Developing a Countywide Arroyo Toad Monitoring Plan

Left – Desiccated arroyo toad excavated almost 1 meter underground during drought (2016)

Right – Desiccated spadefoot tadpoles in created vernal pool habitat (2015)

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San Diego Management

and Monitoring Program
2/26/2020

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SDMMP
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EXAMPLE OF A GOAL AND OBJECTIVE:

The Arroyo toad is an MSP SO Species.

Arroyo toad Goals and Objectives are in Table 2-2.6, of the MSP

The MSP includes the following summary:
"Existing known significant occurrences should be visited annually, outside of the core breeding season (March to July) to inspect and reduce threats that can be managed at the local scale (e.g. road crossings, illegal encroachment, off-road vehicle use, non-native plants, trash dumping, grazing by livestock, and incompatible human recreation). Surveys for arroyo toad should be conducted in MU8 to determine if significant occurrences occur on Conserved Lands, and surveys should continue to be conducted in MUs 3, 4, 5, and 6 in known occupied and potential habitat to determine current distribution and status of arroyo toad, collect data on threats and habitat covariates, and identify management needs. In addition, USGS has collected tissue samples from arroyo toads captured during surveys. Tissue samples should continue to be collected during arroyo toad surveys and all material should be used to conduct a genetic study to evaluate the degree of genetic variation within and between populations and to possibly identify genetic bottlenecks or barriers. This information will also be used to determine source populations to use in re-establishing arroyo toad in previously occupied areas. An arroyo toad working group should be convened to review data on occurrences and threats and to develop long-term goals and objectives and appropriate management actions."

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER

10.1002/2014GL062433

How unusual is the 2012–2014 California drought?

Daniel Griffin[1,2] and Kevin J. Anchukaitis[2]

[1]Department of Geography, Environment and Society, University of Minnesota, Minneapolis, Minnesota, USA, [2]Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA

Key Points:
- Tree rings reveal California drought severity is unusual in 1200 years

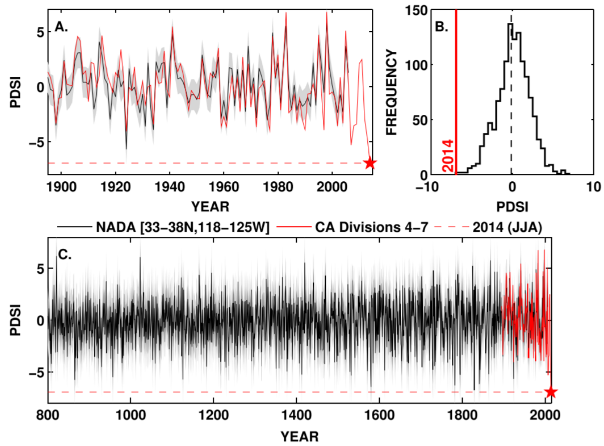

Figure 1. (a) Regional mean North American Drought Atlas (NADA) PDSI for Central and Southern California (33°N to 38°N and 118°W to 125°W; black line) and instrumental June through August NOAA Climate Division 4–7 PDSI (solid red line) for the observational period 1895 to 2014 [*Vose et al.*, 2014]. The JJA season is chosen to match the NADA reconstruction target. Uncertainty (1σ) calculated as the root-mean-squared error from the residual fit of the NADA to the instrumental series shown as the shaded gray region. The red line and star indicate the 2014 value. (b) Distribution of the composite NADA-NOAA JJA PDSI values for the period 800 to 2014. The 2014 value is indicated by the red line and is labeled. (c) Long-term (800 to 2014) composite NADA-NOAA (black line) and instrumental (solid red line) PDSI. The horizontal dashed red line and star indicate the 2014 value. Uncertainty on the composite calculated as the root-mean-squared error from the residual fit of the NADA to the NOAA instrumental series shown as light (2σ) and dark (1σ) shaded gray regions.

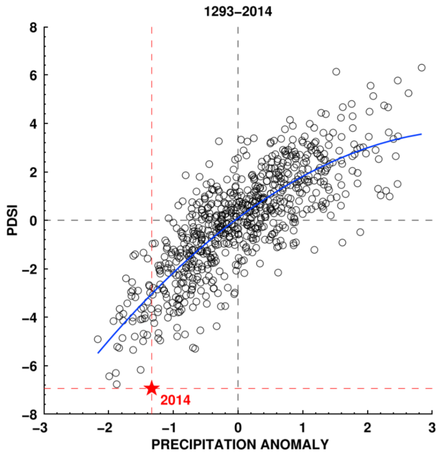

Figure 4. Bivariate distribution of the composite JJA NADA-NOAA PDSI and October–June reconstructed normalized mean precipitation anomalies. The 2014 value is indicated by the red star and dashed red lines and is labeled. The blue curve shows the least squares second-order polynomial fit to the data. Dashed black lines show the zero values for each distribution.

deviations below the long-term (800–2014) mean (Figure 1b) and the cumulative 2012–2014 drought is the worst unbroken drought interval of the last millennium (Figures 3a and 4). Precipitation for 2012–2014 was indeed low but is less than 1.5 standard deviations below the reconstructed long-term normalized regional mean and not unprecedented over the last seven centuries, neither on the annual nor 3 year time scale. These observations from the paleoclimate record suggest that high temperatures have combined with the low but not yet exceptional precipitation deficits to create the worst short-term drought of the last millennium for the state of California.

