

Potential Effects of Climate Change on High Elevation Amphibians and Reptiles in the Sierra Nevada

Carrie Sendak and Kathleen Matthews
USFS Pacific SW Research Station
Sierra Nevada Research Center
Albany, CA



Species

- **Pacific chorus frog** (*Pseudacris regilla*)
 - Formerly Pacific treefrog (*Hyla regilla*)
 - Widely distributed
 - Adults highly terrestrial
 - “Quick” breeders (2-3 months to metamorphosis)
 - No state or federal status

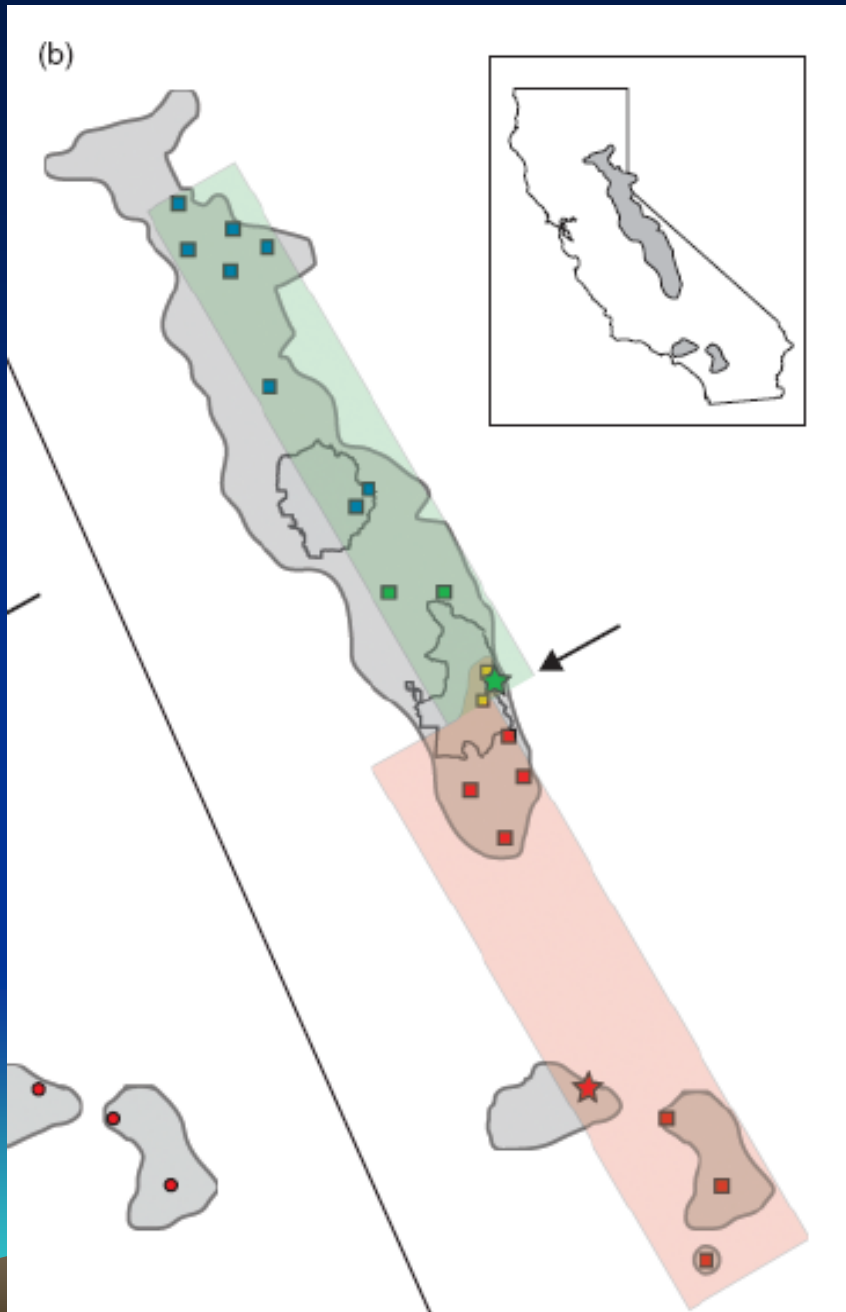


Species

- **Formerly: Mountain yellow-legged frog** (*Rana muscosa*)
 - **Currently 2 species:**
 - Sierra Nevada mountain (*Rana sierrae*)
 - Sierra Madre or Southern mountain (*Rana muscosa*)
- (Vredenburg et al. 2007)



RASI / RAMU Distribution

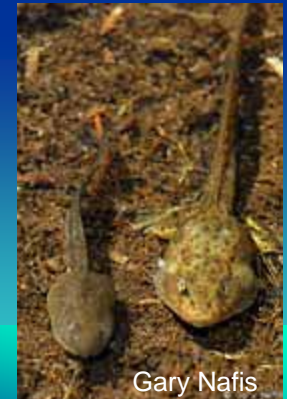


- Contact zone
 - Middle and South Fork Kings River
 - Kings Canyon National Park

From: Vredenburg et al. 2007

More on RASI / RAMU

- Breeds in alpine lakes or slow-moving streams
- Tadpoles overwinter in lakes - 2-4 year larval stage
- Highly aquatic (all life stages)
- Status:
 - DFG – Special Concern
 - USFS – Sensitive
 - Found warranted for federal ESA listing



Species

- **Yosemite toad** (*Bufo canorus*)
- Breeds in wet mountain meadows (up to 11,300ft)
- Larval stage ~ 2 months
- Adults highly terrestrial
- Status:
 - DFG – Special Concern
 - USFS – Sensitive
 - Found warranted for federal ESA listing



Species

- **Southern long-toed salamander** (*Ambystoma macrodactylum sigillatum*)
- At higher elevations, breeds in permanent ponds or lakes
- 2-3 year larval stage
- No state or federal status



Amphibian Declines

- Habitat Fragmentation
- Pesticides / Herbicides
- Introduced, Invasive Species
 - Disease
 - Climate Change



How Does Climate Change Play a Role?

