

Summary

Conservation Status

Distribution

Image

Comprehensive

New Search

**Comprehensive Report:** Record 1 of 3 selected.[<< Previous](#) | [Next >>](#)[See All Search Results](#) | [View Glossary](#)***Gambusia affinis*** - (Baird and Girard, 1853)

Western Mosquitofish

Unique Identifier: AFCNC02010

Informal Taxonomy: Animals, Vertebrates - Fishes

- Bony Fishes - Other Bony Fishes



[Search for Images on Google](#)

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Actinopterygii	Cyprinodontiformes	Poeciliidae	Gambusia

Genus Size: D - Medium to large genus (21+ species)**Concept Reference:** Robins, C. R., et al. 1991. Common and scientific names of fishes from the United States and Canada. American Fisheries Society, Special Publishing 20. 183 pp.**Concept Reference Code:** B91ROB01NAUS**Name Used in Concept Reference:** *Gambusia affinis***Taxonomic Comments:** GAMBUSIA HOLBROOKI from east of the Mobile River formerly was regarded as a subspecies of G. AFFINIS; HOLBROOKI was elevated to full species status by Wooten et al. (1988); this change was adopted in the 1991 AFS checklist (Robins et al. 1991). Page and Burr (1991) retained HOLBROOKI as a subspecies of AFFINIS, noting intergradation in the Mobile Bay basin. GAMBUSIA AFFINIS apparently hybridizes/intergrades with G. HOLBROOKI in some sites in the Chattahoochee and Savannah river drainages (Lydeard et al. 1991).

Member of subgenus ARTHROPHALLUS, AFFINIS species group (Rauchenberger 1989). See Rauchenberger (1989) for a study of the interrelationships of the subgenera and species groups within the genus GAMBUSIA. Some southwestern populations of G. AFFINIS were regarded as a distinct species, G. SPECIOSA, by Rauchenberger (1989); Robins et al. (1991) viewed them as, at most, a subspecies of AFFINIS.

Conservation Status**NatureServe Status****Global Status:** G5**Global Status Last Reviewed:** 20Sep1996**Global Status Last Changed:** 20Sep1996**Rounded Global Status:** G5**Nation:** United States**National Status:**

N5

Nation: Canada**National Status:**

NNR

U.S. & Canada State/Province Status

United States	Alabama (S5), Arizona (SNA), Arkansas (S4), California (SNA), Colorado (SNA), Florida (SNR), Idaho (SNA), Illinois (S4S5), Indiana (SNA), Iowa (SNA), Kansas (SNA), Kentucky (S4S5), Louisiana (S5), Michigan (SNA), Mississippi (S5), Missouri (SNR), Montana (SNA), Navajo Nation (SNA), Nebraska (SNA), Nevada (SNA), New Jersey (SNA), New Mexico (SNA), North Carolina (SNA), Oklahoma (S5), Oregon (SNA), Tennessee (S5), Texas (S5), Utah (SNA), Washington (SNA), Wyoming (SNA)
Canada	Alberta (SNA), Ontario (SNA)