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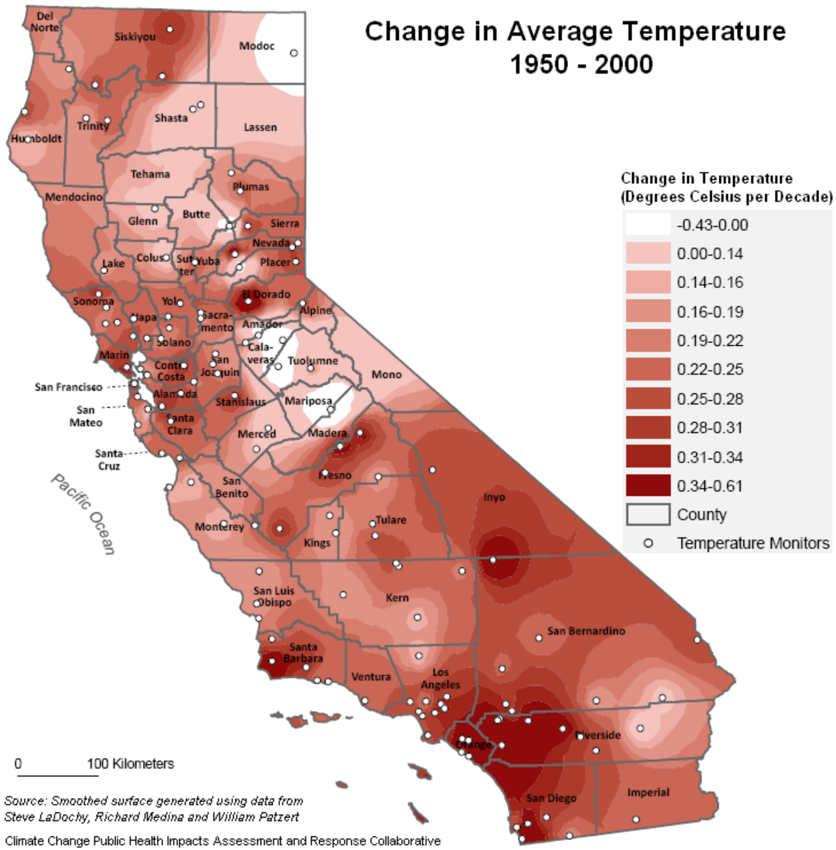
Actual 50 year change in temperature for California

Map A: Change in average temperature



Source: Smoothed surface generated using data from Steve LaDochy, Richard Medina and William Patzert

Climate Change Public Health Impacts Assessment and Response Collaborative

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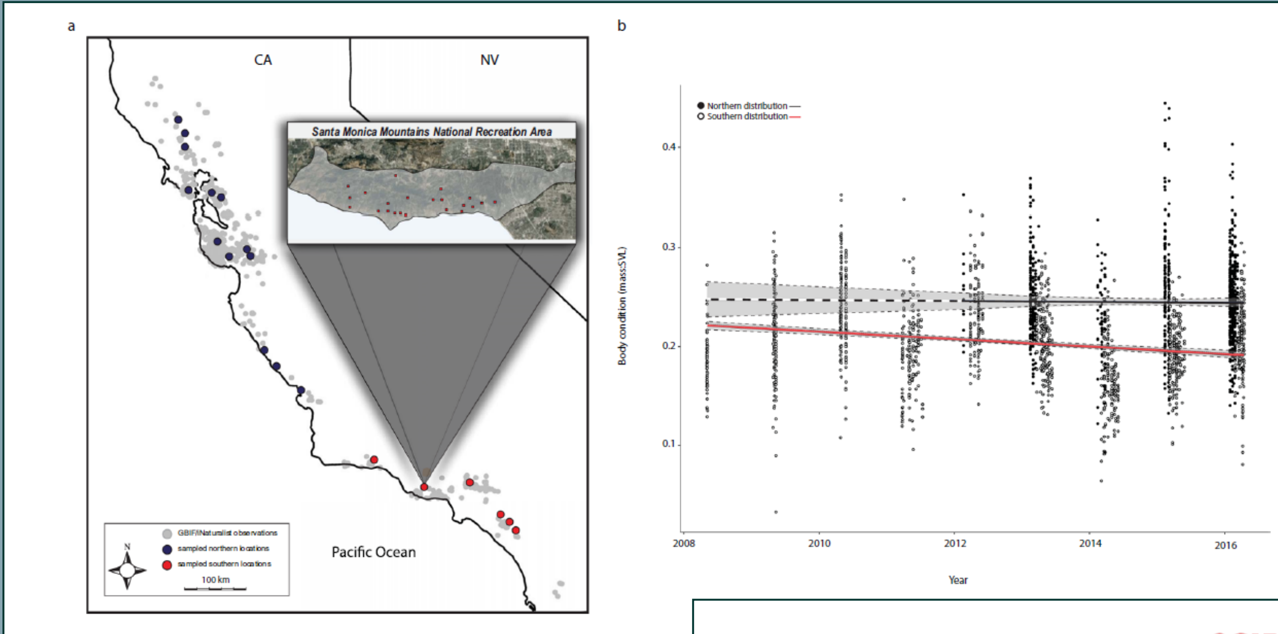

SCIENTIFIC REPORTS
natureresearch

OPEN

Amphibian responses in the aftermath of extreme climate events

Gary M. Bucciarelli[1,2*], Morgan A. Clark[3], Katy S. Delaney[4], Seth P. D. Riley[4], H. Bradley Shaffer[1,2], Robert N. Fisher[5], Rodney L. Honeycutt[3] & Lee B. Kats[3]