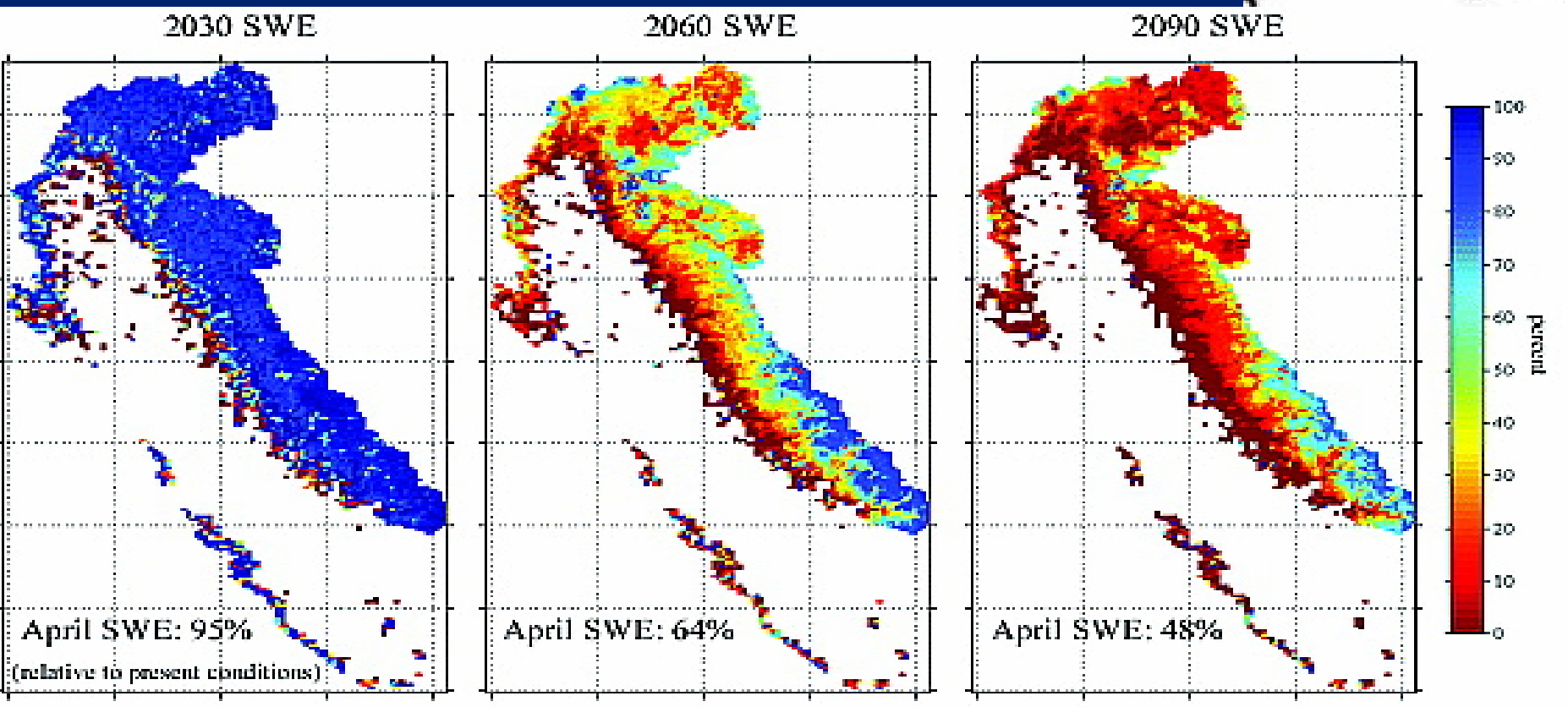


Predicted Effects for the Sierra Nevada

- Increase in temperature (anywhere from 2-6°)
 - 50 - 90% decrease in snowpack by 2099
 - Increase in precipitation fallen as rain
 - Earlier spring snowmelt
 - Several models, variable predictions
- High elevation predictions still need more research



