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Arroyo Toads (*Bufo californicus*) in MCBCP; Findings from 5 years of Population Monitoring and Program Review

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Overview

Introduction

- Arroyo toad
- History of Monitoring on MCBCP
- Occupancy Monitoring Program & Goals

Monitoring Results

- Findings and Trends
- Management Recommendations

Program Review

- Power Analysis
- Evaluation of Sampling Protocols
- Protocol Recommendations

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Arroyo Toad (*Bufo californicus*)

- **Habitat Specialist**
  - Low gradient streams/rivers
  - Sandy substrates/ terraces
  - Breeding- low flow shallow pools
- **Federally Endangered**
  - Range from Monterey County to northern Baja
  - Occupies 25% of former habitat

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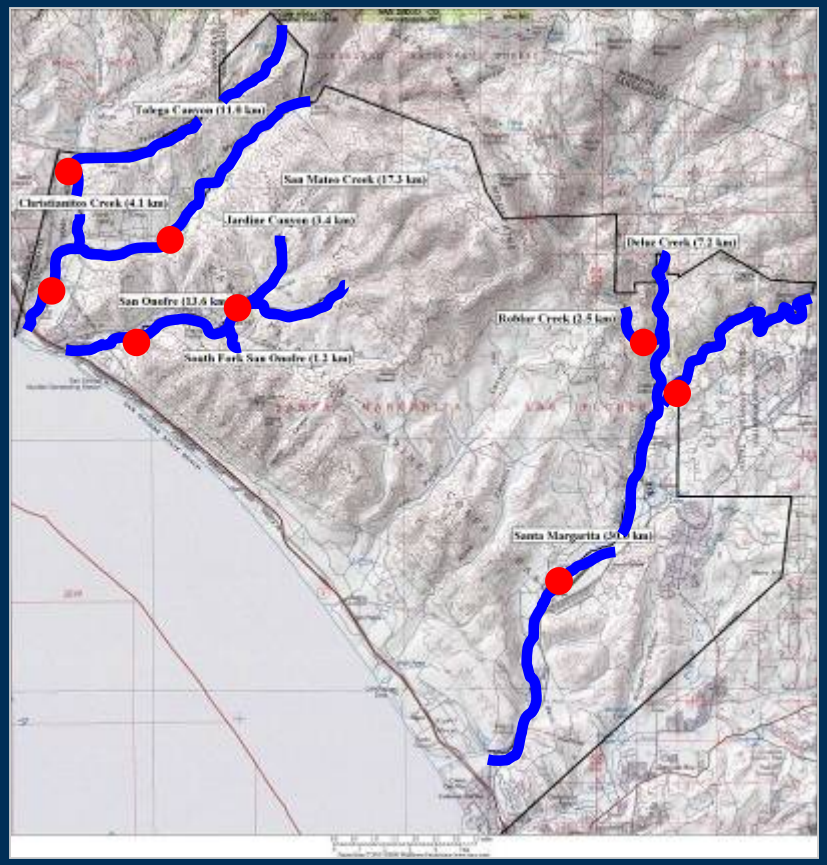
MCBCP Arroyo Toad Monitoring: Camp Pendleton

- Part of Southern California Coastal Recovery Unit (Subregion 7, Unit 3, FWS)
- 3 major watersheds
- 87 km arroyo toad habitat



- Holland 1 km transects 1996-2000

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MCBCP Arroyo Toad Monitoring: Camp Pendleton- 1996-2001

Monitoring Program

- 8- 1km transects - Selectively placed
- Night Counts of Toads- ~ 4X year

Results:

- Highly Variable (survey, site)
- Counts = x*Abundance + y*Detectability + z*Activity (x,y,z?)
- Don’t know what it is telling us about toad populations.
- Abundance- individual detection probability =0.2
- Cannot infer results across species on Base

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MCBCP Arroyo Toad Monitoring: Camp Pendleton- 1996-2000

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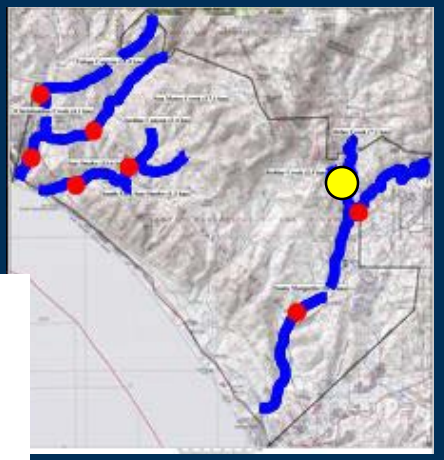