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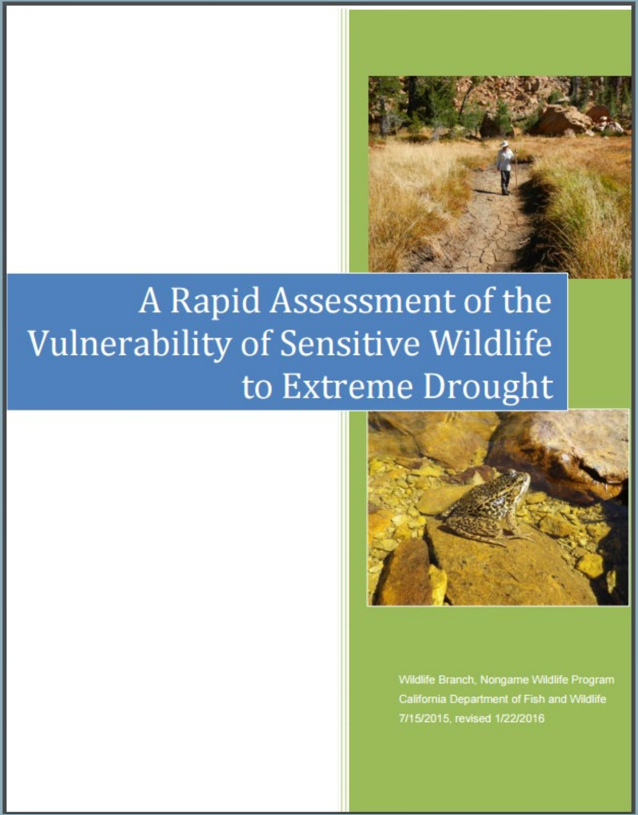
Species listed by California Dept of Fish and Wildlife

Drought Risk Priority I

Arroyo toad
Southwestern pond turtle
California red-legged frog
Two-striped garter snake
South coast garter snake
Southern mountain yellow-legged frog
Southwestern willow flycatcher

Drought Risk Priority II

Western spadefoot
Coast Range newt
Pallid bat
Townsend’s big-eared bat



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Conceptual Model for Arroyo Toads in Sweetwater River Below Loveland Dam *

Risk Hypotheses: The effect of controlled releases on arroyo toad reproductive success varies depending on timing relative to the breeding season; 2) Controlled releases concurrent with a spill event or rain event with flow volume greater than or equal to 350 cubic-feet-per-second (the maximum flow volume for a controlled release is 350 cubic-feet-per-second) will have no additional effect on arroyo toad reproductive success, 3) Controlled releases during dry years will have less of an effect on arroyo toad reproductive success than releases during wet years when more breeding is assumed to be occurring, 4) Changes in the patterns of wet and dry years due to dam operations will have a negative effect on reproductive success and population viability, 5) Reduction in the amount of coarse sediment supply due to entrapment by the reservoir and loss of sediment below the dam by erosion of banks and streambed will have a negative effect on arroyo toad reproductive success due to loss of breeding habitat and 6) Increased vegetation cover due to changes in amount of peak flows (scouring flows to remove vegetation and to maintain or create breeding habitat) will have a negative effect on arroyo toad reproductive success due to loss of breeding habitat.

Possible Management Actions Related to Loveland Dam Operations: 1) Avoid controlled releases during the arroyo toad breeding season, especially March to September; 2) Release during rain or spill events in order to mimic the natural flow of the system; 3) Continue to step up controlled releases (Sweetwater Authority currently ramps releases starting with 100 cubic-feet-per-second on day one, 200 cubic-feet-per-second on day two and 300-350 cubic-feet-per-second on day three) to allow larvae and metamorphs to adjust or escape the rising water levels and increasing flow, but also step down controlled releases to allow larvae to follow the falling water; 4) When controlled releases during the arroyo toad breeding cannot be avoided, survey for egg masses and tadpoles prior to the releases to see if eggs, larvae or metamorphs are present and consider relocating or temporarily captive housing (needs further evaluation); 5) Replace and maintain the coarse sediments required for arroyo toad breeding habitat by dredging sand and fine gravel from the reservoirs and depositing it in Sweetwater River below Loveland Dam; 6) Maintain peak spill releases to allow scouring of vegetation, the removal of exotics and the improvement of water quality in arroyo toad breeding habitat; 7) Control invasive predator species, especially during drier years when they are concentrated in the limited number of pools and easier to eradicate.

Breeding Adult Stage: Breeding is nocturnal in spring after water temperatures reach at least 14°C and water levels (<30cm deep) and speed (<5cm/sec) are appropriate for breeding; females are assumed to lay one egg mass per season, males may mate with multiple females; adults prefer dark nights

Habitat Requirements: Clear still to slow moving water (generally flow rates less than 5 cm per second) with shallow, exposed clean, sandy bottom and open canopy (see influencing factors)

Influencing Factors: Episodic flushing flows & floods are needed to naturally disturb habitat, clear vegetation on sandy terraces and maintain toad habitat; variability in climate, amount of precipitation, & timing of precipitation strongly affect available habitat & breeding- breeding may not occur during drier years.

Dam Risk Factors: Dams alter the amount & timing of flushing flows and sediment supply- lack of flushing flows & sediment supply causes loss of breeding habitat; lack of water in breeding pools due to water impoundment & reduced releases due to storage needs; possible flushing of adults from breeding pools during releases (but assumed to be negligible); mild winters with low to moderate flood scouring & water impoundment enable exotic species to persist in or near most breeding pools- predation by bullfrogs; periods of drought in the system may be extended due to storage needs, resulting in fewer years with optimal breeding conditions.

Other Risk Factors: In drought years, females may find insufficient insect prey to produce eggs before males cease their calling, resulting in no reproduction; lack of water in pools due to low annual precipitation, water diversions, & groundwater pumping; predation by bullfrogs, raccoons and crows; disturbance from mining or road noise- noise pollution does not appear to affect males, but may affect female response; breeding habitat degradation and loss due to exotic plants (Arundo, Tamarisk) or to native plants (water cress); urban runoff can contain contaminants; erosion after fires can cause siltation of breeding habitat.