Changes in Snow-Water Equivalent



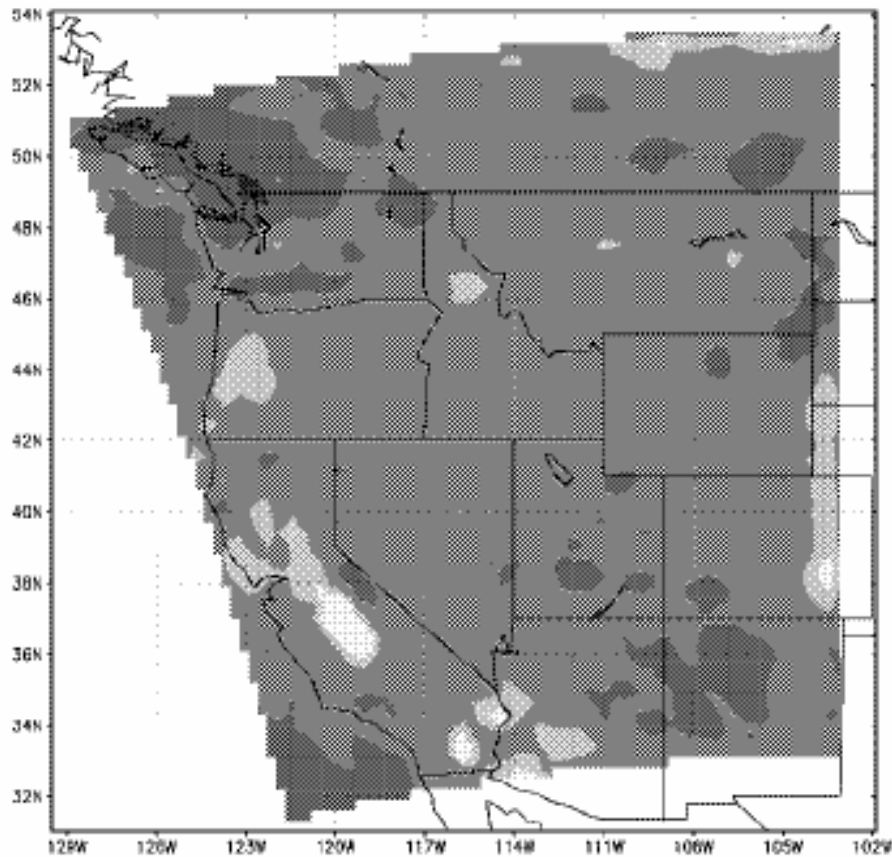
From: Knowles and Cayan 2002

Seasonal Effects on Precipitation

Summer

Change in 95% precipitation

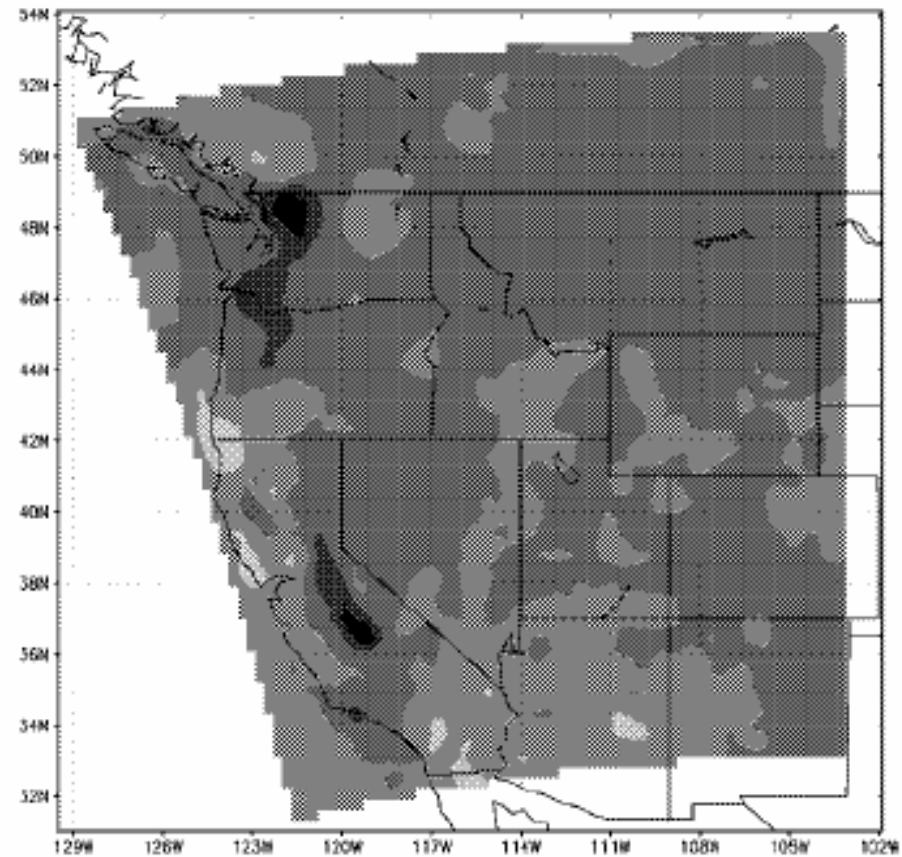
JJA



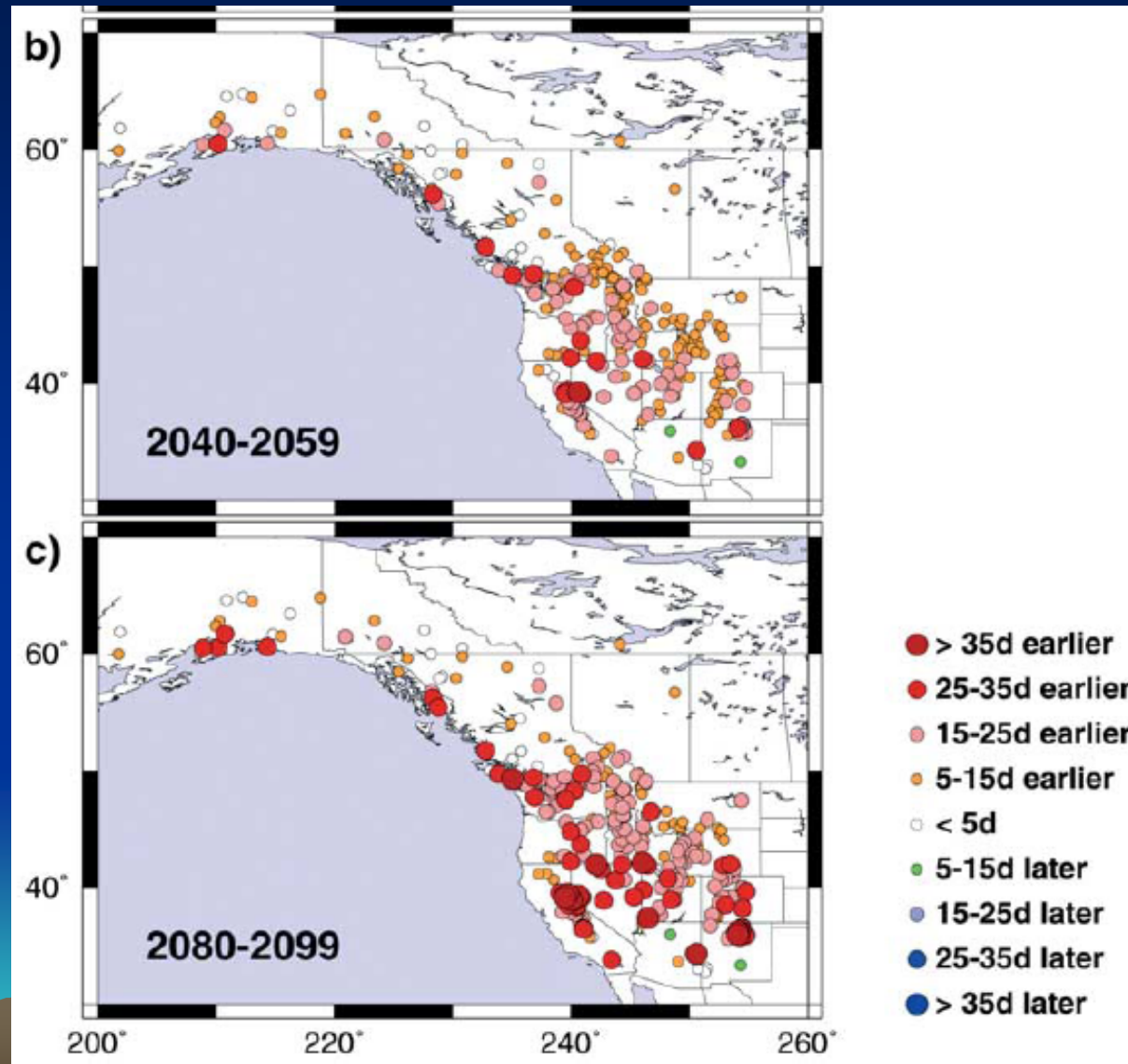
Winter

Change in 95% precipitation

DJF