Other Statuses

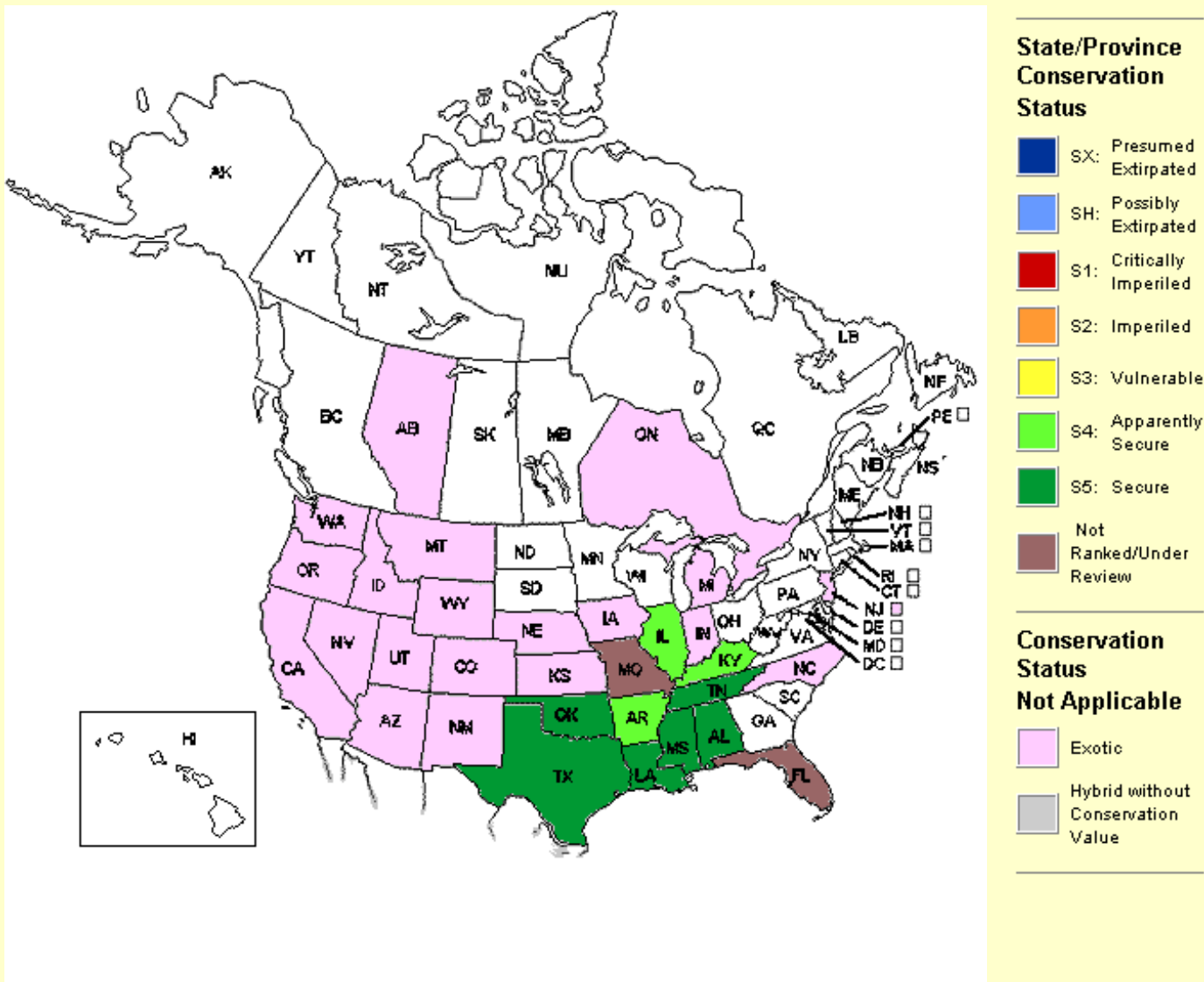
NatureServe Conservation Status Factors

Global Abundance: FH

Global Abundance Comments: "Possibly the single most abundant freshwater fish in the world" (Minckley et al. 1991).

Distribution

U.S. States and Canadian Provinces



Endemism: occurs (regularly, as a native taxon) in multiple nations

U.S. & Canada State/Province Distribution

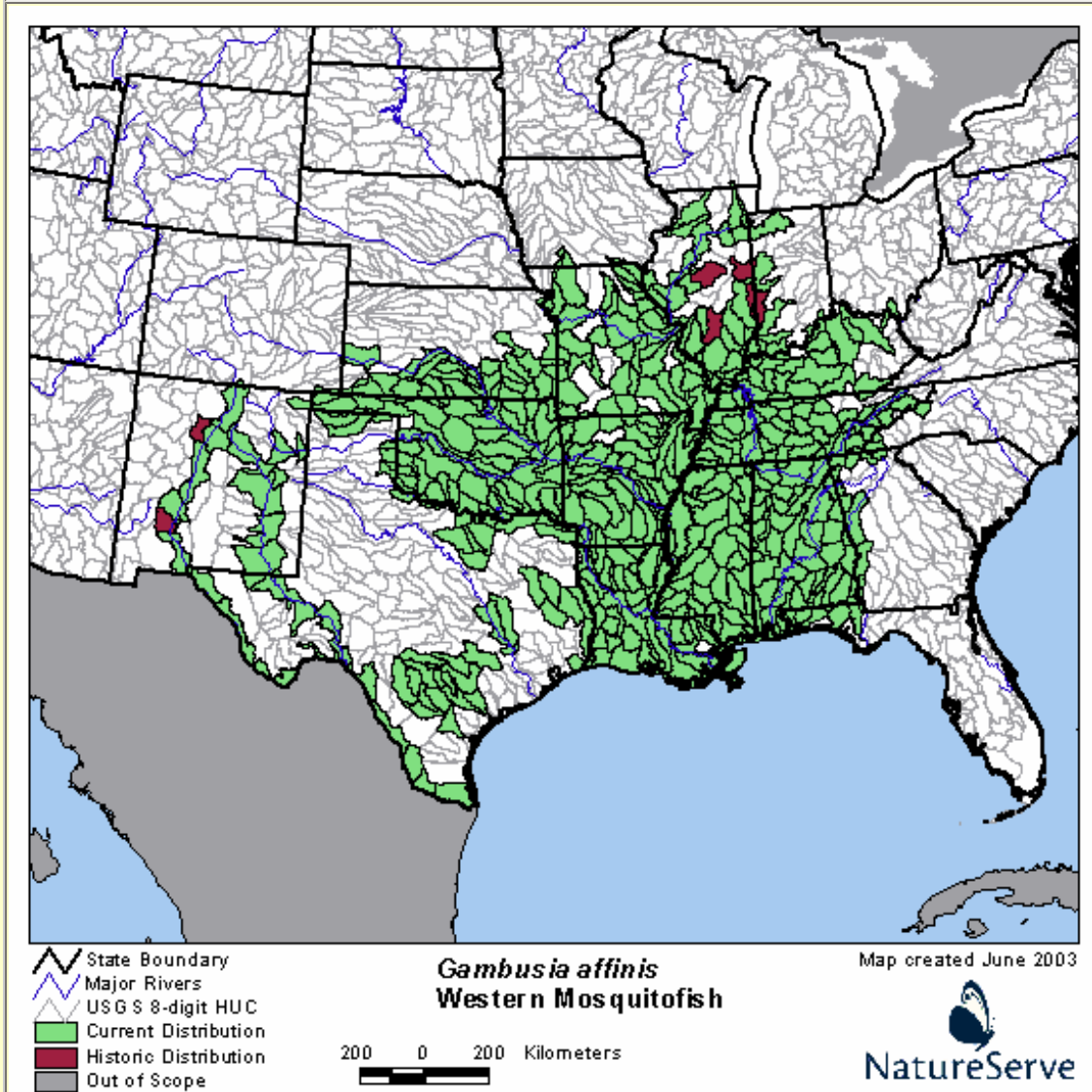
United States	AL, AR, AZ, CA, CO, FL, IA, ID, IL, IN, KS, KY, LA, MI, MO, MS, MT, NC, NE, NJ, NM, NN, NV, OK, OR, TN, TX, UT, WA, WY
Canada	AB, ON

Range Map

No map available.

Global Range Comments: Native to most of south-central U.S., north to Indiana and Illinois, west to Texas, south to southern Mexico, east to Mobile River system. Occurs also in the drainages of the Chattahoochee and Savannah rivers (Lydeard and Wooten 1991). See Walters and Freeman (2000) for information on the distribution of *G. affinis* and *G. holbrooki* in the Conasauga River system, where *G. affinis* widespread and native and *G. holbrooki* is apparently introduced and expanding its range. Widely introduced in the western United States and throughout the world.

Lynch (1992) reported that five or six populations from Georgia, Illinois, Tennessee and Texas were used for most introductions nationwide and worldwide. Within the United States, sources from Illinois, Tennessee and Texas were used to establish mosquitofish in the western half of the country. Therefore, most if not all populations in the western United States are *G. affinis*.

U.S. Distribution by Watershed (based on multiple information sources) ?