Adult Stage (limited knowledge): Lifespan about 5 years; males reach adulthood in 1-2 years, females in 2-3 years; nocturnal, burrow in sand during the day; many sub adult and some adult males move 0.5-1 km perpendicular from streams, but may travel up to 2 km; very dispersed; subsist on native ants and other invertebrates.

Habitat Requirements: Coastal sage scrub, chaparral, or oak woodland, but not grasslands (may travel through); require friable soils and permeable plant understory for burrowing.

Dam Risk Factors: Assume no risk to non-breeding adults in uplands.

Other Risk Factors: Predation by native and exotic predators; native ants displaced by fire ants and Argentine ants; fire; drought; contaminants- pesticides, etc.

BREEDING
Jan – Early July**

ADULTS
Uplands

EGGS
Feb – Early July**

12-20 days

JUVENILES
Uplands

LARVAE
Mar-Early Sept**

65-85 days

METAMORPHS
April-Early Sept**

Egg Stage (12-20 days): Strings of 2000-10000 on sand, gravel, cobble or mud along pool margins away from vegetation

Habitat Requirements: Same as breeding habitat; require lack of sediment/turbidity (can tolerate for a few days)

Dam Risk Factors: Eggs stranded or washed away to unsuitable habitat during dam releases; desiccation due to lack of water in pools due to water impoundment, including reduced releases due to storage needs; mild winters with low to moderate flood scouring & water impoundment enable exotic species to persist in or near most breeding pools- predation by exotic fishes, crayfish.

Other Risk Factors: Eggs stranded or swept away due to flood events; crushing, disturbance or siltation due to humans, sand/gravel mining, floods, runoff, fires; desiccation due to lack of precipitation, water diversions & ground water pumping; contaminants- pesticides, etc.

Juvenile Stage: Toads 17-23 mm are able to dig burrows and change to a nocturnal activity pattern; if conditions permit they may remain along margins of breeding pools for up to 6 months; forage for nocturnal ants and beetles; at 28-30 mm they begin to disperse to uplands (dispersal affected by local drying conditions and suitable microhabitat); can be found in dense concentrations.

Habitat Requirements: Exposed portions of bars bordering breeding pools until sand begins to harden & they begin to disperse to nearby stands of willows and mulefat thickets; take refuge underground within the riparian zone and disperses farther with dampening of stream terraces.

Dam Risk Factors: Assume no risk to juveniles once they have moved upland; smaller juveniles remaining near breeding pools can be washed away to less suitable habitat during dam releases.

Other Risk Factors: Many toads are often exposed and lost to predation by native and exotic predators; native ants displaced by fire ants and Argentine ants; contaminants- pesticides, etc.

Larval Stage (65-85 days): Diurnal; very cryptic; highly specialized foragers- feed on loose organic material in substrate

Habitat Requirements: Similar to breeding habitat; also need detritus, interstitial algae, bacteria, and diatoms

Dam Risk Factors: Larvae stranded or washed away to unsuitable habitat during dam releases; desiccation due to lack of water in pools due to water impoundment & reduced releases due to storage needs; mild winters with low to moderate flood scouring & water impoundment enable exotic species to persist in or near most breeding pools- predation by exotic fishes (green sunfish) bullfrogs.

Other Risk Factors: Predation by garter snakes, birds (killdeer, herons), etc; desiccation due to lack of precipitation, water diversions & ground water pumping; crushing, disturbance or siltation due to humans, sand/gravel mining, floods, runoff, fires; contaminants- pesticides, etc.

Metamorph Stage (10-17 mm): Metamorphosis peaks late April to mid May; diurnal; subsist largely on native ants; found clustered; remain in saturated soil around the margins of the breeding pool for the first 1-3 weeks, usually until the grow to be 15-16 mm; lack mass needed to dig into the surface until they reach 16-17 mm when they can dig shallow pockets in loose sand

Habitat Requirements: Soft, exposed sand and moist sandy benches with partial shading adjacent to pools

Dam Risk Factors: Metamorphs can be washed away to less suitable habitat during dam releases; mild winters with low to moderate flood scouring & water impoundment enable exotic species to persist in or near most breeding pools- predation by exotic fishes (green sunfish) bullfrogs.

Other Risk Factors: Predation from garter snakes, bullfrogs, birds (killdeer, herons); contaminants- pesticides, etc; native ants displaced by fire ants and Argentine ants; crushing or disturbance from

*Based on Atkinson et al. 2003; USFWS 1999 and Sweet 1992.

**These dates may shift in some years depending on precipitation.

Assessing the Risk of Loveland Dam Operations to the Arroyo Toad (*Bufo californicus*) in the Sweetwater River Channel, San Diego County, California

By Melanie C. Madden-Smith[1], Andrea J. Atkinson[1], Robert N. Fisher[1], Wesley R. Danskin[2] and Gregory O. Mendez[2]

