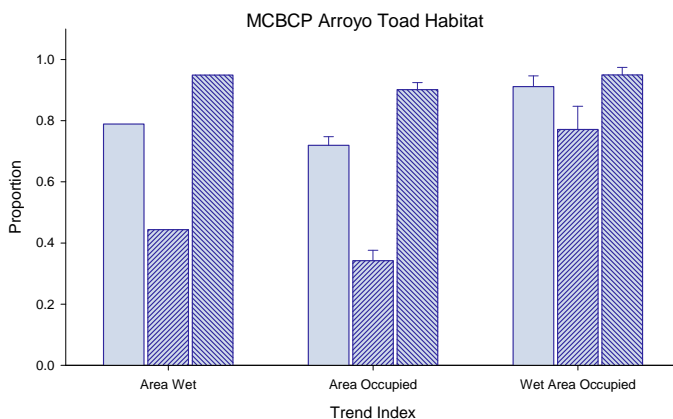


Arroyo Toad Population Monitoring in Southern California; Findings and Trends

In 2003, we implemented a PAO monitoring program for the endangered arroyo toad (*Bufo californicus*) on 87 km of aquatic habitat comprising 3 watersheds within Marine Corps Base Camp Pendleton (MCBCP). Using a part permanent, part rotating panel design, we surveyed 240 sites for the presence of *eggs and larvae* up to 4 times per year. We characterized each site for a suite of landscape, environmental, and hydrological variables. In addition, we continued to conduct nighttime counts of *adult* toads on 8 fixed 1km transects from the monitoring program implemented by Dan Holland in 1996.

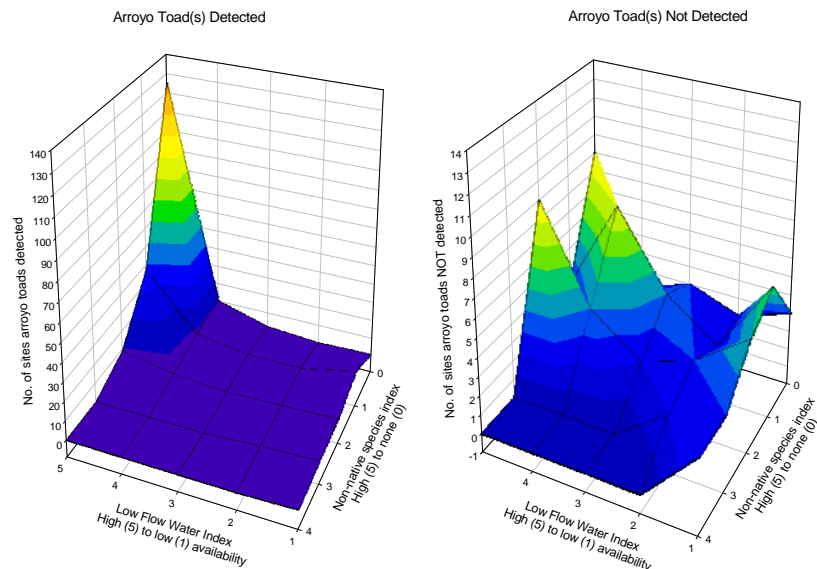
Results: 2003-2005 PAO Monitoring (eggs/larvae)

- High variability in annual rainfall and surface water (44-95%).
- Breeding toad occupancy in wetted areas was relatively stable (77-95%) with no significant change over the three year period.



- PAO Models were evaluated to determine if covariates were predictive of arroyo toad detection probability, occupancy, and/or colonization probabilities.

