THE IMPORTANCE OF RIPARIAN SYSTEMS TO AMPHIBIANS AND REPTILES[1]

John M. Brode and R. Bruce Bury[2]

Abstract.--California has a rich herpetofauna, including about 120 native species. Riparian systems provide habitat for 83% of the amphibian and 40% of the reptile species. Amphibians and reptiles utilize these systems to varying degrees and can be classified according to the type of use. Riparian systems provide corridors for dispersal and also allow certain species to use otherwise unsuitable environments. Amphibians and reptiles may be abundant in riparian systems where they may outnumber other taxa. Harvesting timber and creating reservoirs are detrimental to amphibians and reptiles in the zone of influence of such activities. These activities have their greatest effects upon reptiles and amphibians whose entire life histories occur in the riparian zone.

INTRODUCTION

California has a rich herpetofauna, including about 120 native species. Amphibians and reptiles represent important ecological components of riparian communities, where they may reach high densities. In California, we estimate riparian systems provide habitat for 83% of the amphibians and 40% of the reptiles. Many species are permanent residents of the riparian zone, while others are transient or temporal visitors.

In many (if not most) natural communities, nongame species constitute the greatest portion of vertebrate species, individuals, and biomass; and they are energetically critical elements in the functioning of ecosystems (Bury et al. 1980). Based on figures compiled by Bury et al. (ibid.) 88% of the vertebrate species (fish excluded) in California are nongame.

Much emphasis has been placed on the loss of California's Central Valley riparian forests (Sands 1977). However, there are many other riparian systems in California that have suffered substantial degradation. Logging has proved detrimental to certain animal species that depend on cool, shaded streams. Reservoirs have been created on many streams in California, eliminating the original riparian environment and much of the herpetofauna, while providing habitat for nonnative species which are usually managed more intensely than the original fauna. Many of the species lost, especially the amphibians and reptiles, are endemic to California.

In this paper, we present background information on species diversity and abundance, review the habitat requirements of California amphibians and reptiles, and suggest use classifications for species using riparian systems. Lastly, we review the effects of logging on selected species and discuss the effects of reservoirs on amphibians and reptiles, presenting preliminary data from two preimpoundment studies.

SPECIES DIVERSITY AND ABUNDANCE

Species diversity and abundance of amphibians and reptiles may be dramatic in riparian systems. For example, the riparian system of Corral Hollow Creek, San Joaquin County (fig. 1), supports 7 species of amphibians and 21 species of reptiles, including 13 species of snakes (Stebbins 1966; Sullivan 1981). Burton and Likens (1975) estimated there were 2,950 salamanders per ha. within the Hubbard Brook Experimental Forest, New Hampshire, and concluded there were more salamanders than either birds or small mammals. In biomass, salamanders were 2.6 times greater than birds and approximately equal to mammals. Burton and Likens were surprised at this result as most ecologists have ignored amphibians in ecosystem energy flow and nutrient cycling studies while considering birds and mammals in detail.