U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Final Report

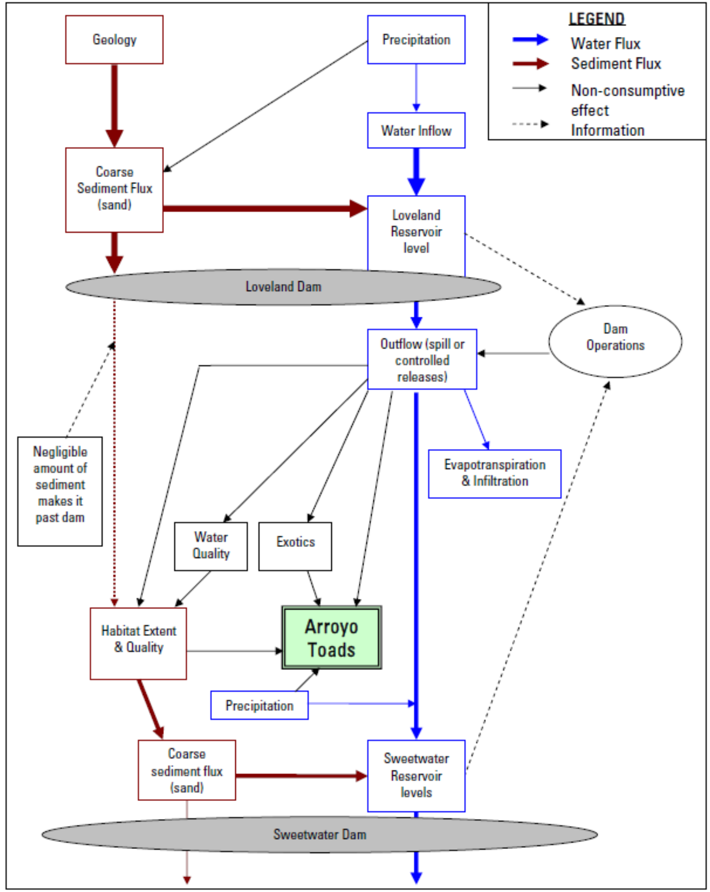

Figure 11. Conceptual model of different effects of Loveland Dam operations on arroyo toad breeding: altered flow amount and timing, altered coarse sediment supply, water quality, and flushing out of exotics.

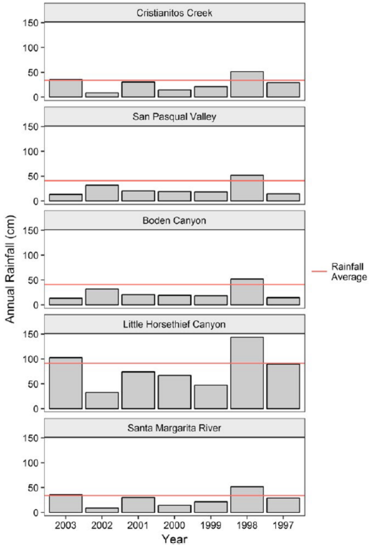

FIGURE 4 Rainfall (in cm) among years at arroyo toad study sites. "Normal" average annual rainfall indicated by (–) (National CLimate Data Center 2017). (Normal for Little Horsethief Canyon is approximately 91 cm/year, for Santa Margarita River and Cristianitos

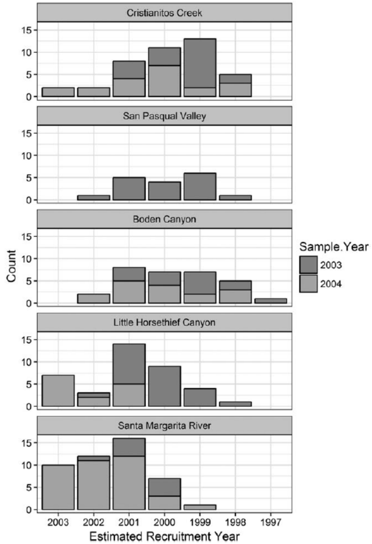

FIGURE 5 Estimated age distribution of arroyo toads among study sites. (Seasonally predictable sites include Santa Margarita River and Little Horsethief Canyon)

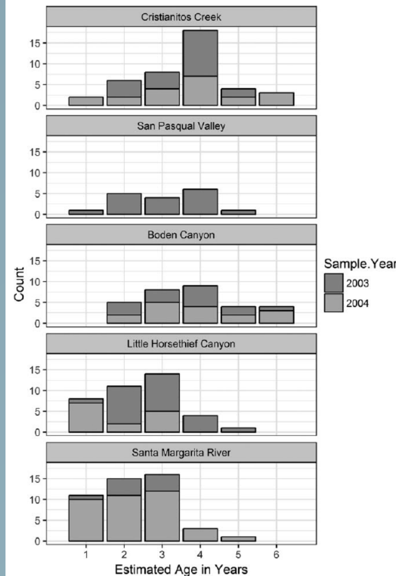

FIGURE 6 Population age structures across study sites. (Seasonally predictable sites include Santa Margarita River and Little Horsethief Canyon)

ORIGINAL RESEARCH

WILEY Ecology and Evolution Open Access

Longevity and population age structure of the arroyo southwestern toad (*Anaxyrus californicus*) with drought implications

Robert N. Fisher[1] | Cheryl S. Brehme[1] | Stacie A. Hathaway[1] | Tim E. Hovey[2] | Manna L. Warburton[1] | Drew C. Stokes[1]

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Journal of Animal Ecology
British Ecological Society
Journal of Animal Ecology 2012 doi: 10.1111/j.1365-2656.2012.02001.x

Joint estimation of habitat dynamics and species interactions: disturbance reduces co-occurrence of non-native predators with an endangered toad

David A. W. Miller[1]*, Cheryl S. Brehme[2], James E. Hines[1], James D. Nichols[1] and Robert N. Fisher[2]

[1]*US Geological Survey, Patuxent Wildlife Research Center, 12100 Beech Forest Rd, Laurel, MD 20708, USA; and* [2]*US Geological Survey, Western Ecological Research Center, San Diego Field Station, 4165 Spruance Road, Suite 200, San Diego, CA 92101, USA*

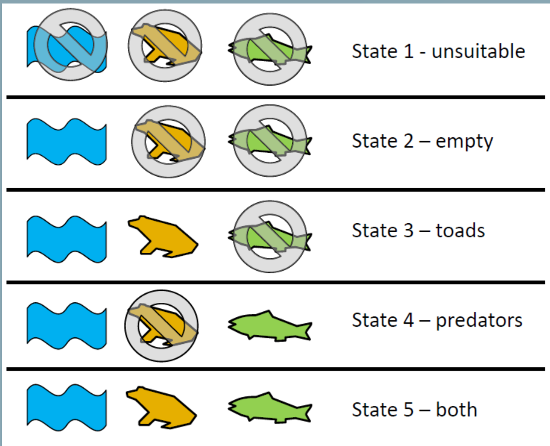

Fig. 1. Possible states in our multi-state occupancy models for the dynamics of toads, predators and habitat.