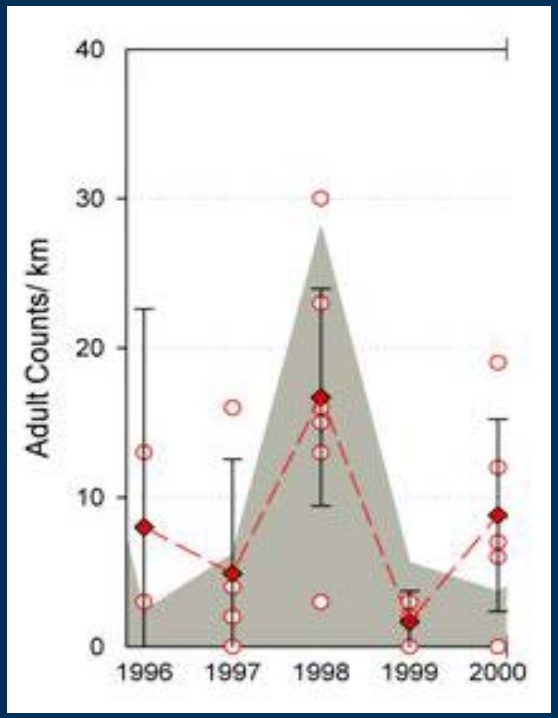

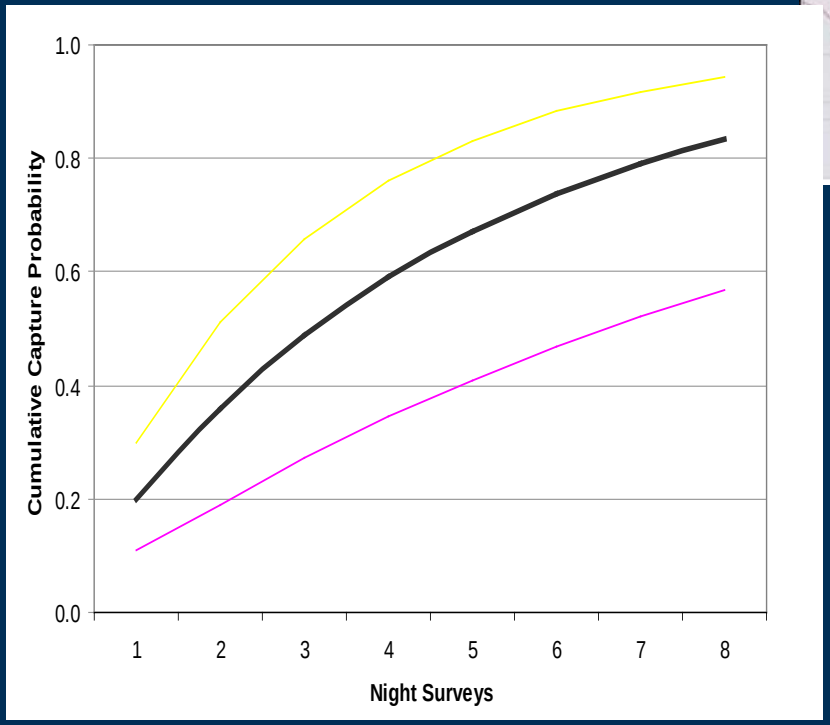

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MCBCP Arroyo Toad Monitoring: Program Goals

- MCBCP contracted USGS in 2002.
- Track trends in breeding populations over entire base within 3 occupied drainages
- Long term monitoring metric least affected by short term fluctuations
- Recommend management actions
- Cost effective
- Scientifically rigorous

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MCBCP Arroyo Toad Monitoring: Multi-agency task force

- U.S. Geological Survey
- Fish and Wildlife Service
- MCB Camp Pendleton
- U.S. Forest Service
- Outside Independent scientists
  - Brad Shaffer
  - Ted Case, UCSD
  - Norm Scott

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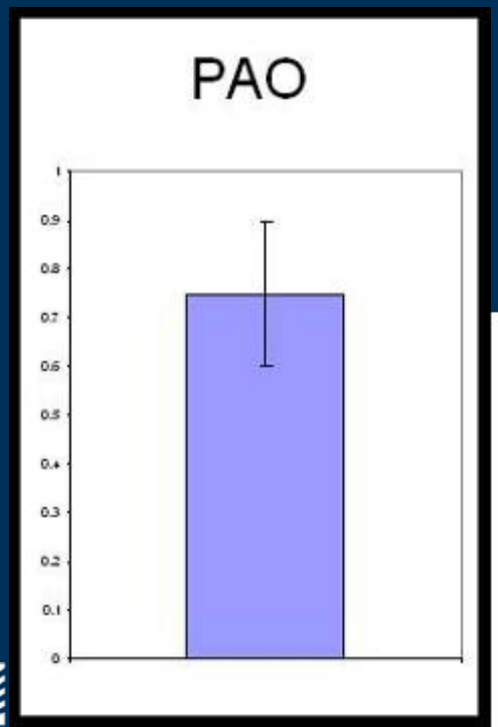
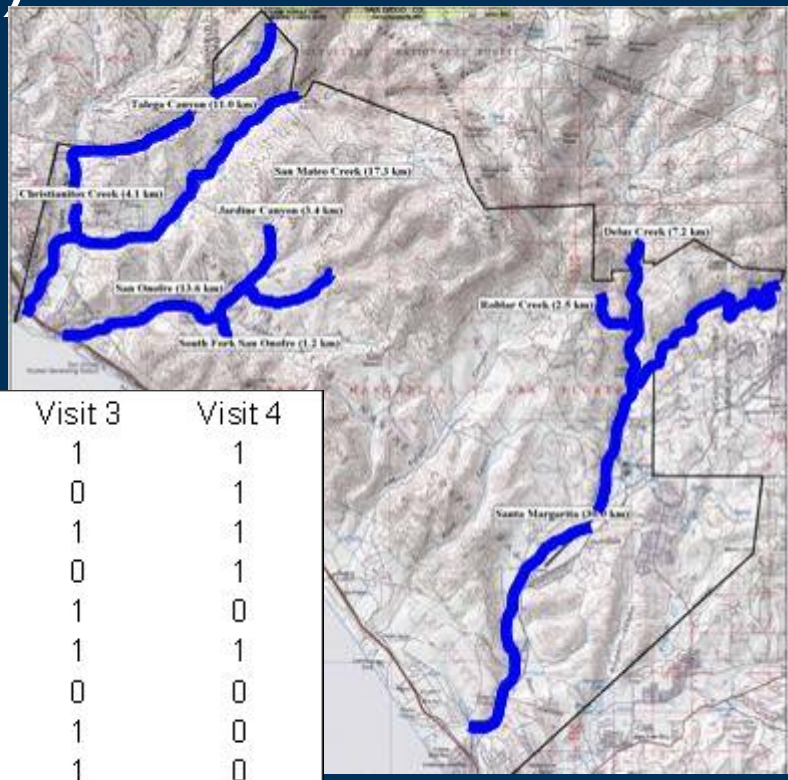
MCBCP Arroyo Toad Monitoring: Design (Implemented 2003)