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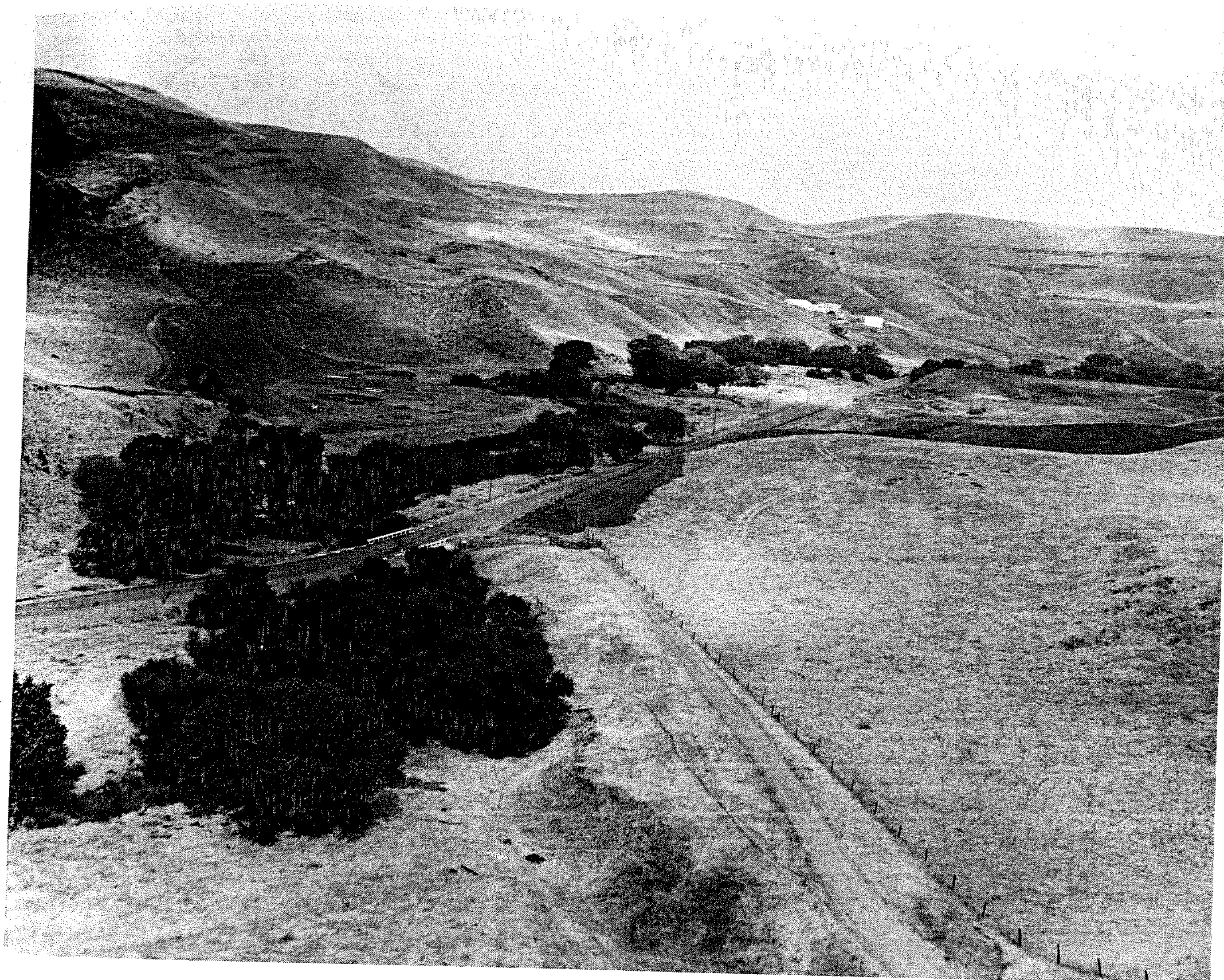

Figure 1.--Corral Hollow Creek, San Joaquin County, California. This riparian system supports 7 species of amphibians and 21 species of reptiles. Photo by John E. Hummel.

Other workers have obtained similar results regarding amphibian abundance. Nussbaum[3] estimated the density of the Siskiyou Mountain salamander (Plethodon stormi) to be 0.27 per m^2 (2,700 per ha.) in optimal habitat. Murphy and Hall (1981) reported in certain streams, Pacific giant salamander (Dicamptodon ensatus) was the dominant vertebrate in both biomass and frequency of occurrence and made up as much as 99% of the total predator biomass in some sites. The population density of an eastern stream salamander (Desmognathus fuscus) was estimated at 0.4 to 1.4 per m^2 (400 to 1,400 per ha.) (Spight 1976); in certain areas, male D. ochrophaeus occur at densities of 4.4 per m^2 (Tilley 1974). Western pond turtle (Clemmys marmorata) may reach densities of 425 per ha. in California ponds and streams (Bury 1979). Fitch (1975) estimated densities of 1,000 to 1,500 ringneck snakes (Diadophis punctatus) per ha. Sullivan (1981) reported a density of 22.4 snakes per km. along an 11-km. road transect in Corral Hollow.

[3] Nussbaum, R.A. 1974. The distributional ecology and life history of the Siskiyou Mountain salamander, Plethodon stormi, in relation to the potential impact of the proposed Applegate Reservoir on this species. 52 p. Report submitted to the US Army Corps of Engineers, Portland, Ore.