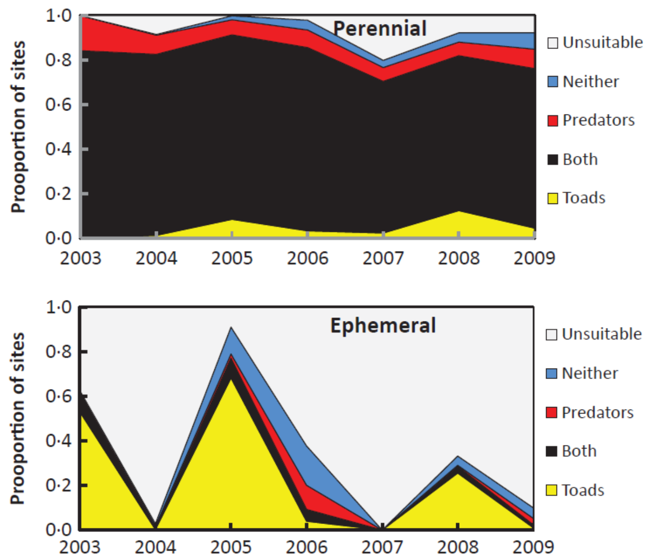

Fig. 3. Estimated proportion of sites in each of the five occupancy states during each year of the study.

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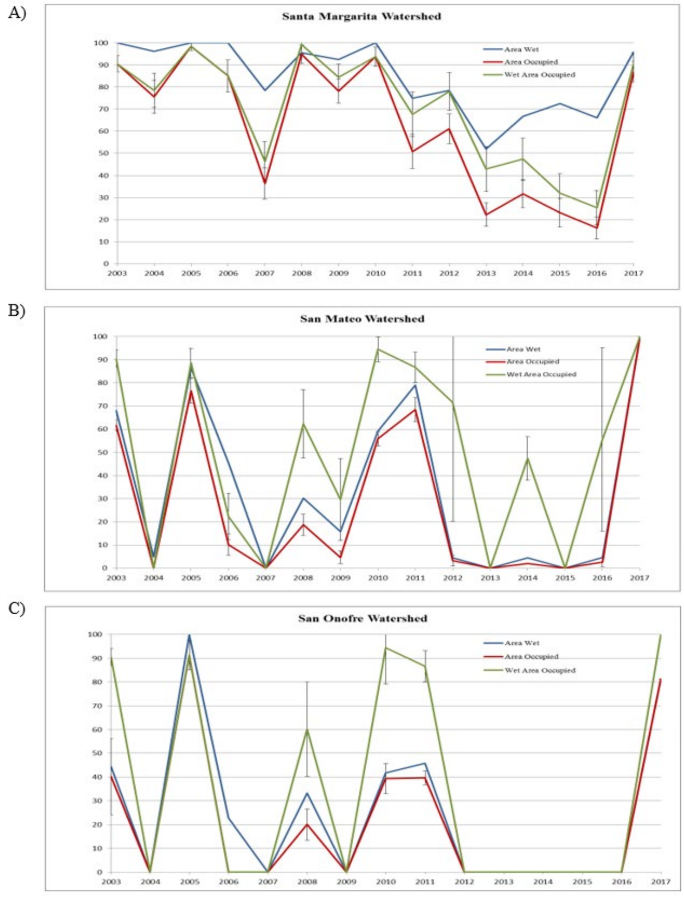

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RESEARCH ARTICLE

Integrating Multiple Distribution Models to Guide Conservation Efforts of an Endangered Toad

Michael L. Treglia[1¤]*, **Robert N. Fisher**[2], **Lee A. Fitzgerald**[1]

1 Department of Wildlife and Fisheries Sciences, Biodiversity Research and Teaching Collections, Applied Biodiversity Science Program, Texas A&M University, College Station, Texas, United States of America, 2 U. S. Geological Survey, Western Ecological Research Center, San Diego Field Station, San Diego, California, United States of America

¤ Current Address: Department of Biological Science, University of Tulsa, Tulsa, Oklahoma, United States of America

* mike-treglia@utulsa.edu

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Multi-scale effects of land cover and urbanization on the habitat suitability of an endangered toad

Michael L. Treglia[a,*], Adam C. Landon[b,c,1], Robert N. Fisher[d], Gerard Kyle[b], Lee A. Fitzgerald[a]

[a] Department of Wildlife and Fisheries Sciences, Biodiversity Research and Teaching Collections, Applied Biodiversity Science Program, Texas A&M University, College Station, TX 77843-2258, USA
[b] Human Dimensions of Natural Resources Lab, Department of Recreation, Parks, and Tourism Sciences, Texas A&M University, College Station, TX 77843-2261, USA
[c] Water Management and Hydrological Science Program, Texas A&M University, College Station, TX 77843-3408, USA
[d] U.S. Geological Survey, Western Ecological Research Center, San Diego Field Station, San Diego, CA, USA

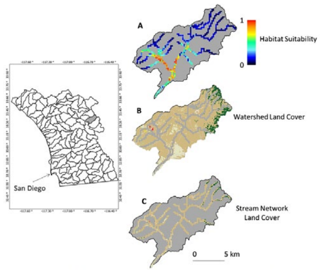

Fig. 2. Example map illustrating the 110 HUCs of original data used to calculate the variables for structural equation models, including Habitat Suitability (A), Land Cover for the Watershed scale (B), and Land Cover for the Stream Network scale (C). These datasets are highlighted for a single watershed in the study area, shaded gray in the inset, which also displays the entire study area. Unique colors in the land cover maps represent individual land cover classes explained in detail at http://www.mrlc.gov/nlcd06_leg.php (Fry et al., 2011).