- **Spatial Approach** (Proportion Area Occupied- MacKenzie et al. 2002, 2003)

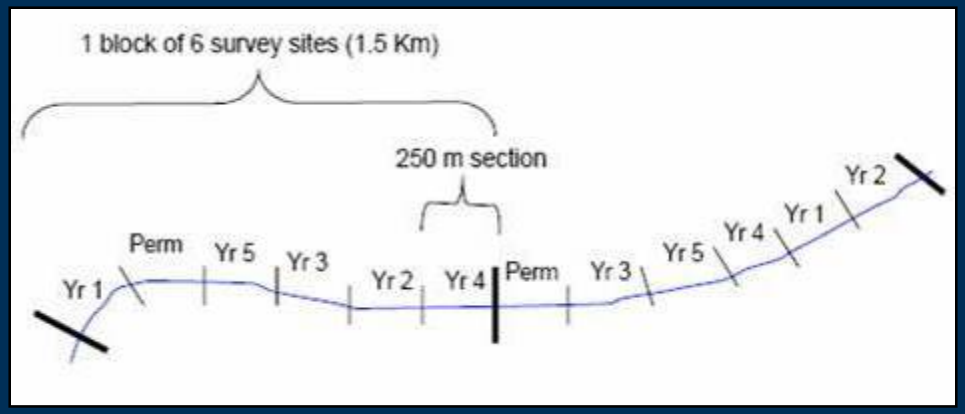


	Visit 1	Visit 2	Visit 3	Visit 4
Site 1	0	1	1	1
Site 2	0	1	0	1
Site 3	1	1	1	1
Site 4	1	1	0	1
Site 5	1	0	1	0
Site 6	1	1	1	1
Site 7	1	1	0	0
Site 8	1	0	1	0
Site 9	0	1	1	0
Site 10	1	1	0	1



MCBCP Arroyo Toad Monitoring: Design

- **Spatial Approach** (Proportion Area Occupied- MacKenzie et al. 2002, 2003)
- **357 survey transects** (250m each)
- **Rotating Panel Design**



5-Year Rotation pattern among groups of sites

		Year						
Group	**# Sites**	2003	2004	2005	2006	2007	2008	2009
Perm (all yrs)	50	X	X	X	X	X	X	X
A=Year 1	50	X					X	
B=Year 2	50		X					X
C=Year 3	50			X				
D=Year 4	50				X			
E=Year 5	50					X		

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Atkinson et al. 2003

MCBCP Arroyo Toad Monitoring: Design

- **Spatial Approach** (Proportion Area Occupied- MacKenzie et al. 2002, 2003)
- **357 survey transects** (250m each)
- **Rotating Panel Design**
- **Survey for AT tadpoles**

DP: 0.85 vs. 0.45

(2003 USGS data)

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MCBCP Arroyo Toad Monitoring: Design

- **Spatial Approach** (Proporti
  MacKenzie et al. 2002, 200
- **357 survey transects**
- **Rotating Panel Design**
- **Survey for AT tadpoles**
- **Covariates**
  - **Site Specific**
  - **Survey Specific**

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MCBCP Arroyo Toad Monitoring: 2 programs

1) **Proportion Area Occupied-**

120- 250m transects – day surveys- eggs/ tadpoles

- 2003- Pilot Studies, Pilot Monitoring
- 2004- Refinement of Protocol

2) Adult counts (continued from 1996)

8- 1 km transects –night surveys

- Holland and Sisk 1996-2000 (average of 4 visits per season)
- USGS 2003-2008 (3 visits per season)

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MCBCP Arroyo Toad Monitoring:

Parameters

- **Initial occupancy** (ψ)
- **Probability of detection** (ρ)
- **Colonization/ extinction** (γ, ε)

Covariates 2003*, 2004- 2008

- **Entrenchment ratio** (ψ, γ, ε)
- ***Sand cover** (ψ, γ, ε)
- **Aquatic veg. cover** (ψ, γ,, ρ)
- **Disturbance level** (ψ, γ, ε)
  - Artillary, troops, heavy equipment
- **Hydroperiod** (ψ, γ, ε)
  - current year
  - previous year
- ***Pres. of predators/competitors** (ψ, γ, ρ)
  - Bullfrog, crayfish, mosquitofish, lg pred. fish, Non-native Index (0-4): Total 1st four above
- **Pres. of low flow shallow water** (ρ)
  - Index (0-5): [0, 1-10%], 11-25%, 26-50%, 51-75%, >75%