Economic Attributes

Management Summary

Stewardship Overview: The spread of mosquitofish outside its native range should be monitored and necessary steps taken to: (1) understand the competitive edge it has over native species, (2) limit its introduction or invasion into new locations, and (3) evaluate the possible benefit of eradication efforts in locations that can be rehabilitated for native fishes.

Species Impacts: Outside their native range, mosquitofish play a role in decreasing populations of native fishes (Miller 1961, Myers 1965, Minckley and Deacon 1968). Due to the number of introductions and corresponding decreases in native fish populations, there can be no doubt of the destructive nature of such introductions. Myers (1965) wrote that almost everywhere introductions have been made, mosquitofish have gradually eliminated or reduced populations of small native fishes. For example, mosquitofish have been instrumental in eliminating native populations of *Poeciliopsis occidentalis* in the southwestern U.S. (Sublette et al. 1990); *P. occidentalis* may be effectively eliminated in 1-3 years (Meffe 1984). Evermann and Clark (1931) reported that mosquitofish in the Salton Sea, California, drove out *Cyprinodon macularius* less than 10 years after introduction to the state. The mechanism for many of these reductions is believed to be predation (Meffe 1985, Courtenay and Meffe 1989). Myers (1965) reported that mosquitofish have even reduced largemouth bass (*Micropterus salmoides*) and carp (*Cyprinus carpio*) populations due to predation on larvae. Another problem is caused when mosquitofish hybridize with other *Gambusia* species (Yardley and Hubbs 1976, Rutherford 1980). Intergradation then corrupts the genome of the native species.

Introduced mosquitofish also prey heavily on amphibian larvae (Goodsell and Kats 1999) and potentially negatively impact salamander and frog populations (Lawler et al. 1999).

Restoration Potential: Not applicable.

Preserve Selection & Design Considerations: Lands do not need to be protected to provide adequate habitat within the native range.

Management Requirements: It is unclear whether management activities can control this fish. Eradication efforts have often been temporarily successful, but either not all individuals were killed or reintroductions were made. Certainly, eradication efforts must be followed with intensive monitoring. Preventative measures, such as barrier construction to obstruct the paths into uncolonized tributaries, should be taken when feasible. Transport and introduction of non-native fishes should be curtailed. Natural flooding regimes in western streams could aid in keeping populations in check. Meffe (1984, 1985) showed that flooding removes proportionally more mosquitofish than native topminnows.

Regulations should be drafted and/or enforced that discourage transport and stocking of non-native fishes into uncolonized habitats. An education program targeted at fishers relating the damage non-native fishes do to the environment should be implemented. An education program targeted at state and federal agencies should be implemented explaining the detrimental impact of stocking mosquitofish for mosquito larvae control. Natural barriers can be enhanced, or new barriers built to prevent the invasion of non-native fishes. Barrier design should not significantly alter stream flow and the potential impact on natural upstream and downstream movements of native fishes should be assessed. Barrier design must be approved by appropriate agencies and the appropriate Desert Fishes Recovery Teams.

Monitoring Requirements: Populations should be monitored at the periphery of their native and introduced ranges. This data will provide information on their spread. It is possible that in certain situations, eradication efforts can be made in newly colonized habitats outside of the native range.

When populations are discovered in a new location outside the native range, a monitoring program should be initiated. Due to the rapid rate of increase and colonization potential, monitoring stations should be set-up in the affected stream and adjacent tributaries. Distances between stations will depend on variation in habitat and permanency of flow. Mosquitofish are usually easily seined and dip-netted, although small mesh sizes should be used to sample juveniles. Due to their habit of swimming just under the water surface, they can be spotted before a collecting effort is made.

Monitoring Programs: Information on mosquitofish is usually gathered incidental to other monitoring programs.

Management Research Needs: Because this is a wide ranging eastern species, much of the biology is known in the native habitat. The following specific topics are research areas that should be addressed relative to locations where introductions have been made: (1) rate of colonization in stream reaches after flooding events or after new introductions, (2) competition for food with native species, comparing diets of all life stages, (3) reproductive potential in introduced locations, emphasizing comparisons with native species, (4) aggression and predation directed towards native species in field studies, and (5) an evaluation of past eradication efforts, and (6) an analysis of sites where mosquitofish and native species have coexisted for several years (e.g. Black Draw, San Bernardino National Wildlife Refuge), and comparison to sites where mosquitofish and native species do not coexist.

Ecology & Life History

Diagnostic Characteristics: *G. holbrooki* usually has seven dorsal rays and a gonopodium with prominent teeth on ray three. *G. affinis* usually has six dorsal rays and lacks prominent teeth on gonopodial ray three. Both subspecies have a chromosome number of $2n = 48$ but female *G. affinis* possess a large heteromorphic sex chromosome which is lacking in *G. holbrooki* (Black and Howell 1979).

In Arizona, *G. affinis* may be confused with *Poeciliopsis occidentalis*, the Sonoran topminnow. In topminnows the gonopodium is asymmetrical to the left, large hooks and serrae absent on gonopodial tip, and the gonopodium reaches beyond the snout when directed forward. The pelvic fins of males are unmodified and somewhat reduced. Many breeding males will be blackened. In *G. affinis* the gonopodium is symmetrical with large hooks and serrae on the tip. The pelvic fins of males are modified with a fleshy appendage on the distal third of the first, short, unbranched ray. Males are rarely blackened.

Reproduction Comments: Fish born early in the spring may reproduce later in the summer and fall. Those born late in the reproductive season overwinter before reproducing (Krumholz 1948). In southcentral Texas, young may be collected from March to October with a peak in abundance in April (Davis 1978). In some constant temperature springs, these fish cease reproduction in winter (Brown and Fox 1966, Davis 1978). However, some populations from thermal habitats (such as cooling ponds and lakes) reproduce year-round (Ferens and Murphy 1974, Bennett and Goodyear 1978). At the Savannah River Power Plant site, South Carolina, fish reproduce throughout the winter although at much reduced brood sizes (Meffe, pers. comm., cited in Constantz 1989). These same workers found that the percentage of reproductively active females increased with increasing water temperature.