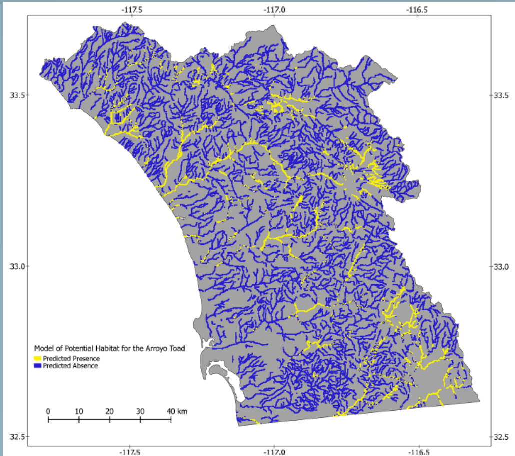

Fig 2. Modeled potential distribution of the arroyo toad in southwestern California. This map depicts the modeled potential distribution of the arroyo toad in streams and stream-side areas of southwestern California. Input data for the model included presence/pseudoabsence data and relatively stable, long-term environmental data representing characteristics of topography, soil, and climate. The Random Forests algorithm was used to develop the model, from which we predicted the probability of arroyo toad presence throughout our study area. The model performed well, with an Area Under the Receiver Operating Curve of 0.957 and a True Skill Statistic of 0.809. The lowest modeled probability of arroyo toad presence for a site known to have arroyo toads was 0.435. Sites with modeled probability of presence lower than this value were designated as not habitat (blue) and sites with probabilities of presence greater than or equal to this value were designated as habitat (yellow). Based on this model, of our 46,305 sample units, arroyo toads were predicted to occur in 14.37%.

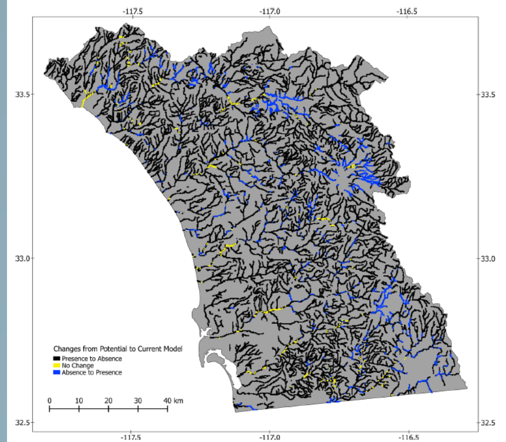

Fig 4. Comparison of two models of the distribution of the arroyo toad in southwestern California. This map was derived from two models for the distribution of the arroyo toad in southwestern California. Both models focused on streams and stream-side areas, and used relatively stable, long-term predictor variables characterizing aspects of soil, topography, and climate. The first model (potential model) only used those predictor variables and was designed to identify areas that may be suitable for the species based on intrinsic characteristics of the landscape. The second model (current model) also integrated more dynamic variables associated with current land cover conditions, and was designed to identify sites that may be suitable for the species, given constraints of land cover characteristics. This map represents the differences in predictions among the two models: black areas represent sites for which prediction of habitat did not change from the potential to the current model; blue represents sites predicted as potential but not current habitat, and yellow represents sites predicted as current but not potential habitat.

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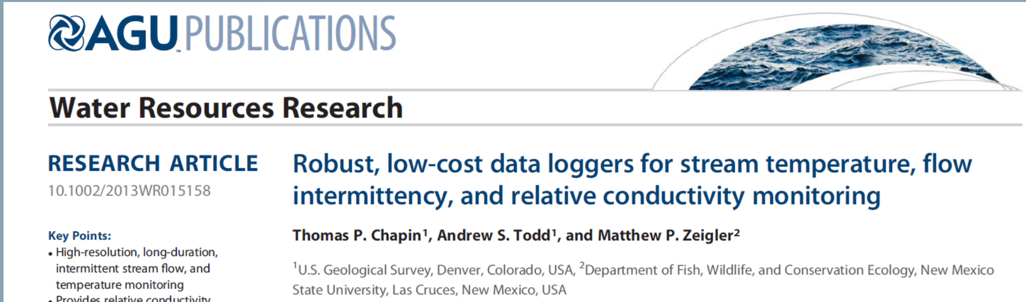
AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE

10.1002/2013WR015158

Robust, low-cost data loggers for stream temperature, flow intermittency, and relative conductivity monitoring

Thomas P. Chapin[1], **Andrew S. Todd**[1], **and Matthew P. Zeigler**[2]

[1]U.S. Geological Survey, Denver, Colorado, USA, [2]Department of Fish, Wildlife, and Conservation Ecology, New Mexico State University, Las Cruces, New Mexico, USA

Key Points:
- High-resolution, long-duration, intermittent stream flow, and temperature monitoring
- Provides relative conductivity