Changes in Timing of Spring Snowmelt



From: Stewart et al. 2004

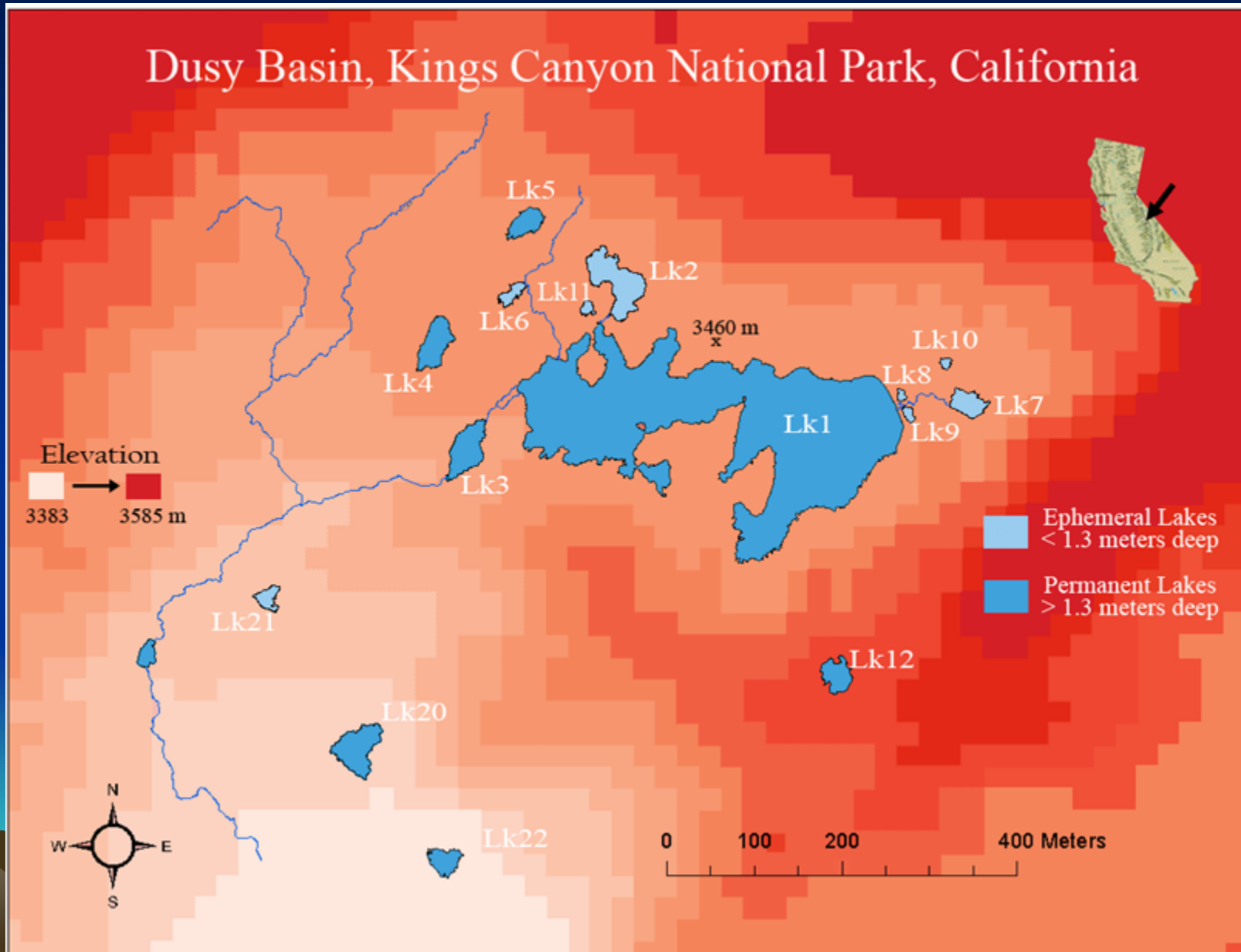
What does this Mean for High Elevation Amphibians?

- Effects will vary for different species
- Reduced larval recruitment (more sink habitats)
 - Interaction of nonnative trout and reduced recruitment
 - Shifts in breeding phenology?