Mosquitofish have internal fertilization and are ovoviviparous (Sublette et al. 1990). Females can store sperm from one copulation and fertilize several broods sequentially (Krumholz 1948). After a gestational period of 21 to 28 days, the young are born alive at a size of approximately eight to nine mm total length (Krumholz 1948). Larger females produce more offspring (Krumholz 1948). Brood sizes of one to 315 young have been reported (Barney and Anson 1921, Moyle 1976). Females annually have four to five broods (Krumholz 1948). Sex ratios are 1:1 at birth, but in older cohorts, the number of males declines relative to the number of females (Krumholz 1948). Under optimal conditions females can become gravid at 6 weeks of age, produce 2-3 broods in first summer. Few individuals live more than 15 months (Moyle 1976).

Life history is flexible, varies with environmental conditions (Stearns 1983).

Ecology Comments

May experience severe winter mortality in some areas, but may quickly reestablish population.

Predators include water snakes (NERODIA) (Mushinsky and Hebrard 1977, Kofron 1978), water birds (Kushlan 1973), spiders (Suhr and Davis 1974), and fishes such as black basses and gars (Hunt 1953).

Habitat Type: Freshwater

Non-Migrant: Y

Locally Migrant: N

Long Distance Migrant: N

Estuarine Habitat(s): Bay/sound, Herbaceous wetland, Lagoon, River mouth/tidal river, Tidal flat/shore

Riverine Habitat(s): BIG RIVER, CREEK, Low gradient, MEDIUM RIVER, Pool, SPRING/SPRING BROOK

Lacustrine Habitat(s): Shallow water

Palustrine Habitat(s): FORESTED WETLAND, HERBACEOUS WETLAND

Habitat Comments: River channels, margins, backwaters; springs, marshes, and artificial habitats of all kinds (Minckley et al. 1991). Often in shallow, often stagnant, ponds and the shallow edges of lakes and streams where predatory fishes

are largely absent and temperatures are high. Most abundant in shallow water with thick vegetation (Hubbs 1971). Also in brackish sloughs and coastal saltwater habitats (Tabb and Manning 1961, Odum 1971). More tolerant of pollution than most other fishes (Lewis 1970, Kushlan 1974). Tolerates dissolved oxygen levels as low as 0.18 mg/L (Ahuja 1964). Cannot tolerate extreme cold; temperature apparently limits range northward (Hubbs 1971). However, some populations are known to overwinter under ice in Indiana and Illinois (Krumholz 1944).

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Opportunistic omnivore; eats mainly small invertebrates, often taken near water surface. Also eats small fishes and, in the absence of abundant animal food, algae and diatoms (Moyle 1976).

Mosquitofish are principally carnivorous, and have strong, conical teeth and short guts (Meffe et al. 1983, Turner and Snelson 1984). They are reported to feed on rotifers, snails, spiders, insect larvae, crustaceans, algae, and fish fry, including their own progeny (Barnickol 1941, Minckley 1973, Meffe and Crump 1987). Cannibalism has been documented by several authors (Seale 1917, Krumholz 1948, Walters and Legner 1980, Harrington and Harrington 1982). Plant material is taken occasionally (Barnickol 1941) and may make up a significant portion of the diet during periods of scarcity of animal prey (Harrington and Harrington 1982). Grubb (1972) showed that anuran eggs from temporary ponds were preferentially selected over those breeding in permanent systems. Several workers have documented changes in the prey community after mosquitofish introduction (Hurlbert et al. 1972, Farley and Younce 1977, Hurlbert and Mulla 1981, Walters and Legner 1980).

Due to their name, these fishes are popularly believed to be "super" mosquito-larvae predators. Reddy and Shakuntala (1979), however, found that adult females grew poorly on a diet of mosquito larvae, but they grew quickly on tubifex worms. These results matched the outcome of preference tests, i.e. worms were chosen over mosquito larvae. Cech et al. (1980) found that juveniles grew more quickly when they were raised on brine shrimp nauplii than tubifex worms. Many biologists have concluded these fishes are no more effective in mosquito-larval control than various native fishes (Cross 1967). The effectiveness of predation on mosquito larvae decreases as water volume decreases (Reddy and Pandian 1973).

Length: 6 centimeters

Population/Occurrence Delineation

Group Name: LIVEBEARERS (POECILIIDS)

Use Class: Not applicable

Minimum Criteria for an Occurrence: Occurrences are based on evidence of historical presence, or current and likely recurring presence, at a given location. Such evidence minimally includes collection or reliable observation and documentation of one or more individuals in appropriate habitat.

Separation Barriers: Dam lacking a suitable fishway; high waterfall; upland habitat.

Alternate Separation Procedure: Each spring system that is undivided by a barrier constitutes a single distinct occurrence. Otherwise, use a separation distance of 10 km for any type of aquatic habitat.

Separation Justification: Separation distance is arbitrary. Because of the difficulty in defining suitable versus unsuitable habitat, especially with respect to dispersal, and to simplify the delineation of occurrences, a single separation distance is used regardless of habitat quality.

Date: 21Sep2004

Author: Hammerson, G.

Population/Occurrence Viability

Authors/Contributors

NatureServe Conservation Status Factors Edition Date: 21Feb2003

Management Information Edition Date: 21Feb2003

Management Information Edition Author: Vives, Stephen P.
Element Ecology & Life History Edition Date: 21Feb2003
Element Ecology & Life History Author(s): Vives, S. P., and G. Hammerson

Zoological data developed by NatureServe and its network of natural heritage programs (see [Local Programs](#)) and other contributors and cooperators (see [Sources](#)).