USE OF RIPARIAN SYSTEMS BY AMPHIBIANS AND REPTILES IN CALIFORNIA

Amphibians that utilize riparian systems in California can be placed in one of three classifications, according to their dependency upon aquatic environments and the extent to which they utilize terrestrial riparian systems (table 1). All amphibians in California, except lungless salamanders of the family Plethodontidae, require aquatic environments to complete their life cycle. Certain frogs (*Rana*, *Ascaphus*) and salamanders (*Rhyacotriton*, some *Batrachoseps*) frequent the riparian zone throughout their lives. Other salamanders and newts (*Ambystoma*, *Taricha*) and some toads (*Bufo*) utilize riparian systems primarily for breeding, spending most of their adult life in upland areas. Lungless salamanders are more generalized in their habitat requirements, but many species utilize

Table 1.--Use classification of amphibians occurring in California riparian systems.

Type of use		
Constant[1]	Breeding[2]	General[3]
Northwestern salamander *Ambystoma gracile*	Long-toed salamander *Ambystoma macrodactylum*	Del Norte salamander *Plethodon elongatus*
Pacific giant salamander *Dicamptodon ensatus*	Rough-skinned newt *Taricha granulosa*	Siskiyou Mountain salamander *Plethodon stormi*
Olympic salamander *Rhyacotriton olympicus*	California newt *Taricha torosa*	Ensatina *Ensatina eschscholtzi*
Dunn's salamander *Plethodon dunni*	Red-bellied newt *Taricha rivularis*	Pacific slender salamander *Batrachoseps pacificus*
Desert slender salamander *Batrachoseps aridus*	Colorado River toad *Bufo alvarius*	California slender salamander *Batrachoseps attenuatus*
Inyo Mountains salamander *Batrachoseps campi*	Western toad *Bufo boreas*	Black salamander *Aneides flavipunctatus*
Tailed frog *Ascaphus truei*	Yosemite toad *Bufo canorus*	Clouded salamander *Aneides ferreus*
Red-spotted toad *Bufo punctatus*	Woodhouse's toad *Bufo woodhousei*	Arboreal salamander *Aneides lugubris*
Black toad *Bufo exsul*	Southwestern toad *Bufo microscaphus*	Limestone salamander *Hydromantes brunus*
California treefrog *Hyla cadaverina*	Great Plains toad *Bufo cognatus*	Shasta salamander *Hydromantes shastae*
Red-legged frog *Rana aurora*	Pacific treefrog *Hyla regilla*	Mount Lyell salamander *Hydromantes platycephalus*
Spotted frog *Rana pretiosa*		
Cascades frog *Rana cascadae*		
Foothill yellow-legged frog *Rana boylei*		
Mountain yellow-legged frog *Rana muscosa*		
Leopard frog *Rana pipiens*		

[1]Species that occur in the riparian zone throughout their lives.
[2]Species that utilize riparian systems primarily for breeding, but may leave the riparian zone as adults.
[3]Species that utilize riparian systems as well as other systems throughout their range.

riparian systems. Wide-ranging plethodontid salamanders (Ensatina) have generalized habitat requirements in the mesic environments of northern California, but tend to associate with riparian systems in xeric environments.

Reptiles that utilize riparian systems in California can also be placed in one of three categories (table 2). Turtles (Clemmys) and most garter snakes (Thamnophis) depend on aquatic environments and occur primarily in the riparian zone throughout their lives. Some lizards (Gerrhonotus) and snakes (Contia) have rather general habitat requirements but become riparian obligates in arid portions of their range. The remaining reptiles that occur in riparian systems (Cnemidophorous, Pituophis, Lampropeltis) are more generalized in their habitat requirements, but they frequent ecotones and water bodies associated with riparian areas.

The riparian zone also provides corridors of dispersal and islands of habitat for many species of amphibians and reptiles, especially in arid climates. The Gilbert's skink (Eumeces gilberti) and ringneck snake (Diadophis punctatus) are foothill species that extend their ranges into the Central Valley along the American River and other riparian corridors. The desert slender salamander (Batrachoseps aridus) and Inyo Mountains salamander (B. campi) are restricted to the narrow riparian zones of desert seeps and springs.