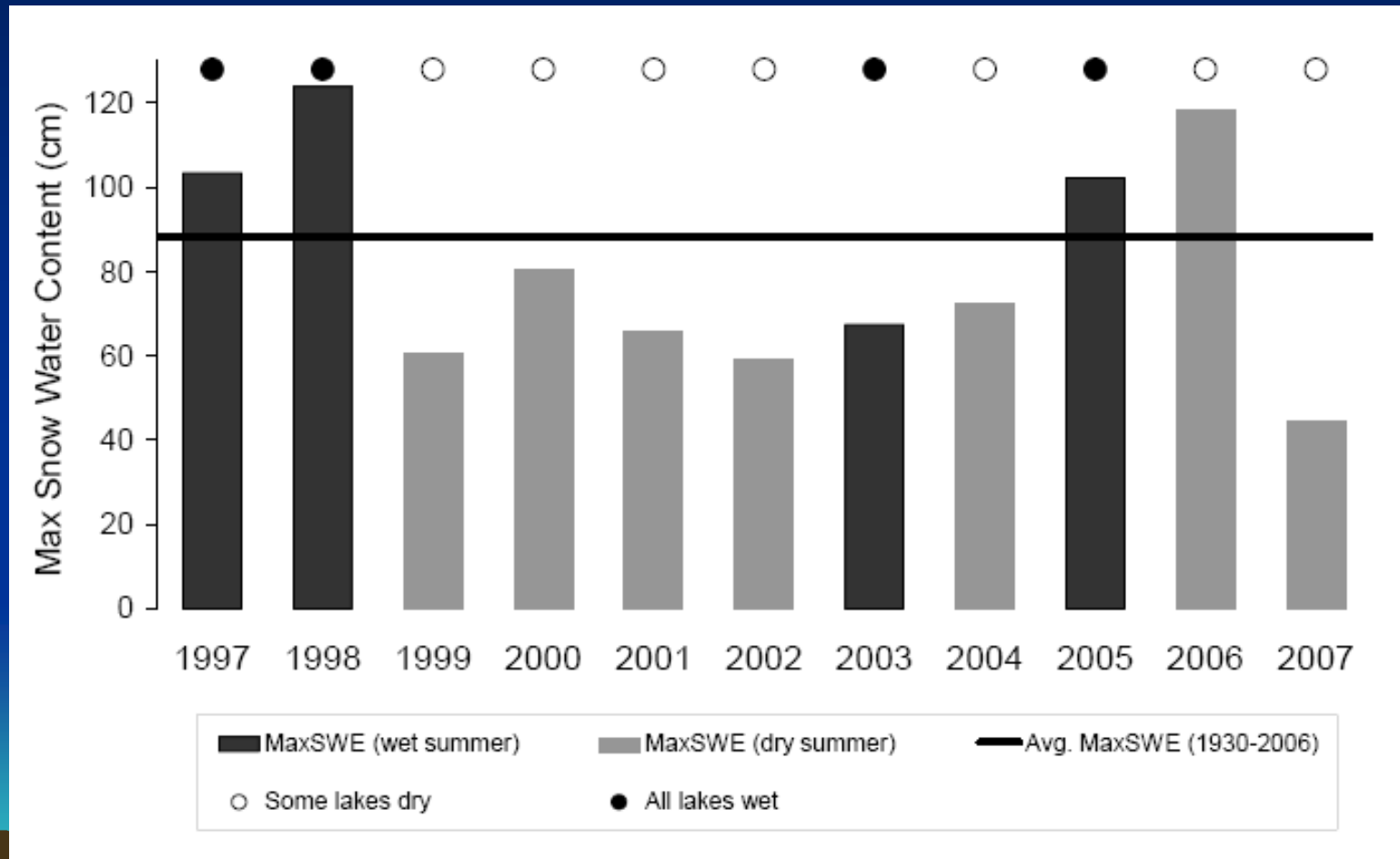


Water Availability vs. Recruitment

Dusy Basin, Kings Canyon National Park, California



Dusy Basin, Kings Canyon

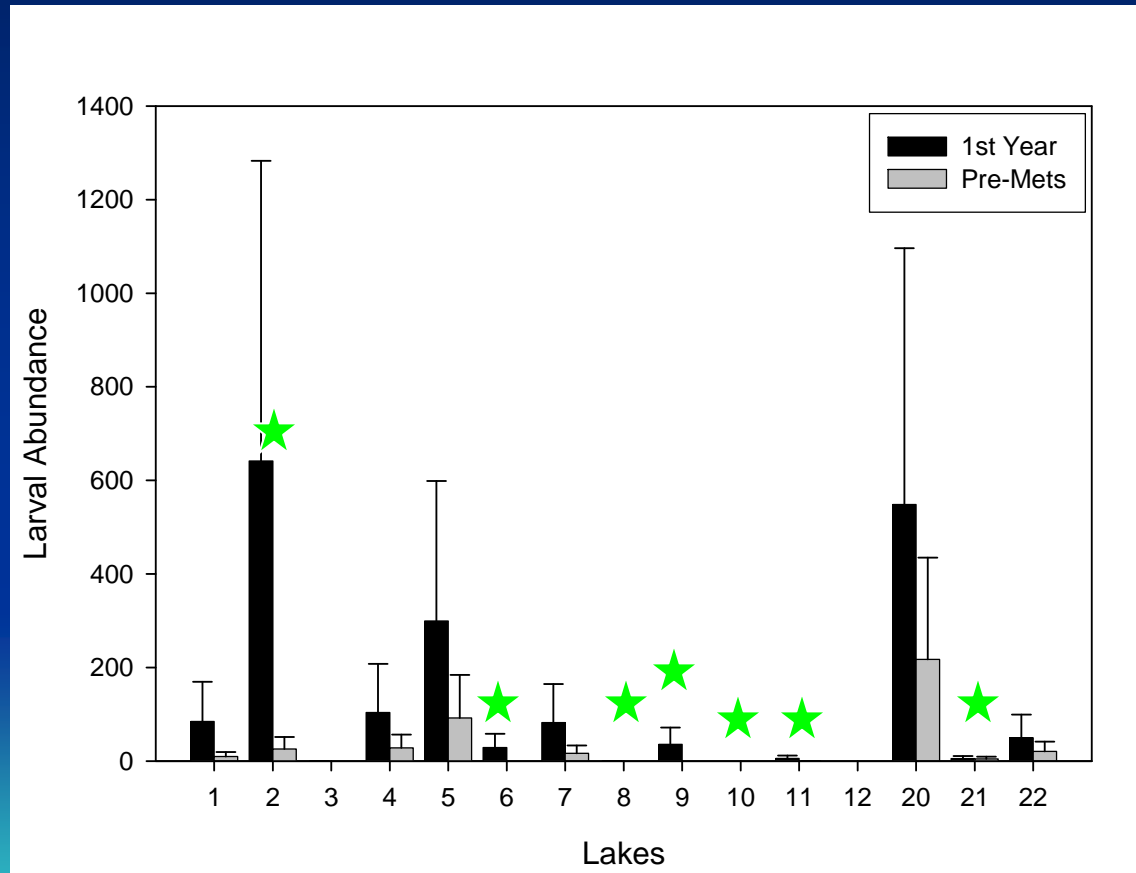


From: Lacan et al. 2008

Reduced Recruitment in Overwintering Larval Species

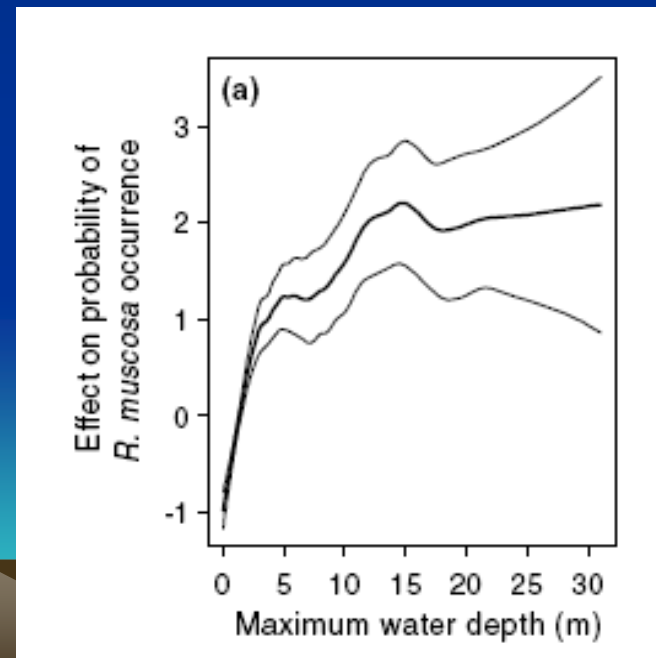
