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
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

Part Two

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

<table>
<thead>
<tr>
<th>Phylogeny - looks can be deceiving</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male size</strong></td>
</tr>
<tr>
<td>65 mm</td>
</tr>
<tr>
<td><strong>Female size</strong></td>
</tr>
<tr>
<td><strong>Calling position</strong></td>
</tr>
<tr>
<td><strong>Egg position</strong></td>
</tr>
</tbody>
</table>

**Identification**

**Nomenclature**

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

**Peterson Field Guides**

*Western Reptiles and Amphibians* *(Third Edition)*

Robert C. Snellings
IDENTIFICATION AND DIFFERENTIATION

Critically Important for Protection of Individuals and Populations

WHY?

IDENTIFICATION
Frogs and Toads in California

IDENTIFICATION
Foothill Yellow-Legged Frog
*Rana boylii*

IDENTIFICATION
Sierra Nevada Yellow-legged Frog
*Rana sierrae*

IDENTIFICATION
Sierran Treefrog
*Pseudacris sierra*

IDENTIFICATION
Bullfrog
*Lithobates catesbeianus*
California Red-legged Frog

Variation in California Red-Legged Frogs

Colorful With Minimal Pattern

Male vs. Female
DIFFERENTIATING FEATURES
Adults

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

IDENTIFICATION
Bullfrog Egg Mass

IDENTIFICATION
Treefrog Egg Mass

CRF Egg Masses
**Gosner Embryo/Tadpole Staging System**

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

(Gosner 1960)

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**Tadpole Comparisons**

- Western Toad Tadpole  
- Red-Legged Frog Tadpole

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**Relative Location of Eyes**

- Treefrog  
- Red-Legged Frog

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**Body Profiles**

- Red-Legged Frog Tadpole  
- Bullfrog tadpole
TADPOLE COMPARISONS

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

IDENTIFICATION

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

DIFFERENTIATING FEATURES

Larvae

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

Call Comparisons:

California red-legged frog vs. American bullfrog

(Davidson 1995)

- *R. draytonii*
- *R. draytonii*
- *L. catesbeianus*

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)
Ecology of the California Red-legged Frog

May 5, 2016

Trish and Greg Tatarian, presenters

Elkhorn Slough Coastal Training, sponsor
**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)

**Tadpole Food**

- “Aufwuchs” (Slime!)
- Algae, fungi
- Microscopic animals
- Carrion

**Frog Food**

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

Terrestrial prey = 90% of total prey items

(Bishop 2011)

**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

Source: www.elnino.noaa.gov

Climate

El Nino-Southern Oscillation

Source: www.elnino.noaa.gov
How does the California Mediterranean climate affect CRF?

Calm and Stable Water is ESSENTIAL for Egg Laying

San Simeon - Spring

San Simeon - Summer
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

Ecology of the California Red-legged Frog

May 5, 2016

Trish and Greg Tatarian, presenters

Elkhorn Slough Coastal Training, sponsor
EIGHT-YEAR STUDY
(Scott, et. al., 2001)

Populations in four coastal streams
San Luis Obispo County
> 700 marked frogs

Survivorship

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

Roughly Speaking...

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

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

 Manage for Tadpoles and Juveniles

CRF MOVEMENTS

Why?
Where?
When?
**RESEARCH STUDIES**

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

Santa Cruz Co.  

Fellers & Kleeman (2007)  
Marin Co.  

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

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**INTERPRETING MOVEMENT STUDIES**

- Climatic Regime
- Length & Seasonality of Study
- Habitat Characteristics

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### Inland Habitat Movement Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Round Valley</th>
<th>San Pablo Watershed</th>
<th>Plumas Nat. Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding Timing</td>
<td>December</td>
<td>December</td>
<td>February</td>
</tr>
<tr>
<td>Sample Size</td>
<td>n = 49</td>
<td>n = 22</td>
<td>n = 13</td>
</tr>
<tr>
<td>% of Sample Moved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial</td>
<td>42%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Aquatic</td>
<td>26.5%</td>
<td>18%</td>
<td>1%</td>
</tr>
<tr>
<td>Duration of Terrestrial Movements</td>
<td>1-6 days</td>
<td>1-7 days</td>
<td></td>
</tr>
<tr>
<td>Average Distance</td>
<td>91 m</td>
<td>215 m</td>
<td>10 m</td>
</tr>
<tr>
<td>Greatest Distance</td>
<td>661 m</td>
<td>643 m</td>
<td>152 m</td>
</tr>
</tbody>
</table>