References

- ALLEN, CRAIG R., STEPHEN DEMARAIS, AND R. SCOTT LUTZ. 1994. RED IMPORTED FIRE ANT IMPACT ON WILDLIFE: AN OVERVIEW. *TEXAS J. SCI.* 46(1):51-59.
- ANDERSON, ALLISON A., CLARK HUBBS, KIRK O. WINEMILLER, AND ROBERT J. EDWARDS. 1995. TEXAS FRESHWATER FISH ASSEMBLAGES FOLLOWING THREE DECADES OF ENVIRONMENTAL CHANGE. *SOUTHWEST. NAT.* 40(3):314-321.
- Ahuja, S. K. 1964. Salinity tolerances of *GAMBUSIA AFFINIS*. *Indian J. Expl. Biol.* 2:9-11.
- Al-Daham, N. K., and M. N. Bhatti. 1977. Salinity tolerance of *GAMBUSIA AFFINIS* (Baird and Girard) and *HETERPNEUSTES FOSSILIS* (Bloch). *Journal of Fish Biology* 11:309-13.
- Bacon, E. J., Jr., W. H. Neill, Jr., and R. B. Kilambi. 1968. Temperature selection and heat resistance of the mosquitofish, *GAMBUSIA AFFINIS*. Pages 411-6 in *Proc. 22nd Ann. Conf. Southeastern Assoc. Game and Fish Comm.*
- Bahr, L.M. and J.J. Hebrard. 1976. Barataria Basin: Biological Characterization. CWR, LSU. Sea Grant Publication No. LSU-T-76-005.
- Baird, S. F., and C. Girard. 1853. Descriptions of new species of fishes collected by Captains R. B. Marcy, and Geo. B. M'Clellan, in Arkansas. *Proc. Acad. Nat. Sci. Phila.* 6:390-2.
- Barney, R. L., and B. J. Anson. 1921. Seasonal abundance of the mosquito destroying top-minnow, *GAMBUSIA AFFINIS*, especially in relation to fecundity. *Anatomical Record* 22:317-335.
- Barnickol, P. G. 1941. Food habits of *GAMBUSIA AFFINIS* from Reelfoot Lake, Tennessee, with special reference to malarial control. *Rept. Reelfoot Lake Biol. Sta.* 5:5-13.
- Bence, J. R., and W. W. Murdoch. 1986. Prey size selection by the mosquitofish: relation to optimal diet theory. *Ecology* 67:324-36.
- Bennett, D. H., and C. P. Goodyear. 1978. Response of mosquitofish to thermal effluent. Pages 498-510 in J. H. Thorp and J. W. Gibbons (editors). *Energy and Environmental Stress in Aquatic Systems*. Department of Engery Symposium Series. CONF-771114.
- Black, D. A., and W. M. Howell. 1979. The North American mosquitofish, *GAMBUSIA AFFINIS*: a unique case in sex chromosome evolution. *Copeia* 1979:509-13.
- Brown, C. J. D., and A. C. Fox. 1966. Mosquito fish (*GAMBUSIA AFFINIS*) in a Montana pond. *Copeia* 1966:614-6.
- Casterlin, M. E., and W. W. Raynolds. 1977. Aspects of habitat selection in the mosquitofish, *GAMBUSIA AFFINIS*. *Proc. Pap. Annu. Conf. California Mosq. Vector Control Assoc.* 48:45-7.
- Cech, J. J., Jr., M. J. Massingill, and T. E. Wragg. 1980. The food demands of mosquitofish, *GAMBUSIA AFFINIS*. *Proc. Pap. Annu. Conf. California Mosq. Vector Control Assoc.* 48:45-7.
- Collier, Albert. 1936. The mechanism of internal fertilization in *GAMBUSIA*. *Copeia* 1936:45-53.
- Constantz, G. D. 1989. Reproductive biology of poeciliid fishes. Pages 33-50 in Meffe, G. K., and F. F. Snelson, Jr. (editors). *Ecology and evolution of livebearing fishes (Poeciliidae)*. Prentice Hall, Englewood Cliffs, New Jersey.
- Courtenay, W. R., Jr., and G. K. Meffe. 1989. Small fishes in strange places: a review of introduced poeciliids. Pages 319-31 in Meffe, G. K., and F. F. Snelson, Jr. (editors). *Ecology and Evolution of Livebearing Fishes (Poeciliidae)*. Prentice Hall, Englewood Cliffs, New Jersey.
- Cowley, D. W., and J. E. Sublette. 1987. Distribution of fishes in the Black River drainage, Eddy County, New Mexico. *Southwestern Naturalist* 32:213-21.
- Cross, F. B. 1967. Handbook of fishes of Kansas. University of Kansas Museum of Nautal History Miscellaneous Publication No. 45. 357 pp.
- Douglas, Neil H. 1974. Freshwater fishes of Louisiana. Claitor's publ. div. Baton Rouge, Louisiana. 443 pp.
- Etnier, David A. and Wayne C. Starnes. 1993. *The Fishes of Tennessee*. University of Tennessee Press, Knoxville. 681 pp.
- Evermann, B. W., and H. W. Clark. 1931. A distributional list of the species of freshwater fishes known to occur in California. *Calfronia Fish and Game Department Fish Bull.* 35:1-67.
- Farley, D. G., and L. C. Younce. 1977. Some effects of *GAMBUSIA AFFINIS* (Baird and Girard) on selected non-target organisms in Fresno County rice fields. *Proc. Pap. Annu. Conf. California Mosq. Vector Control Assoc.* 45:87-94.
- Gerhardt, H. C. 1974. Behavioral isolation of the treefrogs *HYLA CINEREA* and *HYLA ANDERSONII*. *Amer. Midl. Nat.* 91:424-33.
- Goodsell, J. A., and L. B. Kats. 1999. Effect of introduced mosquitofish on Pacific treefrogs and the role of alternative prey.

Conservation Biology 13:921-924.