Abundance of RASI larva in all lakes (Dusy Basin, Kings Canyon, 1997-2008)

- in seasonal (★) vs. permanent lakes



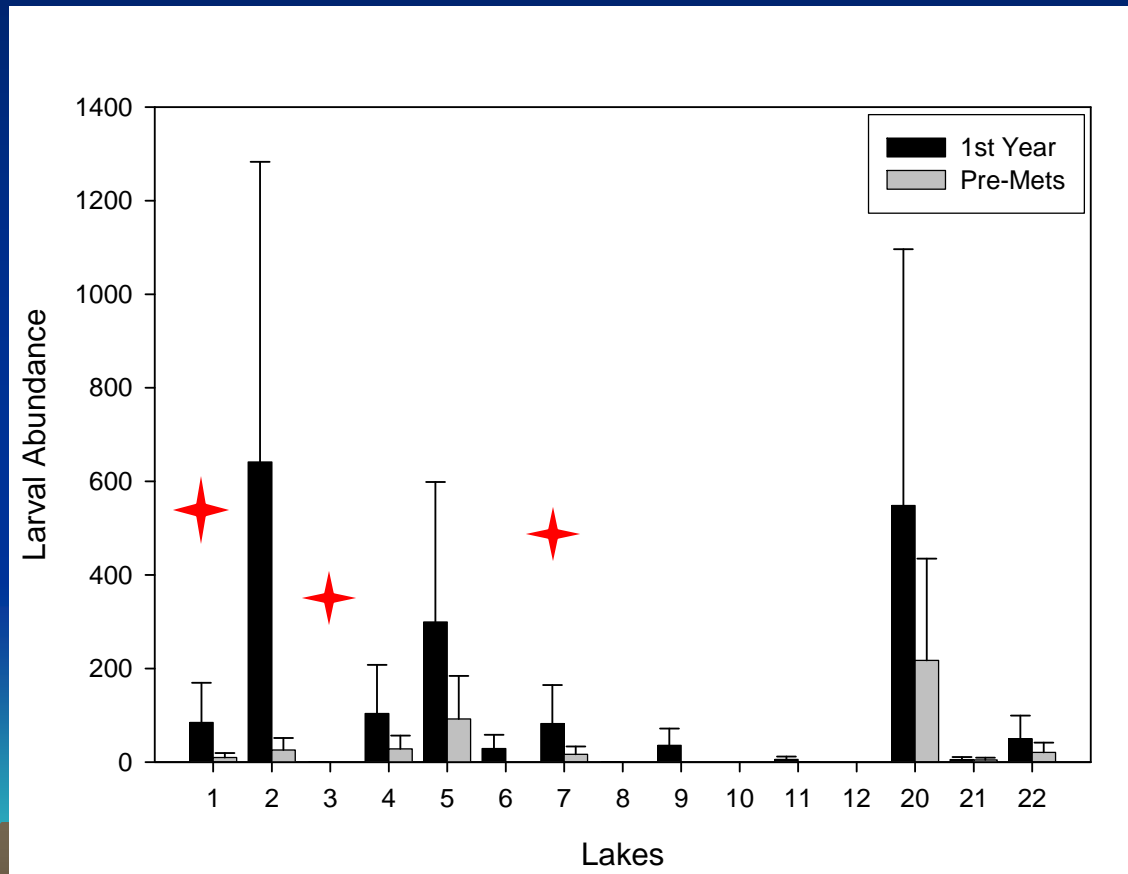
Recruitment (lack thereof)

- Increase in lake drying = less aquatic-stage survival to metamorphosis
- Increase in “sink” habitats
- Mtn. yellow-legged frog occurrence associated with deeper lakes, but...