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MCBCP Arroyo Toad Monitoring:

2004-2008 Occupancy Models: Results

Colonization/ extinction (γ, ε)

- Hydrology (ephemeral vs. perennial)
- Year - nonequilibrium

Probability of detecting arroyo toads (ρ)

- ↑Low Flow Shallow water Index
  - 1.4X more likely to detect AT for each level of index
  - Cumulative 5.4X
- ↓Non-native index (0-4)
  - Mosquitofish, bullfrogs, crayfish, predatory fish
  - 1.8X less likely per species/group
  - Cumulative 10.5X

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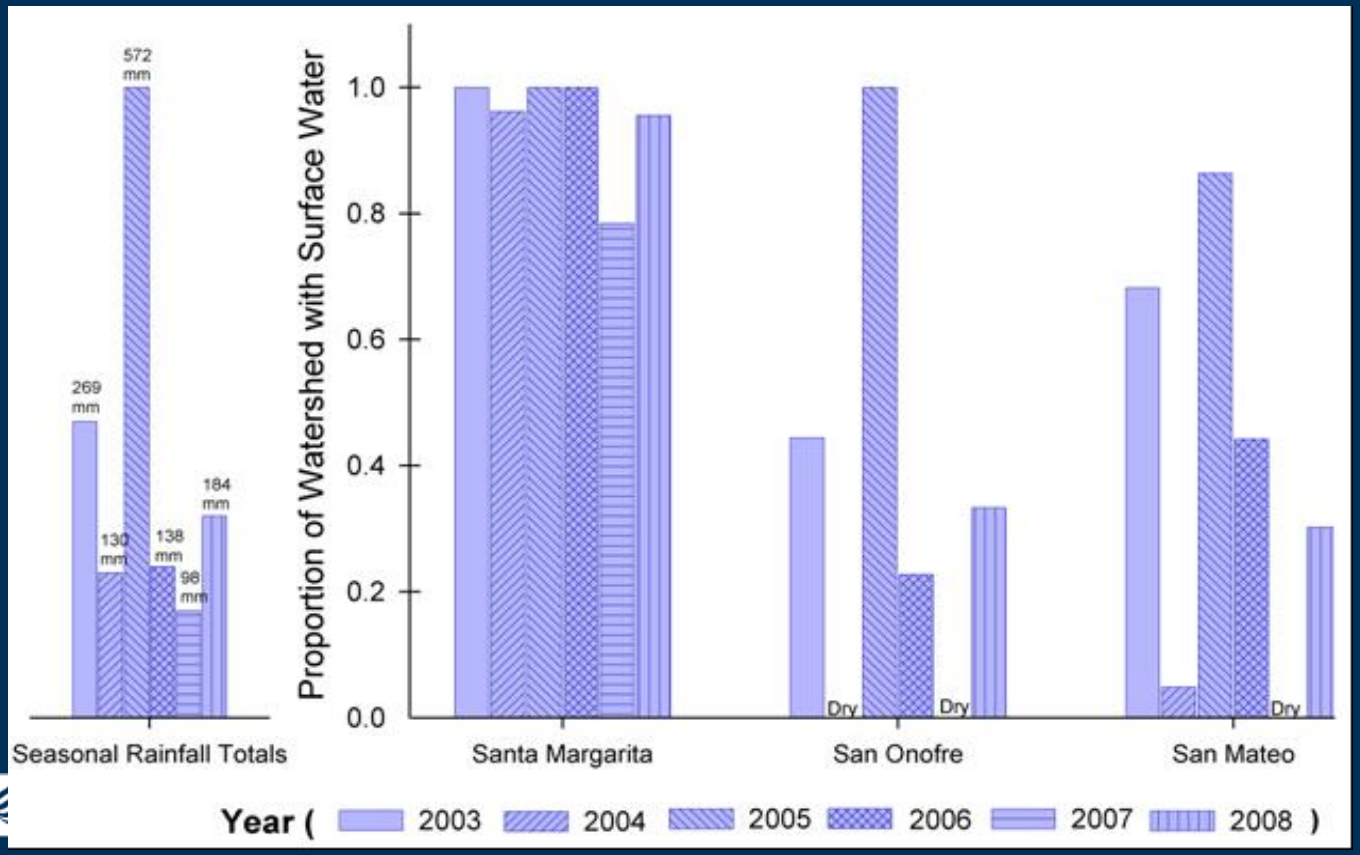
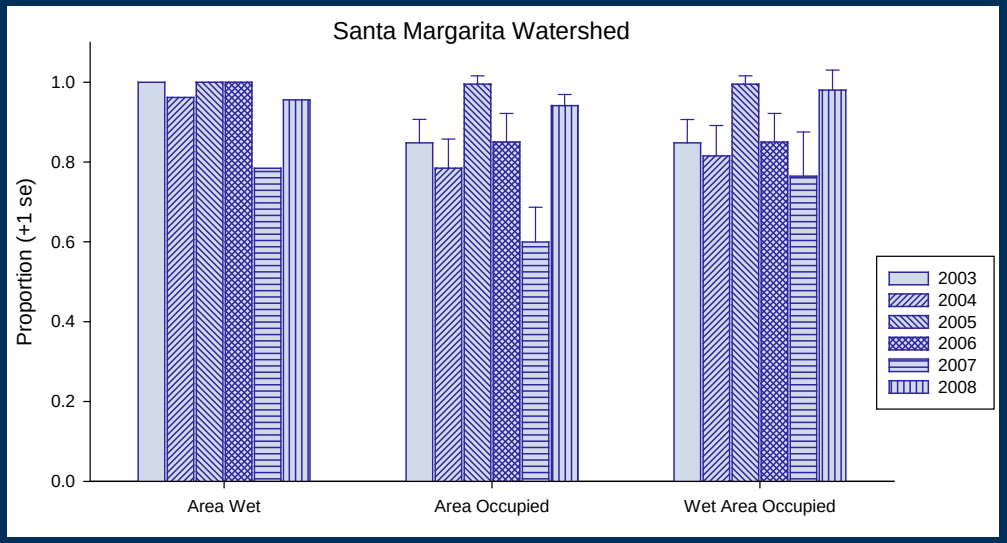
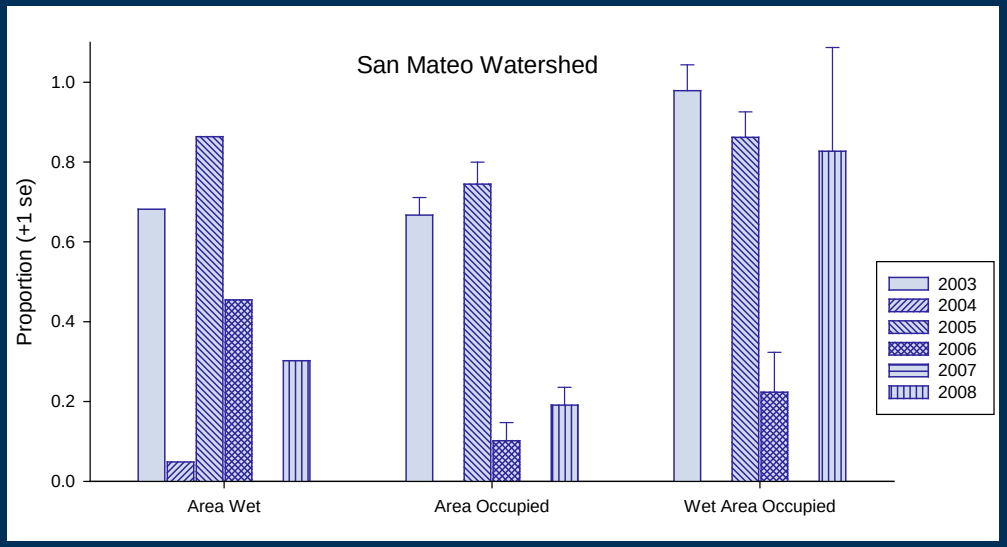
MCBCP Arroyo Toad Monitoring: Trends- Ephemeral v. Perennial