- Grubb, J. C. 1972. Differential predation by *GAMBUSIA AFFINIS* on the eggs of seven species of anuran amphibians. *American Midland Naturalist* 88:102-8.
- Harrington, R. W., Jr., and E. S. Harrington. 1982. Effects on fishes and their forage organisms of impounding a Florida salt marsh to prevent breeding by salt marsh mosquitoes. *Bulletin of Marine Science* 32:523-31.
- Hollander, R. R. 1986. Microanalysis of scales of poeciliid fishes. *Copeia* 1986:86-91.
- Hubbs, C. 1971. Competition and isolation mechanisms in the *GAMBUSIA AFFINIS* x *G. HETEROCHIR* hybrid swarm. *Texas Mem. Mus. Bull. No. 19.* 46 p.
- Hunt, B. P. 1953. Food relationships between Florida spotted gar and other organisms in the Tamiami Canal, Dade County, Florida. *Trans. Amer. Fish. Soc.* 82:13-33.
- Hurlbert, S. H., J. Zedler, and D. Fairbanks. 1972. Ecosystem alteration by mosquitofish (*GAMBUSIA AFFINIS*) predation. *Science* 175:639-41.
- Hurlbert, S. H., and M. S. Mulla. 1981. Impacts of mosquitofish (*GAMBUSIA AFFINIS*) predation on plankton communities. *Hydrobiologica* 83:125-51.
- Krumholz, L. A. 1944. Northward acclimatization of the western mosquitofish, *GAMBUSIA AFFINIS AFFINIS*. *Copeia* 1944:82-5.
- Krumholz, L. A. 1948. Reproduction in the western mosquitofish, *GAMBUSIA AFFINIS AFFINIS* (Baird and Girard), and its use in mosquito control. *Ecological Monographs* 18:1-43.
- Kushlan, J. A. 1974. Effects of a natural fish kill on the water quality, plankton, and fish population of a pond in the Big Cypress Swamp, Florida. *Trans. Am. Fish. Soc.* 103:235-43.
- La Rivers, I. 1994. *Fishes and fisheries of Nevada*. University of Nevada Press, Reno. 782 pp.
- Lam, T. H. 1983. Environmental influences on gonadal activity in fish. Pages 65-116 in W. S. Hoar, D. J. Randall, and E. M. Donaldson (editors). *Fish Physiology*, Vol. 9B. Academic Press, New York, New York.
- Lawler, S. P., D. Dritz, T. Strange, and M. Holyoak. 1999. Effects of introduced mosquitofish and bullfrogs on the threatened California red-legged frog. *Conservation Biology* 13:613-622.
- Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980. *Atlas of North American Freshwater Fishes*. North Carolina State Museum of Natural History. 867 pp.
- Lewis, W. M., Jr. 1970. Morphological adaptations of cyprinodontoids for inhabiting oxygen deficient waters. *Copeia* 1970:319-26.
- Lydeard, C., and M. C. Wooten. 1991. Occurrence of *GAMBUSIA AFFINIS* in the Savannah and Chattahoochee drainages: previously undescribed geographic contacts between *G. AFFINIS* and *G. HOLBROOKI*. *Copeia* 1991:1111-1116.
- Lynch, J. D. 1992. Anthropochore dispersal of *GAMBUSIA AFFINIS* and *GAMBUSIA HOLBROOKI* and their aboriginal distributions. Page 134 in *Am. Soc. Ich. Herp. Meeting Abstracts*.
- Maglio, V. J., and D. E. Rosen. 1969. Changing preference for substrate color by reproductively active mosquitofish, *GAMBUSIA AFFINIS* (Baird and Girard) (Poeciliidae, Atheriniformes). *Amer. Mus. Nov.* 2397.
- Martin, R. G. Sexual and aggressive behavior, density and social structure in a natural population of mosquitofish, *GAMBUSIA AFFINIS HOLBROOKI*. *Copeia* 1975:445-54.
- McGinnis, S. M. 1984. *Freshwater fishes of California*. Univ. California Press, Berkeley. viii + 316 pp.
- Meffe, G. K. 1984. Effects of abiotic disturbance on coexistence of predator-prey fish species. *Ecology* 65:1525-1534.
- Meffe, G. K. 1985. Predation and species replacement in American southwestern fishes: a case study. *Southwestern Naturalist* 30:173-187.
- Meffe, G. K., D. A. Hendrickson, W. L. Minckley and J. N. Rinne. 1983. Factors resulting in decline of the endangered Sonoran topminnow (Atheriniformes: Poeciliidae) in the United States. *Biological Conservation* 25:135-59.
- Meffe, G. K., and F. F. Snelson, Jr., editors. 1989. *Ecology and evolution of livebearing fishes (Poeciliidae)*. Prentice Hall, Englewood Cliffs, New Jersey. 453 pp.
- Meffe, G. K., and M. L. Crump. 1987. Possible growth and reproductive benefits of cannibalism in the mosquito fish. *American Naturalist*.
- Miller, R. R. 1961. Man and the changing fish fauna of the American Southwest. *Paper Michigan Academy Science, Arts, and Letters* 46:365-404.
- Miller, R. R., and C. H. Lowe. 1967. The fishes of Arizona. Pages 133-51 in Lowe, C. H. (editor). *The Vertebrates of Arizona*. University of Arizona Press, Tucson, Arizona.
- Minckley, W. L. 1973. *Fishes of Arizona*. Arizona Game and Fish Department, Phoenix, Arizona.
- Minckley, W. L., G. K. Meffe, and D. L. Soltz. 1991. Conservation and management of short-lived fishes: the cyprinodontoids. Pages 247-82 in W. L. Minckley and J. E. Deacon (editors). *Battle Against Extinction: Native Fish Management in the American West*. University of Arizona Press, Tucson, Arizona.
- Minckley, W. L., and J. E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species." *Science* 159:1424-32.
- Moyle, P. B. 1976. *Inland fishes of California*. University of California Press, Berkeley, California. 405 pp.
- Mushinsky, H. R., and J. J. Hebrard. 1977. Food partitioning by five species of water snakes in Louisiana. *Herpetologica* 33:162-6.
- Myers, G. S. 1965. The fish destroyer. *Trop. Fish Hobbyist* 1965:31-5.
- Odum, W. E. 1971. Pathways of energy flow in a south Florida estuary. *Univ. Miami Sea Grant Tech. Bull. No. 7*, Miami, Florida.
- Otto, R. G. 1973. Temperature tolerance of the mosquitofish, *GAMBUSIA AFFINIS* (Baird and Girard). *Journal of Fish Biology* 5:575-85.

