

Bridging Science and Management of Amphibians and Reptiles: Climate Change

Amphibian and reptile conservation is of paramount concern in the US, Australia and worldwide as the tally of species and population declines continues to mount. Habitat loss, degradation and fragmentation are the chief causes of losses. In many areas. **Climate is tightly linked to habitat conditions and the biology of these species.** Amphibians have been previously considered environmental indicators because they are especially sensitive to temperature and moisture regimes, are centrally nested in food webs, have complex life histories, and rely on both aquatic and terrestrial habitats. Turtles share some of these characteristics, making them particularly vulnerable to changes in their environments. Lizard reproductive failure and overwinter mortality have resulted from recent variation in seasonal weather patterns – hence, concerns have been raised for them as well, especially lizards in temperate-zone habitats. Similar concerns have been raised for snakes. Changes in communities due to climate-driven habitat alteration are not well understood. Temperature-dependent sex determination in some lizards and turtles may be affected by climate variation, with consequences for future reproduction if only one sex is produced. Furthermore, interactions of climate with other stressors on these taxa are little studied.



Above: The receding shoreline of Lost Lake, Oregon, USA, left an estimated half-million Western Toad (*Anaxyrus boreas*) eggs high-and-dry in 1989 (Blaustein and Olson 1991, Science 253: 1461), after several years with below-average precipitation. Mass mortality episodes such as this are projected to increase in many areas due to reduced precipitation, increased temperature, or changed seasonal weather patterns. Photo: D.H. Olson

“Adaptation management” is a term that natural resource managers use to describe what can be done to address threats to species, such as climate change. It includes habitat protection and restoration measures. Key tools in the manager toolbox to address the effects of climate change on amphibians and reptiles are provided on the back of this page. These tools likely provide benefits to a host of other taxonomic groups as well.



Above: Breeding site enhancement and hydroperiod manipulation are potential tools to consider to manage the effects of variable climate conditions on amphibians. In this photograph, a wind- and solar-powered pump system is used to maintain the water level in a constructed pond, drawing from groundwater sources in New Mexico, USA. These ponds benefit a host of wildlife, but in particular, they provide essential habitat for the threatened Chiricahua Leopard Frog (*Lithobates chiricahuensis*). (Photo: Turner Ranch Properties, L.P.; M. Christman, USFWS, Albuquerque, NM; C. Kruse, Turner Enterprises, Inc.; Fig. 1 in Shoo et al. 2011.)

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Key Reference:
 Shoo et al. 2011. Engineering a future for amphibians under climate change. J. Applied Ecology 48: 487-792.

Example climate change predictions, effects on amphibians and reptiles, and tools available to natural resource managers to address known and potential threats.

Climate Change Predictions*	Effects on Habitats and Animals	Adaptation Management Toolbox
<p>1. Warmer, Drier</p>  <p>Above: Directional felling of logs toward ephemeral ponds in forests is being examined as a means of providing refugia and reducing mortality during amphibian metamorph dispersal, a particular concern in dry years. Photo: Sally Nickelson, Cedar River Watershed. Project design: Heidy Barnett, Seattle Public Utilities.</p>	<p>Warmer, drier terrestrial refugia</p> <ul style="list-style-type: none"> a) Limits of tolerance exceeded for some life stages b) Changed spatial distribution of suitable and optimal breeding, foraging, dispersal, or overwintering habitats c) Fragmentation of some habitats due to altered microclimate regimes d) Altered species ranges e) Altered community dynamics f) Altered synergisms of stressors on animals <ul style="list-style-type: none"> - E.g., Diseases, Fire regimes, Chemicals <p>Altered hydroperiods of wetlands and streams</p> <ul style="list-style-type: none"> a) Early drying of ephemeral ponds and streams b) Receding shorelines of permanent lakes and streams <ul style="list-style-type: none"> - Increased exposure to aquatic predators 	<ul style="list-style-type: none"> 1) Installation of microclimate and microhabitat refugia [artificial wetting, irrigation systems, added shelter microhabitats (down wood, burrows, cover boards), litter supplementation, canopy cover manipulation, riparian buffers, hill-shaded refugia]. 2) Enhancement and restoration of breeding sites (install heterogeneous pond breeding sites varying in depth and size, restoration of breeding site complexes/clusters/networks, install artificial breeding sites). 3) Manipulation of hydroperiod or water levels at aquatic breeding sites (artificial extension of hydroperiods via irrigation, installation of drainage ditches, pond creation or excavation, vegetation management, use of solar-powered pumps).
<p>2. Variable/extreme climate patterns</p> <ul style="list-style-type: none"> a) Altered timing of precipitation and temperature patterns, for example: <ul style="list-style-type: none"> - Early “spring” - Early/late “fall” - Freezing conditions after spring thaw - Warm periods in winter 	<p>Altered phenology</p> <ul style="list-style-type: none"> a) Early or late breeding, metamorphosis <ul style="list-style-type: none"> - “Harsh” climate conditions after breeding - Altered timing of peak flows and floods - Altered community dynamics - Altered synergisms b) Winter mortality 	<ul style="list-style-type: none"> 4) For rare species warranting intervention, consideration of relocation, repatriation, reintroduction, transplantation, and headstarting. See ongoing projects at www.parcplace.org. 5) Review and revision of project- to landscape-scale management designs and policies to address climate factors for species.

*Climate change predictions vary considerably with geographic location, and there is uncertainty tied to all climate change models.