2003-2008 Rainfall Patterns and Proportion of each watershed with surface water for AT breeding



MCBCP Arroyo Toad Monitoring: Trends- Ephemeral v. Perennial





Importance of Wet Years

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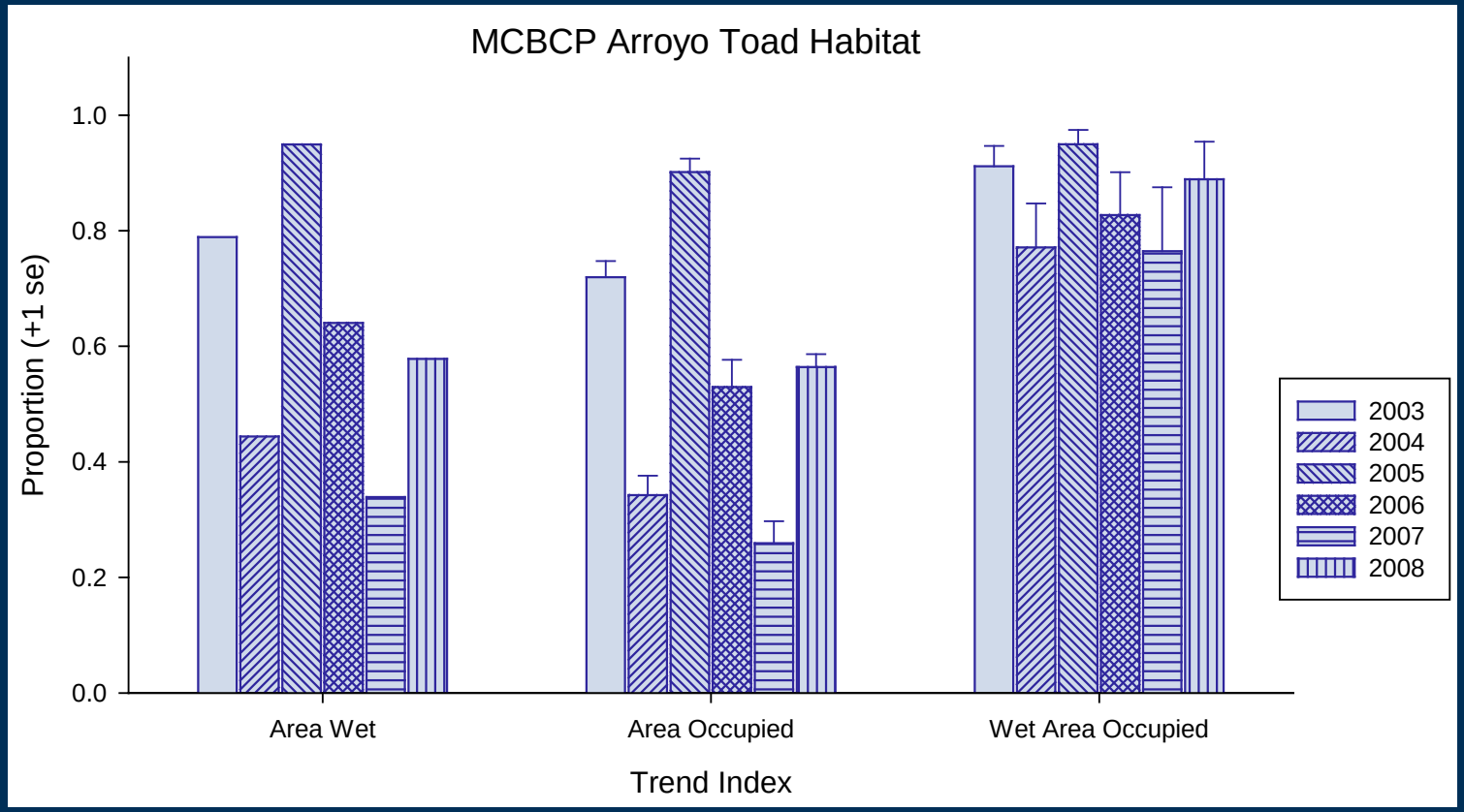
MCBCP Arroyo Toad Monitoring: Trend Metrics-Occupied Habitat



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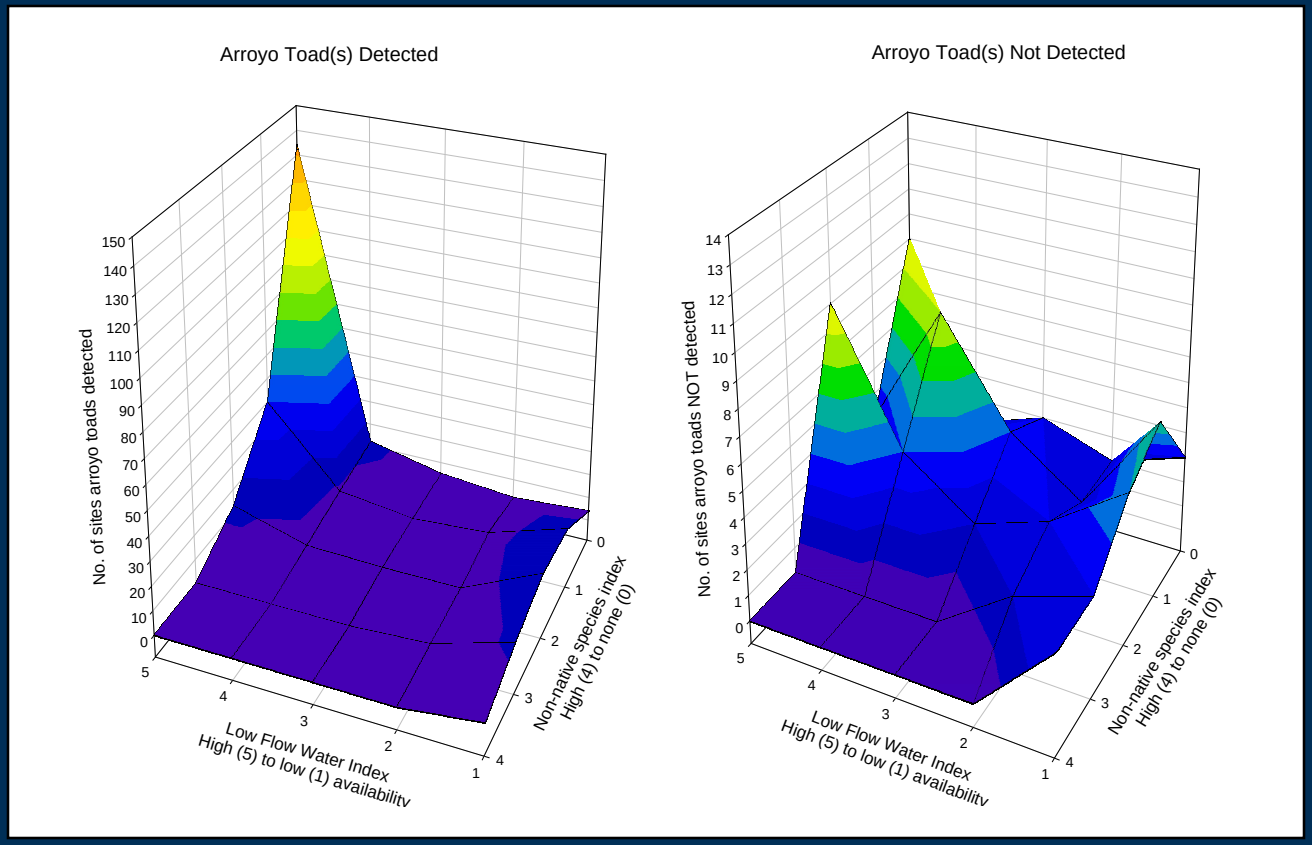
MCBCP Arroyo Toad Monitoring:

- **Arroyo toad presence in relation to low flow shallow water and non-native species indices**



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Non-native species-Direct effects
2008 Bullfrog Study

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One night of dead toads

2008 Estimate: 120 toads consumed per km per month by bullfrogs- Breeding Season in lower Santa Margarita River

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MCBCP Arroyo Toad Monitoring: Conclusions

- Proportion Wet Area Occupied is most stable long-term monitoring metric
- Population dynamics differ in ephemeral vs. perennial waters.
  - Ephemeral- stochastic processes
  - Perennial- deterministic processes
- Probability of detecting arroyo toads are significantly & negatively associated with the presence of non-native aquatic species
- Association likely from both direct effects (predation/competition) and indirect effects (change in hydrology)
- Adult counts not informative for tracking population trends: Primary benefits: document presence of toads in dry years, document calling/onset of breeding.

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MCBCP Arroyo Toad Monitoring: Management Recommendations

- Modify water releases at the Temecula Gorge (Cooperative Water Resource Management Agreement between MCBCP and Rancho California Water District) to simulate natural pattern.
- Continue non-native aquatic species control (bullfrogs, crayfish, beaver, plants)
- Continue to manage military training activities within riparian and channel areas during the early breeding season (February- July).
- Prevent or minimize habitat loss in upland areas.
- Support creation of models and mitigation measures to address impacts of the Orange County HCP (SSNCCP), Santa Rosa Plateau development, and the proposed Foothill-South Toll Highway on the hydrology of the San Mateo Watershed.

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MCBCP Arroyo Toad Monitoring: Program Review

Power Analysis- 4 sampling scenarios

- Current Design: 60 permanent + 60 5-yr rotation
- Alternate 1: same effort: 120 permanent sites
- Alternate 2: reduced effort: 60 permanent sites
- Alternate 3: current design- sampled every other year

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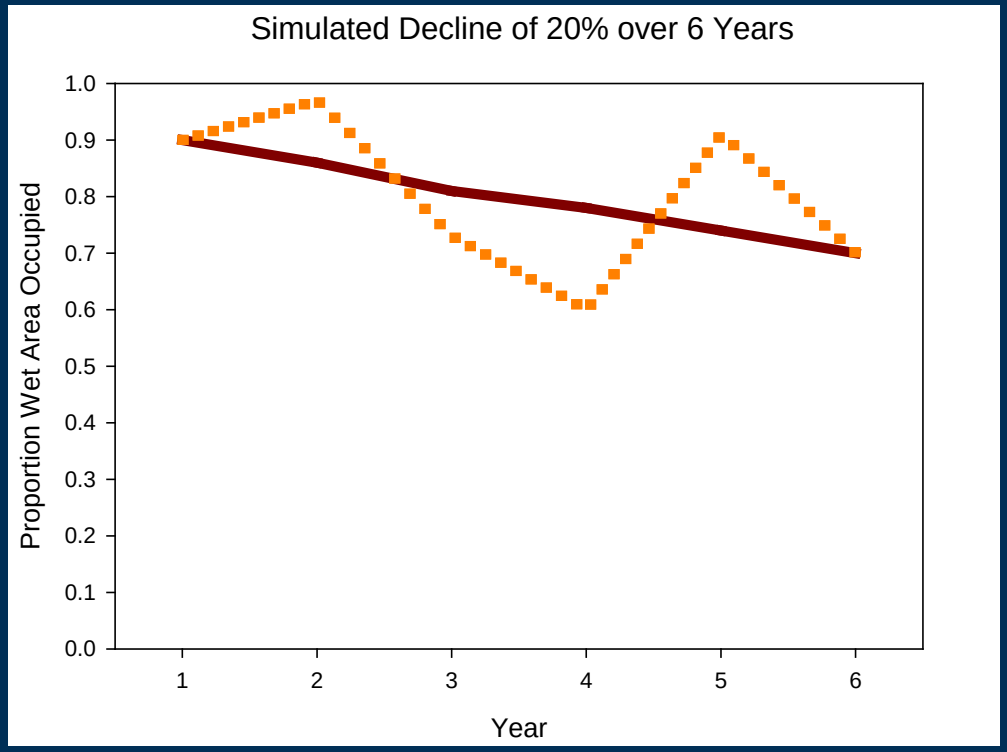
MCBCP Arroyo Toad Monitoring: Program Review

Data simulated: 20% decline over 6 years

- Ephemeral sites: Variable declines/ increases (good & bad years)
- Perennial: Constant slow decline



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MCBCP Arroyo Toad Monitoring: Power Analysis: 4 Sampling Scenarios

Comparison to 'True' Data & Models

- **Bias and Precision**

- **Model Comparisons (LRT, power $\chi 2$, $\alpha = 0.05$)**
  - Power to detect 20% decline over 6 years vs. no change
  - Ephemeral & Perennial
  - Power to distinguish different patterns of decline (i.e ephemeral perennial 'groups')

- **'True models': p-values (t-tests)**
  - Perennial- Extinction coefficient different from 0
  - Perennial- % occupancy Year 1 vs. Year 6 significantly different?
  - Ephemeral- % occupancy Year 1 vs. Year 6 significantly different?