- Page, L. M., and B. M. Burr. 1991. A field guide to freshwater fishes: North America north of Mexico. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.
- Page, L.M. and B.M. Burr. 1991. A Field Guide to Freshwater Fishes. Houghton Mifflin Co. Boston. B91PAG01PAUS.
- Peden, A. E. 1973. Variation in anal spot expression of gambussin females and its effect on male courtship. *Copeia* 1973:250-63.
- Peden, A. E. 1975. Differences in copulatory behavior as partial isolating mechanisms in the poeciliid fish GAMBUSIA. *Canadian Journal of Zoology* 53:1290-6.
- Perry, W. Guthrie, and Brandon J. Carter. Seasonal occurrence of fishes collected from beach seining, Southwest LA. 1979. *La. Acad. of Sci.* 42(): 24-38.
- Platania, S.P. 1990. Biological summary of the 1987 to 1989 New Mexico-Utah ichthyofaunal study of the San Juan River. Prepared by Department of Biology, University of New Mexico, Albuquerque, for New Mexico Department of Game and Fish, Santa Fe, under contract 78-516.6-01, and U.S. Bureau of Reclamation, Salt Lake City, UT, under cooperative agreement 7-FC-40-05060.
- Platania, S.P. and K.R. Bestgen. 1988. Study of the rare and endangered fishes of the San Juan River, New Mexico: 1988 report of activity. Prepared by Department of Biology, University of New Mexico, Albuquerque, for New Mexico Department of Game and Fish, Santa Fe, under contract 516.6-74-23 and U.S. Bureau of Reclamation, Salt Lake City, UT, under cooperative agreement 7-FC-40-05060.
- ROSS, STEPHEN T. 1996. INLAND FISHES OF MISSISSIPPI. SELECTED SPECIES ACCOUNTS. COAUTHORED WITH W. M. BRENNEMAM, W.T. SLACK, M.T. O'CONNELL, AND T.L. PETERSON. ILLUSTRATED BY D.G. ROSS. DRAFT COPY.
- Rauchenberger, M. 1989. Systematics and biogeography of the genus GAMBUSIA (Cyprinodontiformes: Poeciliidae). *American Museum Novitates* (2951):1-74.
- Reddy, S. R., and K. Shankuntala. 1979. Comparative studies of the food intake, growth and food conversion of two lavivorous fishes. *Proc. Indian Acad. Sci.* 88:425-32.
- Reddy, S. R., and T. J. Pandian. 1973. Effect of volume of water on predatory efficiency of the fish GAMBUSIA AFFINIS, *Current Science* 42:644-5.
- Rees, D. M. 1934. Notes on mosquito fish in Utah. GAMBUSIA AFFINIS (Baird and Girard). *Copeia* 1934:157-9.
- Regan, J. D. 1961. Melanism in the poeciliid fish, GAMBUSIA AFFINIS (Baird and Girard). *American Midland Naturalist* 65:139-43.
- Robins, C. R., et al. 1991. Common and scientific names of fishes from the United States and Canada. *American Fisheries Society, Special Publishing* 20. 183 pp.
- Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brookeri, E.A. Lackner, R.N. Lea, and W.K. Scott. 1980. A LIST OF COMMON & SCIENTIFIC NAMES OF FISHES FROM THE US AND CANADA (4TH ED). AMERICAN FISHERIES SOC., SPECIAL PUBLICATION NO. 12, 174 PP.
- Rutherford, D. A. 1980. Hybridization in GAMBUSIA NOBILIS (Pisces, Poeciliidae): an endangered species in the pecos River drainage of Texas and New Mexico. Baylor University, Waco, Texas. M.S. Thesis.
- Salibian, A. 1977. Aclimatacion de GAMBUSIA AFFINIS HOLBROOKI (Girard 1859) de Chile en soluciones de alta salinidad. *Noticario Mensua, Mus. Nac. Hist. Natur., Chile.* 22:4-7.
- Scribner, K. T. 1993. Hybrid zone dynamics are influenced by genotype-specific variation in life-history traits: experimental evidence from hybridizing GAMBUSIA species. *Evolution* 47:632-646.
- Seale, A. 1917. The mosquito fish, GAMBUSIA AFFINIS (Baird and Girard) in the Phillipine Islands. *Phillippine J. Sci.* 12:177-87.
- Shakuntala, K., and R. Reddy. 1979. Influence of temperature-salinity combinations on the food intake, growth and conversion efficiency of GAMBUSIA AFFINIS (Pisces). *Polish Arch. Hydrobiol.* 26:173-81.
- Simpson, J., and R. Wallace. 1982. *Fishes of Idaho*. University Press of Idaho, Moscow. 238 pp.
- Smith, P. W. 1979. *The fishes of Illinois*. Univ. Illinois Press, Urbana. 314 pp.
- Stearns, S. C. 1983. A natural experiment in life-history evolution: field data on the introduction of mosquito fish (GAMBUSIA AFFINIS) to Hawaii. *Evolution* 37:601-17.
- Stearns, S. C. 1983. The evolution of life-history traits in mosquito fish since their introduction to hawaii in 1905: rates of evolution, heritabilities, and developmental plasticity. *American Zoologist* 23:65-75.
- Stearns, S. C., and R. D. Sage. 1980. Maladaptation in a marginal population of the mosquitofish GAMBUSIA AFFINIS. *Evolution* 34:65-75.
- Stearns. S. C. 1984. Heritability estimates for age and length at maturity in two populations of mosquito fish that shared ancestors in 1905. *Evolution* 38:368-75.
- Sublette, J. E., M. D Hatch, and M. Sublette. 1990. *The fishes of New Mexico*. University New Mexico Press, Albuquerque, New Mexico. 393 pp.
- Suhr, J. M., and J. D. Davis. 1974. The spider DOLOMEDES SEXPUNCTATUS as a predator on mosquitofish, GAMBUSIA AFFINIS, in Mississippi. *Assoc. Southeast. Biol. Bull.* 21:87.
- Turner, C. L. 1941. Morphogenesis of the gonopodium in GAMBUSIA AFFINIS AFFINIS. *Journal of Morphology* 69:161-85.
- Turner, J. S., and F. F. Snelson, Jr. 1984. Population structure, reproduction and laboratory behavior of the introduced BELONESOX BELIZANUS (Poeciliidae) in Florida. *Environmental Biology of Fishes* 10:89-100.
- Walters, D. M., and B. J. Freeman. 2000. Distribution of GAMBUSIA (Poeciliidae) in a southeastern river system and use of fin ray counts for species determination. *Copeia* 2000:555-559.