Historically, riparian corridors probably facilitated the maintenance of genetic continuity between populations. Now, due to habitat disruption, certain populations are isolated. The wide-ranging California slender salamander (Batrachoseps attenuatus) was probably once common in the southern Sacramento Valley. Now, in the Valley this species is restricted to a few isolated remnants of valley oak woodland while still common elsewhere. Ultimate consequences of habitat disruption include local extinctions, reduction in species diversity, and loss of population heterogeneity.

EXAMPLES OF ACTIVITIES DETRIMENTAL TO AMPHIBIANS AND REPTILES IN RIPARIAN SYSTEMS

Timber Harvest

The tailed frog (Ascaphus truei), the most primitive frog in North America, is highly specialized for life in cool, fast-flowing waters. The southern terminus of the species in the United States is in small streams along the north coast and in the North Coast Range of California (Bury 1968). Larval Ascaphus prefer temperatures at or below 15°C., and avoid waters over 22°C. (deVlaming and Bury 1970); such behavior is unlike any other native frog, and underscores the dependence of Ascaphus on a cool, shaded habitat. Removal of timber by lumbering or fire results in the disappearance of tailed frogs, apparently due to increased temperatures of the exposed stream-bed (Noble and Putnam 1931; Bury 1968).

Similarly the Olympic salamander (Rhyacotriton olympicus) frequents cool ravines and rivulets in northwestern California. This species is absent in open (postlogging) habitat; logging apparently eliminates populations even in wet, coastal redwoods (Bury in prep.).

The Siskiyou Mountain salamander (Plethodon stormi) inhabits shaded talus slopes in canyons and along stream courses above the floodplain. Nussbaum[3] considered the gradual elimination of the overstory vegetation by clearcutting to be a serious threat to this species.

Reservoirs

Barrett and Cordone (1980) counted 1,272 reservoirs in California. Out of these, 926 (73%) are "mixed" or "warm water" types, those most commonly found on foothill and mid-elevation streams and rivers. Reservoirs have adverse effects on amphibians and reptiles by flooding their habitats. They often result in bodies of water with fluctuating levels, which prevents reestablishment of natural riparian communities. In addition, reservoirs are usually managed for human activities.

Specific examples of the effects of reservoirs on amphibians and reptiles are few. Nussbaum[3] estimated that the Applegate Reservoir in Oregon and California would cover 1.06% of the total known range and 2.1% of the estimated total population of the Siskiyou Mountain salamander. He further stated that although the construction of Applegate Reservoir in itself will pose no threats to the continued existence of P. stormi, the effects of Applegate Reservoir added to numerous other man-caused effects could seriously threaten the existence of the species.

We do not have data regarding the numbers of individual amphibians and reptiles that may have been affected by previous reservoir construction in California, but information on two proposed reservoir projects will serve as examples of what may be lost.

Los Vaqueros Reservoir

The primary effect of the proposed Los Vaqueros Reservoir will be on Kellogg Creek, Contra Costa County. Preliminary investigations by the Department of Fish and Game (DFG) indicate that the Kellogg Creek area supports at least 6 species of amphibians and 12 species of reptiles. The reservoir, as proposed, would inundate 12 km. of tributaries. An additional 6.4 km. of Kellogg Creek would be affected below the dam due to changes in streamflow.

A species of special concern that occurs in Kellogg Creek is the red-legged frog (Rana aurora--fig. 2), which is well adapted for living in arid environments with intermittent or temporary aquatic habitat. However, it has

Table 2.--Use classification of reptiles occurring in California riparian systems.