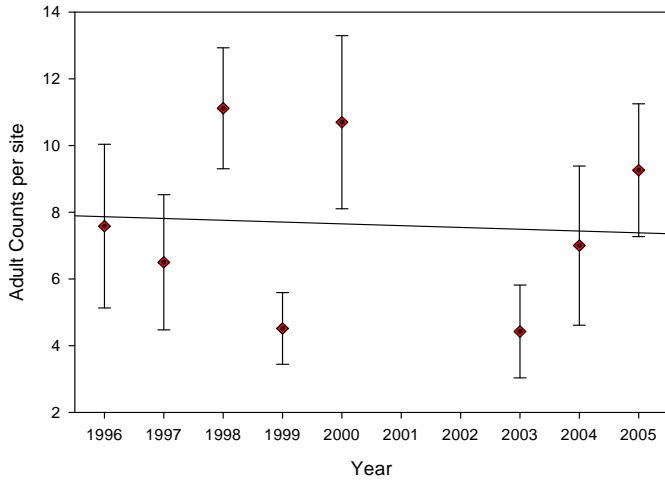
- Detection probability: The probability of detecting arroyo toad larvae was positively associated with proportion of low-flow shallow water and negatively associated with number of non-native species. These two variables were correlated with one another, so that during the arroyo toad breeding season, non-native species were associated with deep and faster flowing water.



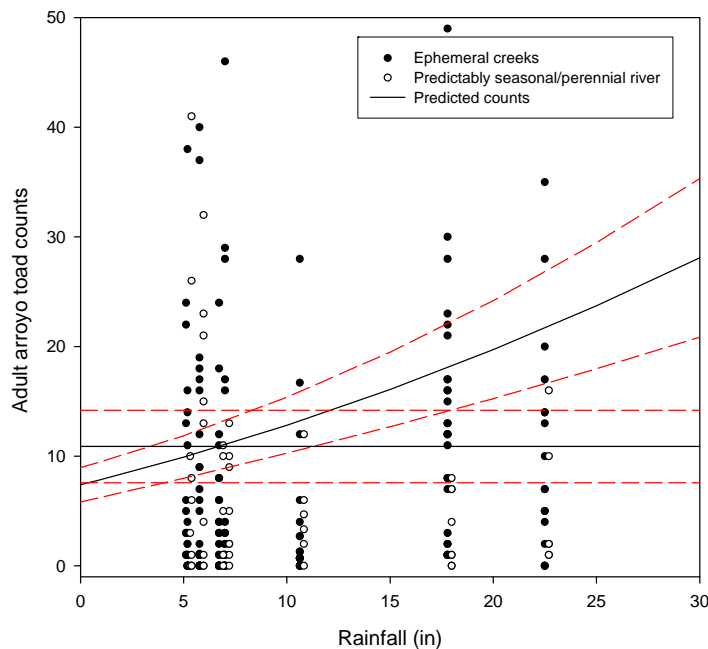
- Occupancy: absence of crayfish and low numbers of non-native species were the two most significant predictors of arroyo toad presence.
 - The probability that arroyo toads occupied a site was 11.6 times lower when crayfish were present. Occupancy probability was 2.9 times lower for each aquatic non-native species/class, so at a site where we found all four non-native species/classes, we were 70 times less likely to find arroyo toad larvae.
- Colonization/Extinction: Models did not converge for most analyses. Future years of data should increase power to evaluate effects of covariates on these parameters.

Results: 1996-2005 Adult counts

- Adult activity had high annual variability (+/- 44% of mean), but has been relatively stable over the last decade.



- Population dynamics differ among the watersheds according to hydroperiod. Toad activity (adult counts) in the *ephemeral* watersheds was significantly associated with the amount of seasonal rainfall. In contrast, toad activity in the *predictably seasonal to perennial* Santa Margarita River watershed was not.



Threats of increasing urbanization of upper watersheds outside base:

- Increased impervious surface areas alter runoff patterns and watershed hydrology.
- Change from ephemeral to more perennial systems with deeper channels with faster water flow.
- Lower water quality.
- Increased colonization of non-native competitors and predators.

Management Implications:

- Control of non-native aquatic species, especially crayfish and bullfrogs.
- Hydrological engineering considerations in development and mitigation plans to lessen impacts of increased urbanization.

Future analyses:

- Association of environmental covariates (i.e. hydroperiod, non-native species) with colonization & extinction rates.
- PAO analyses of other co-occurring amphibian species (*Bufo boreas*, *Rana catesbeiana*, *Pseudacris cadaverina*, *Pseudacris regilla*)

Predictive equations:

Ephemeral creeks
 $y = (2.72 + 0.086 * \text{RAINFALL (in)})^2$
 $p = <0.0001$

Predictably seasonal/perennial river
 $y = 10.89$ (se = 3.3)
 Not different from null