- Walters, L. L., and E. F. Legner. 1980. Impact of the desert pupfish, *CYPRINODON MACULARIUS*, and *GAMBUSIA AFFINIS* on fauna in pond ecosystems. *Hilgardia* 48:1-18.
- Winkler, P. 1979. Thermal preference of *GAMBUSIA AFFINIS* as determined under field and laboratory conditions. *Copeia* 1979:60-4.
- Woodling, J. 1985. Colorado's Little Fish: A Guide to the Minnows and Other Lesser Known Fishes in the State of Colorado. Colorado Division of Wildlife, Denver.
- Woodling, J. 1985. Colorado's little fish: a guide to the minnows and other lesser known fishes in the state of Colorado. Colorado Division of Wildlife, Denver. 77 pp.
- Wooten, M. C., K. T. Scribner, and M. H. Smith. 1988. Genetic variability and systematics of *GAMBUSIA* in the southeastern United States. *Copeia* 1988:283-289.
- Wurtsbaugh, W. A., J. J. Check, Jr. and J. Compton. 1980. Effect of fish size on prey size selection in *GAMBUSIA AFFINIS*. *Proc. Pap. Annu. Conf. Calif. Mosq. Vector Control Assoc.* 48:48-51.
- Yardley, D. and C. Hubbs. 1976. An electrophoretic study of two species of mosquitofish with notes on genetic subdivision. *Copeia* 1976:117-20.
- Zimmerer, E. G. 1983. Effect of salinity on the size-hierarchy effect in *POECILIA LATIPINNA*, *P. RETICULATA* and *GAMBUSIA AFFINIS*. *Copeia* 1983:243-5.

The Small Print: Trademark, Copyright, Citation Guidelines, Restrictions on Use, and Information Disclaimer.

Note: Data presented in NatureServe Explorer at <http://www.natureserve.org/explorer> were updated to be current with NatureServe's central databases as of **February 2005**.

Note: This report was printed on **May 18, 2005**.

Trademark Notice: "NatureServe", NatureServe, NatureServe Explorer, The NatureServe logo, and all other names of NatureServe programs referenced herein are trademarks of NatureServe. Any other product or company names mentioned herein are the trademarks of their respective owners.

Copyright Notice: Copyright © 2005 NatureServe, 1101 Wilson Boulevard, 15th Floor, Arlington Virginia 22209, U.S.A. All Rights Reserved. Each document delivered from this server or web site may contain other proprietary notices and copyright information relating to that document. The following citation should be used in any published materials which reference the web site.

Citation for data on website including Watershed and State Distribution maps:

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.4. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: May 18, 2005).

Citation for Bird Range Maps of North America:

Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Bird Range Maps of North America:

"Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE."

Citation for Mammal Range Maps of North America:

Patterson, B.D., G. Ceballos, W. Sechrest, M.F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2003. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Mammal Range Maps of North America:

"Data provided by NatureServe in collaboration with Bruce Patterson, Wes Sechrest, Marcelo Tognelli, Gerardo Ceballos, The Nature Conservancy-Migratory Bird Program, Conservation International-CABS, World Wildlife Fund-US, and Environment Canada-WILDSPACE."

NOTE: Full metadata for the Bird Range Maps of North America is available at:

<http://www.natureserve.org/library/birdDistributionmapsmetadatav1.pdf>.

Full metadata for the Mammal Range Maps of North America is available at:

<http://www.natureserve.org/library/mammalsDistributionmetadatav1.pdf>.

Restrictions on Use: Permission to use, copy and distribute documents delivered from this server is hereby granted under the following conditions:

1. The above copyright notice must appear in all copies;
2. Any use of the documents available from this server must be for informational purposes only and in no instance for commercial purposes;
3. Some data may be downloaded to files and altered in format for analytical purposes, however the data should still be referenced using the citation above;
4. No graphics available from this server can be used, copied or distributed separate from the accompanying text. Any rights not expressly granted herein are reserved by NatureServe. Nothing contained herein shall be construed as conferring by implication, estoppel, or otherwise any license or right under any trademark of NatureServe. No trademark owned by NatureServe may be used in advertising or promotion pertaining to the distribution of documents delivered from this server without specific advance permission from NatureServe. Except as expressly provided above, nothing contained herein shall be construed as conferring any license or right under any NatureServe copyright.

Information Warranty Disclaimer: All documents and related graphics provided by this server and any other documents which are referenced by or linked to this server are provided "as is" without warranty as to the currentness, completeness, or accuracy of any specific data. NatureServe hereby disclaims all warranties and conditions with regard to any documents provided by this server or any other documents which are referenced by or linked to this server, including but not limited to all implied warranties and conditions of merchantability, fitness for a particular purpose, and non-infringement. NatureServe makes no representations about the suitability of the information delivered from this server or any other documents that are referenced to or linked to this server. In no event shall NatureServe be liable for any special, indirect, incidental, consequential damages, or for damages of any kind arising out of or in connection with the use or performance of information contained in any documents provided by this server or in any other documents which are referenced by or linked to this server, under any theory of liability used. NatureServe may update or make changes to the documents provided by this server at any time without notice; however, NatureServe makes no commitment to update the information contained herein. Since the data in the central databases are continually being updated, it is advisable to refresh data retrieved at least once a year after its receipt. The data provided is for planning, assessment, and informational purposes. Site specific projects or activities should be reviewed for potential environmental impacts with appropriate regulatory agencies. If ground-disturbing activities are proposed on a site, the appropriate state natural heritage program(s) or conservation data center can be contacted for a site-specific review of the project area (see [Visit Local Programs](#)).

Feedback Request: NatureServe encourages users to let us know of any errors or significant omissions that you find in the data through (see [Contact Us](#)). Your comments will be very valuable in improving the overall quality of our databases for the benefit of all users.



© 2005
NatureServe

Version 4.4 (07 April 2005)
Data last updated: February 2005