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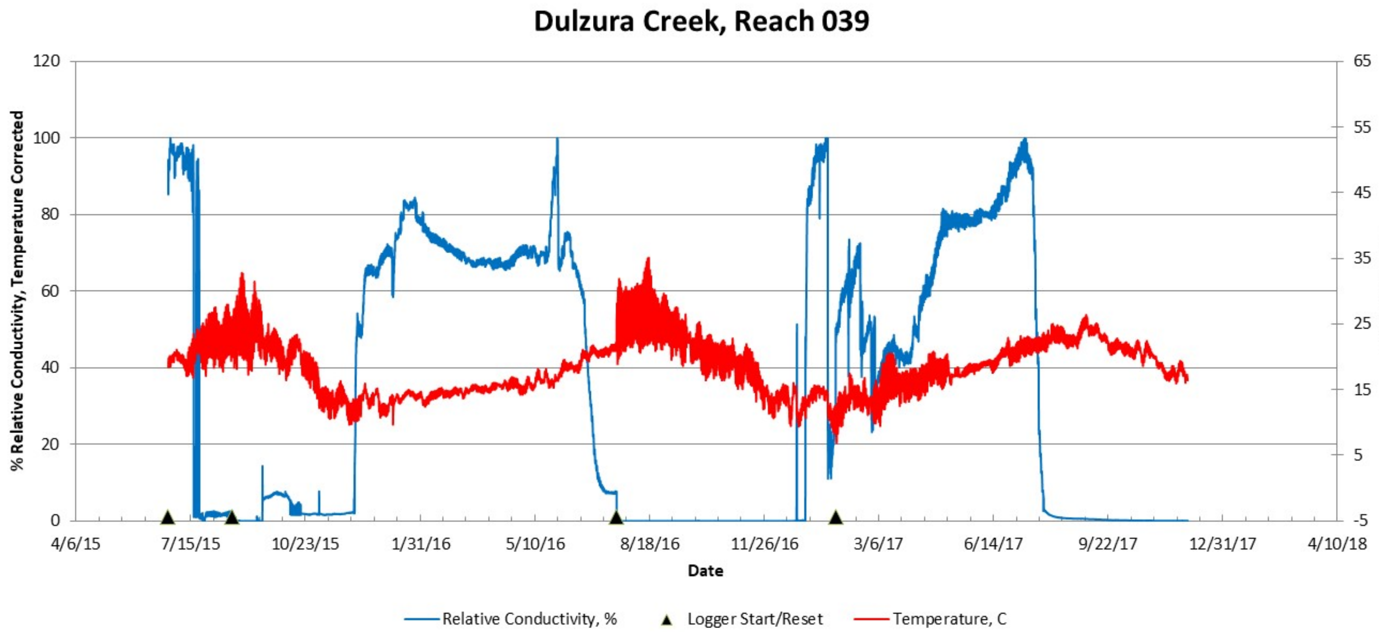
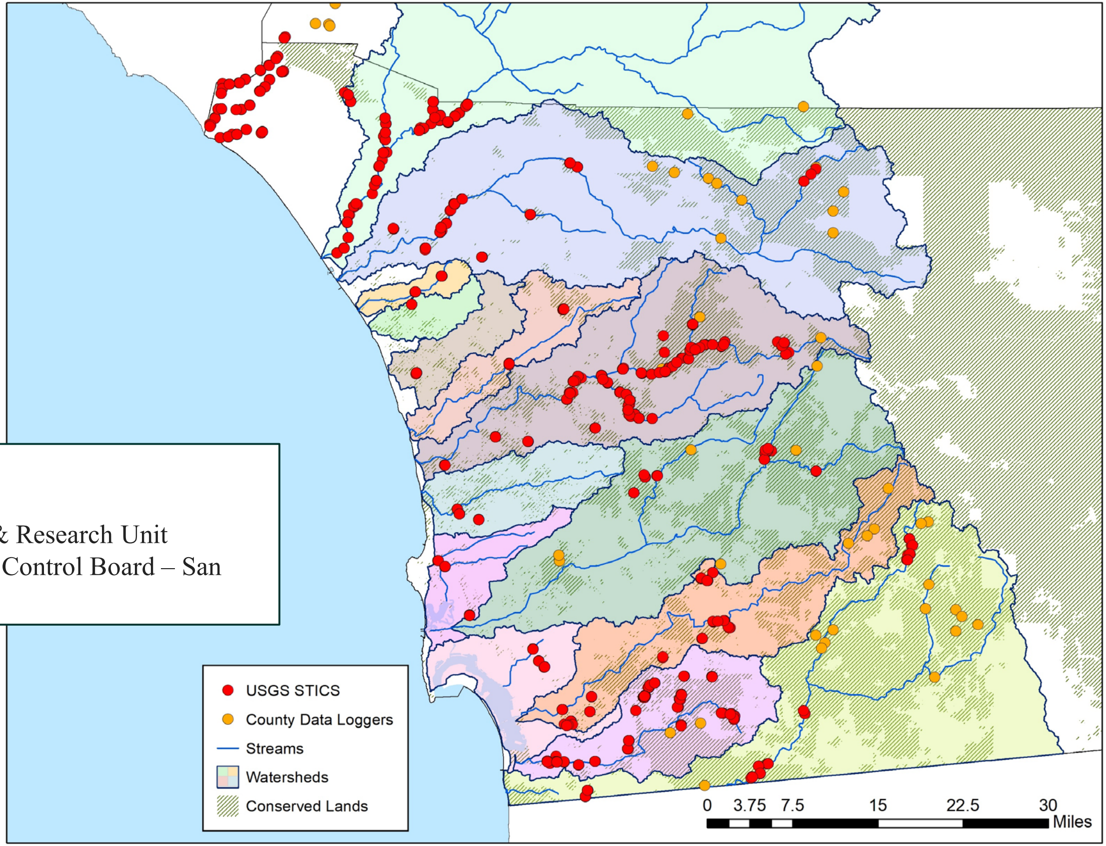

Dulzura Creek, Reach 039
120
100
80
60
40
20
0
% Relative Conductivity, Temperature Corrected
65
55
45
35
25
15
5
-5
Temperature °C
4/6/15
7/15/15
10/23/15
1/31/16
5/10/16
8/18/16
11/26/16
3/6/17
6/14/17
9/22/17
12/31/17
4/10/18
Date
Relative Conductivity, %
Logger Start/Reset
Temperature, C

Sites with Dataloggers starting in 2015



Orange dots:
Chad L Loflen
Monitoring Assessment & Research Unit
California Water Quality Control Board – San Diego Region

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