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MCBCP Arroyo Toad Monitoring: Power Analysis: 4 Sampling Scenarios

		Sample Designs			
		Current Design: 60 Sites Permanent & 60 Sites Rotation	120 Sites Permanent	60 Sites Permanent	60 Sites Permanent & 60 Sites Rotation sampled every other year
		Same effort	Same effort	Reduced effort	Reduced effort*
Bias (observed /expected)	Ψ	+4%	+3%	+3%	+3%
	ε	-31%	-23%	-29%	-6%*
	γ	-25%	-26%	-26%	-31%*
	ρ	+2%	+3%	0%	-1%
Precision (standard error /mean)	Ψ	5%	6%	8%	5%
	ε	35%	31%	47%	29%*
	γ	58%	41%	58%	85%*
	ρ	2%	2%	3%	3%

Abbreviations: psi= occupancy (Ψ), gamma= colonization rate (γ), eps= extinction rate (ε), p= detection probability (ρ)

* extinction and colonization not directly comparable to annual efforts

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MCBCP Arroyo Toad Monitoring: Power Analysis: 4 Sampling Scenarios

		Sample Designs			
		Current Design: 60 Sites Permanent & 60 Sites Rotation	120 Sites Permanent	60 Sites Permanent	60 Sites Permanent & 60 Sites Rotation sampled every other year
Comparison	Model/ Test	Same effort	Same effort	Reduced effort	Reduced effort
Constant extinction (perennial)	Power α=0.05	91%	97%	68%	81%
Variable colonization/ extinction (ephemeral)	Power α=0.05	100%	100%	100%	100%
Distinguish groups (ephemeral vs. perennial)	Power α=0.05	100%	100%	99%	87%
Estimated parameters from "true" models	Per: ε = 0	p<0.0001	p<0.0001	p<0.0001	p<0.0001
	Per: Yr 6 = Yr 1	p=0.054	p=0.074	p=0.108	p=0.063
	Eph: Yr 6 = Yr 1	p=0.067	p=0.074	p=0.097	p=0.062

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MCBCP Arroyo Toad Monitoring Program Review : Conclusions & Recommendations

- **Current and alternate sampling strategies evaluated all have high power to detect:**
  - Annual fluctuations
  - Long-term gradual decline
  - Differing patterns of decline among watersheds

Recommended Strategies:

- Trends over time = 120 permanent sites
- Coverage of entire Base over time = current program (60 perm+60 rotation)
- Reduced effort = 60 permanent sites
  - Sampling every other year not recommended due to importance of wet year for assessing status of populations in ephemeral systems.

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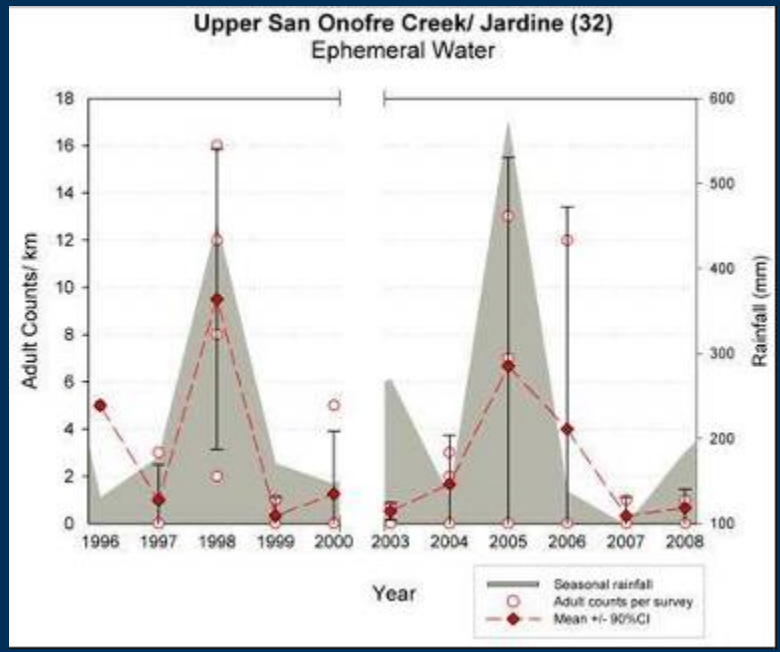
MCBCP Arroyo Toad Monitoring Program Review : Conclusions & Recommendations

- **Recommend Discontinuation of Night Count Surveys as Monitoring Program.**
  - Few night surveys each year sufficient to establish onset of breeding
  - Night surveys can be done in low rainfall years to try to document toads on dry transects
  - Big savings cost & effort

- **Addition of density metric- AT larvae**



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MCBCP Arroyo Toad Future Studies:

- Unknown: Toad movement- overwintering
  - Effect of Arundo removal in lower Santa Margarita River
  - Upland movement in relation to watersheds, landscape, and channel characteristics
  - Direct Relation to habitat management

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