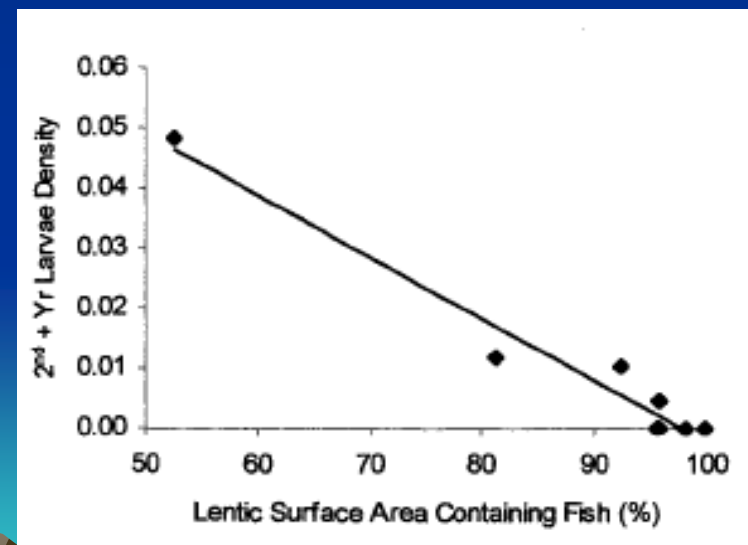
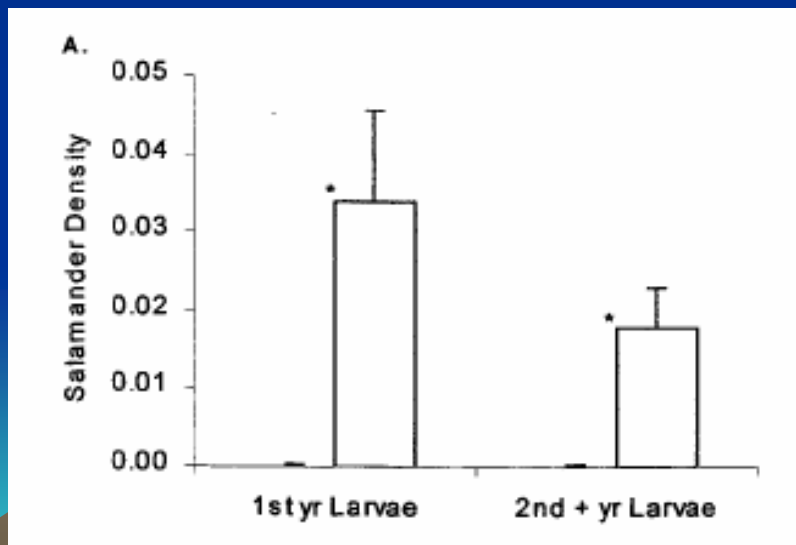
Effects of Nonnative Trout Dusy Basin, Kings Canyon

- in fish (✦) vs. fishless lakes (1997-2008)



Effects of Nonnative Trout

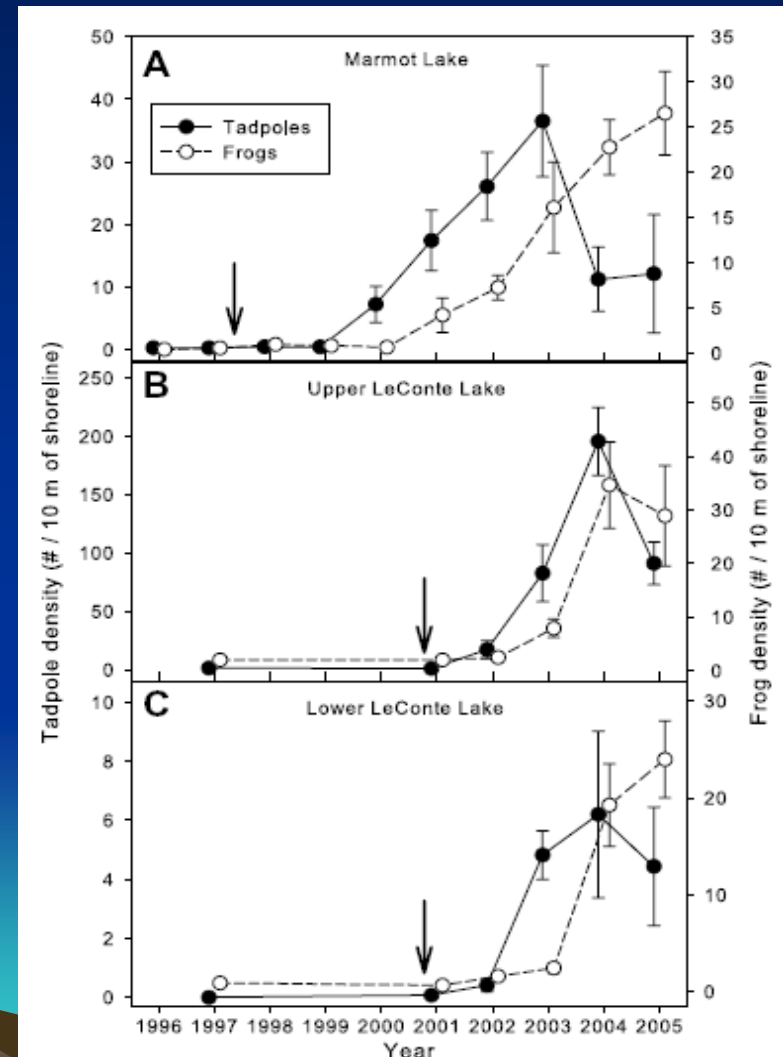
- Long-toed salamander densities in stocked vs. fishless lakes



