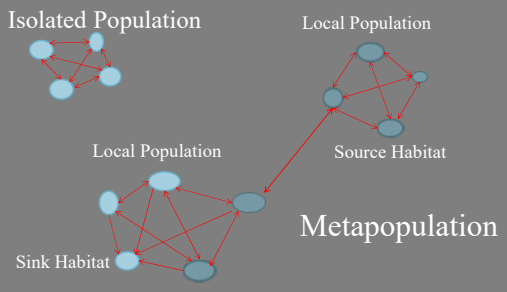
Terminology

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

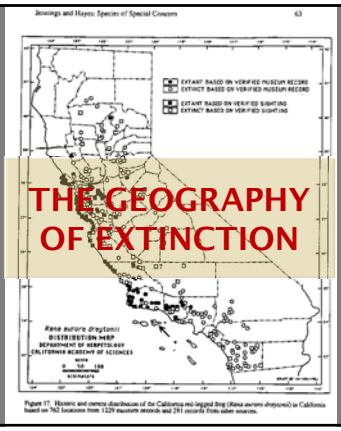


POPULATION DYNAMICS

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

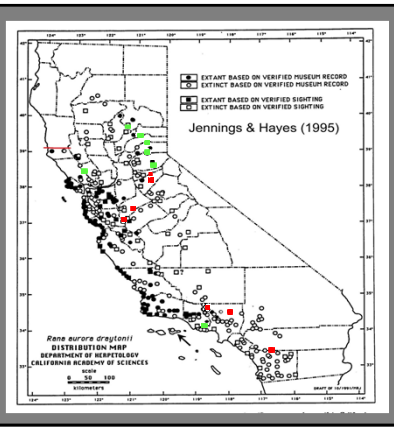
(*Sjögren 1991*)



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."

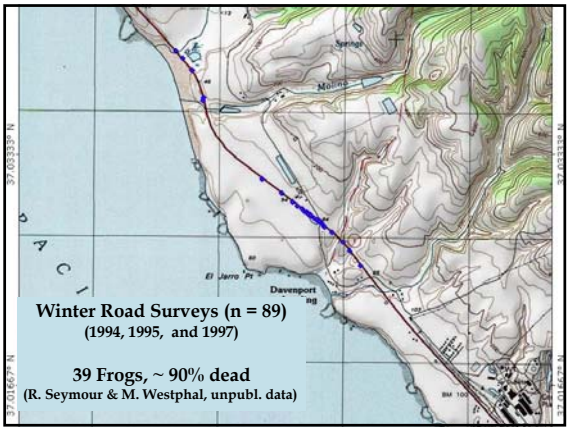
(*Hanski and Gilpin 1997*)

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 Influences

- 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 Influences

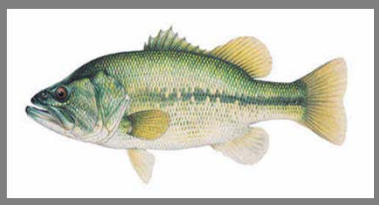
THREATS

Exotic Predators

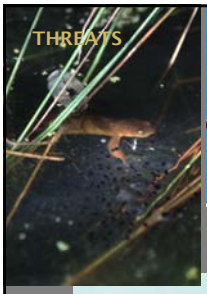
THREATS

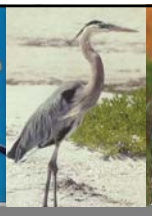
Introduced
Centrarchid Fish

Bluegill &
Largemouth bass

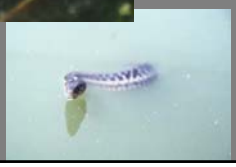


THREATS





Native Predators



THREATS

Agricultural Chemicals

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

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

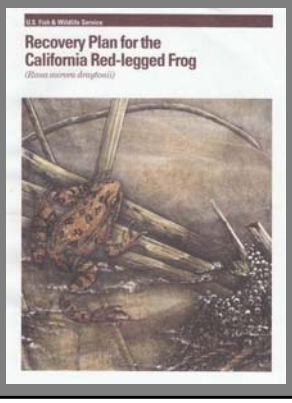
MANAGEMENT

MANAGEMENT

Management Tools

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

MANAGEMENT



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

MANAGEMENT Constructed Breeding Pond - *Failed*

MANAGEMENT Constructed Pond – Successful for Breeding

MANAGEMENT

Constructed Summer Habitat

MANAGEMENT Buffer Zones

MANAGEMENT

Translocation

Moving adults out of impact areas prior to impact to, or loss of, habitat

MANAGEMENT

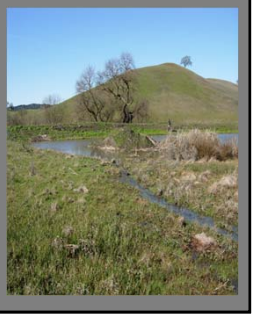
Translocation

- 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

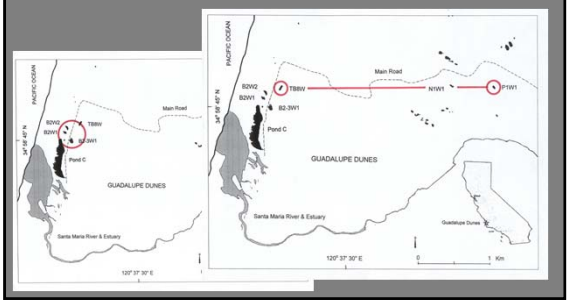
March 3 – Frog mass: 148g

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
198?-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

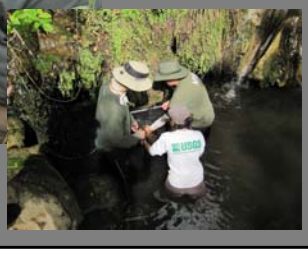
POPULATION RE-ESTABLISHMENT

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

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 CNDDB 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*
Non-breeding	1	1
Breeding	2	4
Intervals (min.)	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