Type of use		
Constant[1]	Arid[2]	General[3]
Western pond turtle *Clemmys marmorata*	Western skink *Eumeces skiltonianus*	Western fence lizard *Sceloporus occidentalis*
Sonoran mud turtle *Kinosternon sonoriense*	Gilberts skink *Eumeces gilberti*	Sagebrush lizard *Sceloporus graciosus*
Common garter snake *Thamnophis sirtalis*	Panamint alligator lizard *Gerrhonotus panamintinus*	Long-tailed brush lizard *Urosaurus graciosus*
Western aquatic garter snake *Thamnophis couchi*	Northern alligator lizard *Gerrhonotus coeruleus*	Western whiptail lizard *Cnemidophorus tigris*
Checkered garter snake *Thamnophis marcianus*	Ringneck snake *Diadophis punctatus*	Southern alligator lizard *Gerrhonotus multicarinatus*
	Sharp-tailed snake *Contia tenuis*	California legless lizard *Anniella pulchra*
	Western terrestrial garter snake *Thamnophis elegans*	Western blind snake *Leptotyphlops humilis*
		Rubber boa *Charina bottae*
		Racer *Coluber constrictor*
		Striped racer *Masticophis lateralis*
		Gopher snake *Pituophis melanoleucus*
		Common kingsnake *Lampropeltis getulus*
		California mountain kingsnake *Lampropeltis zonata*
		Northwestern garter snake *Thamnophis ordinoides*
		Western black-headed snake *Tantilla planiceps*
		Night snake *Hypsiglena planiceps*
		Western rattlesnake *Crotalus viridis*

[1] Species that occur primarily in the riparian zone throughout their lives.
[2] Species that depend on riparian systems in the arid parts of their range.
[3] Species that utilize riparian systems as well as other systems throughout their range.

little tolerance for habitat disturbances or competition from exotic species. Approximately 18 km. of red-legged frog habitat, virtually the entire Kellogg Creek population, could be adversely affected if Los Vaqueros Reservoir impoundment project is built.

Thomes-Newville Reservoir

The primary effect of the proposed Thomes-Newville Reservoir will be on the North Fork Stony Creek, Glenn and Tehama Counties. Preliminary investigations by DFG indicate that the North Fork Stony Creek area supports at least 4 species of amphibians amd 14 species of reptiles. The proposed reservoir will inundate about 14 km. of perennial stream and about 40 km. of intermittent stream. In addition, about 13 km. of Thomes Creek may be affected by water diversion. Another species of special concern, the foothill yellow-legged frog (Rana boylei) occurs in North Fork Stony Creek and its tributaries. These frogs are adapted to rocky foothill streams. Salt Creek, on the project site, supports an excellent population of yellow-legged frogs. The majority of the yellow-legged frog population will be affected adversely if this project is completed.

CONCLUSIONS

Amphibians and reptiles represent important ecological components of riparian communities. Many species are permanent residents of the riparian zone, while others are transient or temporal visitors.

Amphibians and reptiles may be abundant in riparian systems where they can outnumber other taxa. Riparian systems provide important corridors of dispersal for many species. Disruption of these corridors can cause isolation and may lead to local extinctions.

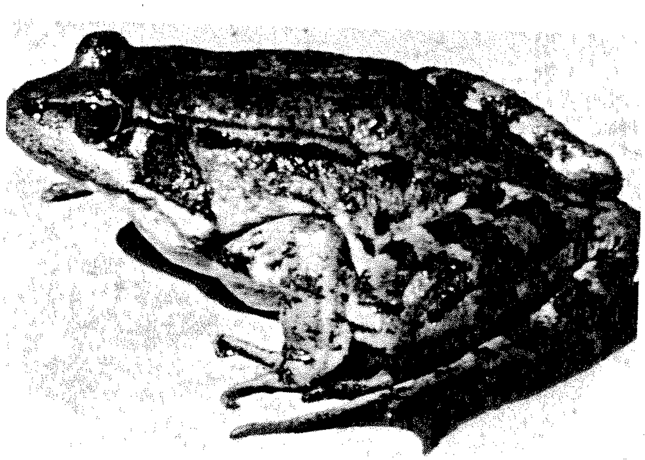

Figure 2.--Adult red-legged frog (Rana aurora). Photo by Robert L. Livezey.

Activities which affect riparian systems adversely have their greatest effects on those amphibians and reptiles that occur in the riparian zone throughout their life. There is critical need for more quantified studies on how these activities directly affect riparian herpetofaunas; and a need for research on the relation of amphibians and reptiles to structural diversity of riparian vegetation.

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