From: Pilliod2001

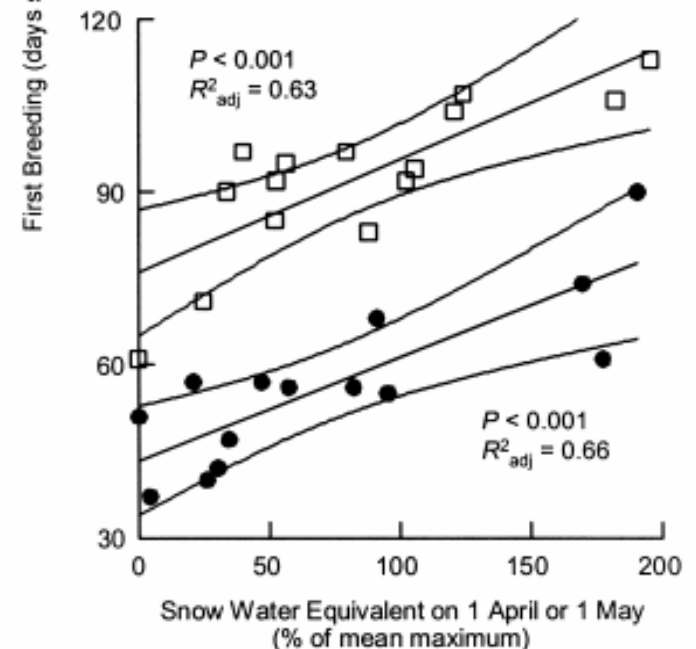
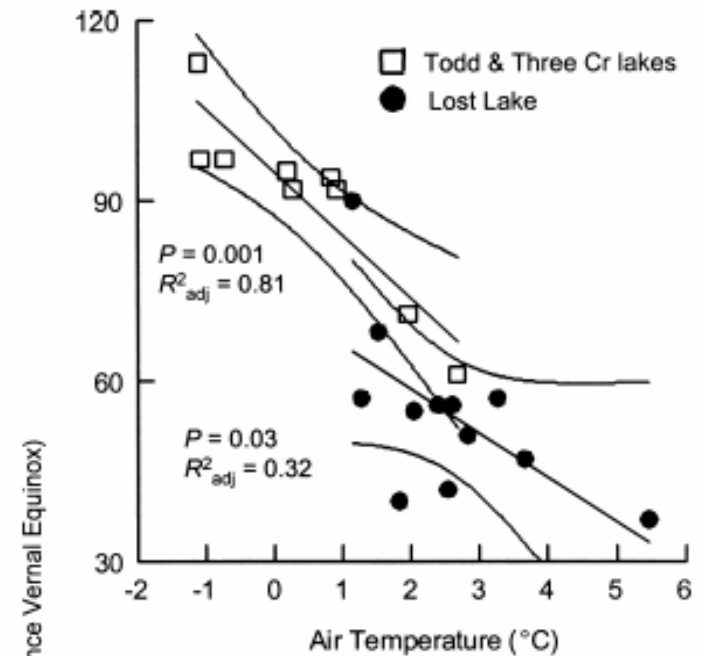
Would the Amphibians' Breeding Shift with Fish Removal?

- Density of RAMU \uparrow after fish removal in KCNP
- Possible long-term shift of gravid females to “more” permanent lakes if fish were removed = increase recruitment



Breeding Phenology

- Timing of snowmelt linked to amphibian breeding
- Shift to earlier breeding has been documented in some species



What about Reptiles?

- Mountain Garter Snake (*Thamnophis elegans elegans*)
- Wandering Garter Snake (*Thamnophis elegans vagrans*)
- Sierra Garter Snake (*Thamnophis couchii*)



Mountain and Wandering Garter Snakes



**Distribution of
Thamnophis elegans
in California**

-  ***T. e. elegans***
-  ***T. e. terrestris***
-  ***T. e. vagrans***
-  **Intergrades**



- Intergrades of Mountain and Wandering garter snakes
- Occupy variety of habitats, including high elevation meadows and lakes up to 13000ft

Sierra Garter Snake



- Primarily found in mid to higher elevation streams and rivers
- Can occur in meadows and lakes
- Found up to 8000 ft

Potential Indirect Effects of Climate Change on Garter Snakes



Predictor Variables for Occurrence

- Mountain Yellow-legged
 - NO fish
 - Deeper water
- Mountain Garter Snake
 - All of the above + AMPHIBIANS





csendak



Conclusions

- The Climate's A Changin' in the Sierra Nevada
- Uncertainty of the level of impacts on high elevation
- Possible reduced recruitment if lakes start drying more often or too quickly
- Combined with nonnative fish effects could mean trouble for both amphibians and reptiles unless...



Conservation

- ...Nonnative fish removal of permanent lakes where amphibians have a good likelihood to breed



Current and Future Studies

- Long-term monitoring of RASI in Dusy Basin, Kings Canyon NP
 - Egg mass deposition
 - Abundance and recruitment
 - Climate (SWE, temp, precipitation)
 - Lake levels
 - P/A of Garter Snakes

- Fish removal experiments in Dusy?



References

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