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### Coastal Habitat Movement Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Santa Cruz Co</th>
<th>Marin Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding Timing</td>
<td>November</td>
<td>December</td>
</tr>
<tr>
<td>Sample Size</td>
<td>n = 36</td>
<td>n = 123</td>
</tr>
<tr>
<td>% of Sample Moved</td>
<td>14-32%</td>
<td>29%</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>10-23%</td>
<td>2%</td>
</tr>
<tr>
<td>Aquatic</td>
<td>14%</td>
<td>27%</td>
</tr>
<tr>
<td>Duration of Terrestrial Movements</td>
<td>25-50 days</td>
<td>4 days</td>
</tr>
<tr>
<td>Average Distance</td>
<td>1,200 m</td>
<td>430 m</td>
</tr>
<tr>
<td>Greatest Distance</td>
<td>2,800 m</td>
<td>1,400 m</td>
</tr>
</tbody>
</table>

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**Generalities**

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

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

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

“Isolated populations will not persist without management.”
(Hanski and Gilpin 1997)

THREATS

NAME A FEW

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

Winter Road Surveys (n = 89)

39 Frogs, ~ 90% dead
(R. Seymour & M. Westphal, unpubl. data)
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.
Exotic Predators

Native Predators

THREATS

Introduced
Centrarchid Fish
Bluegill &
Largemouth bass

THREATS

Agricultural Chemicals

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)
**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)

**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)

**Climate Change Potential Effects**

<table>
<thead>
<tr>
<th>Biology</th>
<th>Deluge</th>
<th>Drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding habitat</td>
<td>Increases</td>
<td>Decreases</td>
</tr>
<tr>
<td>Egg survival</td>
<td>Stays the same</td>
<td>Stays the same or decreases</td>
</tr>
<tr>
<td>Larval survival</td>
<td>Stays the same or decreases</td>
<td>Decreases</td>
</tr>
<tr>
<td>Metamorphic survival</td>
<td>Dependent on larval stage</td>
<td>Decreases</td>
</tr>
<tr>
<td>Adult</td>
<td>Stays the same</td>
<td>Decreases</td>
</tr>
</tbody>
</table>

**Management Tools**

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

**Constructed Breeding Pond - Failed**

**MANAGEMENT**

**Constructed Pond – Successful for Breeding**

**MANAGEMENT**

**Buffer Zones**

**MANAGEMENT**

**Translocation**

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

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

MANAGEMENT

Translocation - successful
San Pablo Dam

April Creek Barn

Translocation - Egg Deposition

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

MANAGEMENT

Translocation – Guadalupe Oil Field
Unsuccessful

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
PINNACLES NATIONAL MONUMENT (2001)

BEAR GULCH RESERVOIR HISTORY

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

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

NUMBER OF EGG MASSES AND TADPOLES RELEASED

<table>
<thead>
<tr>
<th>Year</th>
<th>Egg Masses</th>
<th>Tadpoles Released</th>
<th>Metam.</th>
<th>Adults Juv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>5</td>
<td>116</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>9</td>
<td>914</td>
<td>151</td>
<td>12</td>
</tr>
<tr>
<td>2003</td>
<td>3</td>
<td>841</td>
<td>421</td>
<td>29</td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>485</td>
<td>31</td>
<td>12</td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td>329</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td>68</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td>20</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

MONITORING

Additional Sites Added
RECAP

Management Tools

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

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

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

REGULATORY PROCESS

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

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

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

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

PROTOCOL SURVEYS

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

<table>
<thead>
<tr>
<th>Surveys</th>
<th>Diurnal</th>
<th>Nocturnal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-breeding</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Breeding</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Intervals (min.)</td>
<td>7 days</td>
<td>7 days</td>
</tr>
</tbody>
</table>

SURVEY EQUIPMENT

**MOST SURVEYS:**
- Decontamination supplies
- Chest waders
- Headlamps and Lights
- Binoculars
- Dip nets (permit required)

**SPECIAL CIRCUMSTANCES:**
- Float tubes or boat

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.