any reasonable assessment of current or historical distribution, population size, or trends. In addition, the petitioners do not provide information, and we have none available in our files, indicating that the range or abundance of the snowflies has been curtailed.

Although the petition provides an inventory of various activities or elements that may pose potential threats to the straight snowfly or the Idaho snowfly, as data on their current population distribution, abundance, and trend are completely lacking, and there is no evidence that either species has suffered any population decline or reduction in range, the petitioners' conclusion that both species ''are in imminent danger of extinction'' (Petition, p. 5) appears to be purely speculative. We have limited or no data on the actual exposure of the straight snowfly or Idaho snowfly to the purported threats, or whether that exposure, should it occur, would cause a negative population response, let alone result in the present or threatened endangerment of the species. All available threat information presented is generalized in nature, and both the NatureServe accounts and the IDFG Comprehensive Wildlife Conservation Strategy concede that ''specific threats to Idaho populations have not been identified'' (IDFG 2005, pp. 592–584; NatureServe 2010a, p. 2; NatureServe 2010b, p. 1). While we may agree with the petition's description of impaired aquatic habitat conditions within the range of these two species, we simply have no information to link the effect of these conditions with the snowfly populations. Therefore the petition lacks substantial information to indicate the threats listed in the petition are significantly impacting the straight snowfly or Idaho snowfly or threatening their continued existence. Based on the information presented in the petition and available in our files, we have no evidence to suggest that threats may be acting on either the straight snowfly or the Idaho snowfly such that either species may currently be in danger of extinction or likely to become so within the foreseeable future. Therefore, we conclude that a reasonable person would not believe that the measure proposed in the petition may be warranted.

On the basis of our determination under section 4(b)(3)(A) of the Act, we find the petition does not present substantial scientific or commercial information to indicate that listing either the straight snowfly or Idaho snowfly as endangered or threatened under the Act is warranted at this time. Although we will not review the status of these species at this time, we encourage interested parties to continue to gather data that will assist with the conservation of the straight snowfly and Idaho snowfly. If you wish to provide information regarding the straight snowfly or Idaho snowfly you may submit your information or materials to the State Supervisor, Idaho Fish and Wildlife Office (see **ADDRESSES**), at any time.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Idaho Fish and Wildlife Office (see **ADDRESSES**).

Authors

The primary authors of this notice are the staff members of the Idaho Fish and Wildlife Office (see **ADDRESSES**).

Authority

The authority for this action is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: July 21, 2011.

Gregory E. Siekaniec,

Acting Director, U.S. Fish and Wildlife Service.

[FR Doc. 2011–19445 Filed 8–1–11; 8:45 am]

BILLING CODE 4310–55–P

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2011–0047; MO 92210–0–0008–B2]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Redrock Stonefly as Endangered or Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list the Redrock stonefly (*Anacroneuria wipukupa*) as endangered or threatened and to designate critical habitat under the Endangered Species Act of 1973, as amended. After review of all available scientific and commercial information, we find that listing the Redrock stonefly is not warranted at this time. However, we ask the public to submit to us any new information that becomes available concerning the threats to the Redrock stonefly or its habitat at any time.

DATES: The finding announced in this document was made on August 2, 2011.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS–R2–ES–2011–0047. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Arizona Ecological Services Office, 2321 West Royal Palm Road, Suite 103, Phoenix, AZ 85021. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Steve Spangle, Field Supervisor, Arizona Ecological Services Office (see **ADDRESSES**); by telephone at 602–242–0210; or by facsimile at 602–242–2534. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Federal Lists of Threatened and Endangered Wildlife and Plants that contains substantial scientific or commercial information that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we will determine that the petitioned action is: (1) Not warranted, (2) warranted, or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

Previous Federal Actions

On June 25, 2007, we received a formal petition dated June 18, 2007, from WildEarth Guardians requesting that we list the Redrock stonefly as either endangered or threatened and that critical habitat be designated under the Act. This species was part of a petition to list 475 species in the southwestern United States. WildEarth Guardians incorporated all analyses, references, and documentation provided by NatureServe in its online database at *http://www.natureserve.org* into the petition. This included information produced by the Natural Heritage Network, particularly the Heritage Data Management System compiled by the Arizona Game and Fish Department (AGFD) (AGFD 2004, pp. 1–3).

Relative to the Redrock stonefly, the petition provided information on the species' current distribution, indicating it was limited to Oak Creek, Yavapai County, Arizona. The remaining information was general in nature describing factors that influence the entire stonefly order. The petition clearly identified itself as a petition and included the identification information required at 50 CFR 424.14(a). We sent a letter to the petitioners dated July 11, 2007, acknowledging receipt of the petition and stating that the petition was under review. The 90-day finding was published in the **Federal Register** on December 16, 2009 (74 FR 66866). This notice constitutes the 12-month finding on the June 18, 2007, petition to list the Redrock stonefly as endangered or threatened.

Species Information

Taxonomy and Species Description

The Redrock stonefly is an aquatic insect in the Family Perlidae and the Order Plecoptera. Immature stoneflies, or nymphs, are aquatic and generally live in cold-water streams. The nymphs have external gills, which may be present on almost any part of the body. Nymphs appear very similar to adults but lack wings (Stewart and Harper 1996, p. 218). Most stonefly nymphs are herbivorous, feeding on submerged leaves and algae, but other stonefly species are predaceous and feed on other aquatic macroinvertebrates (Stewart and Harper 1996, p. 217). Stoneflies remain in nymph form for 1 to 3 years, depending on species, before emerging and becoming terrestrial adults (Bouchard 2004, p. 77). Adult stoneflies generally only survive for a few weeks, and emerge only during specific times of the year. Some adult stoneflies do not feed at all, but those that do are herbivorous.

The family Perlidae includes relatively large, predaceous stoneflies. They have external gills found on three thoracic (middle body) segments (Bouchard 2004, p. 85). The *Anacroneuria* genus is the largest genus in the Perlidae family, primarily occurring in the Neotropical regions of Central and South America (Jewitt 1958, p. 159; Bispo and Froehlich 2004, p. 191). There are 231 described and 19 undescribed species within this genus occurring from the southernmost United States to South America (DeWalt *et al.* 2010, p. 1). The genus *Anacroneuria* expanded northward into Central America, Texas, and Arizona about 4 million years ago after the formation of the Isthmus of Panama, during the Pliocene Period (Fochetti and Tierno de Figueroa 2008, p. 374).

Anacroneuria was confirmed to exist in the United States when Redrock stonefly was described from Yavapai County, Arizona (Baumann and Olson 1984, pp. 489–492). *Anacroneuria* nymphs (immature stages) were first collected in Oak Creek at Page Springs in 1975, and the first adults were collected from Oak Creek at Redrock Crossing in 1978 (Baumann and Olson 1984, p. 489).

The Redrock stonefly is a large-winged stonefly. Adult male body lengths range between 0.4 to 0.5 inches (in) (10 to 12 millimeters (mm)), and female body lengths are 0.6 in (15 mm). Overall coloration is the same between genders: yellow head, brown and yellow body with bands bordering the midline. Redrock stonefly legs are covered with small brown spines on the upper surface, and the abdomen has many small spinules on the edges (Baumann and Olson 1984, pp. 489–492). Stewart and Harper (1996, pp. 231, 255, 258) provide morphological characters to separate *Anacroneuria* adults and nymphs from other Perlidae genera. *Anacroneuria* adults and nymphs are distinguished from all other southwestern Perlidae for having two ocelli (simple eyes) on top of their head rather than three. The only other western Perlidae genus with two ocelli is *Neoperla,* but it is not found in Arizona (Stewart and Stark 2002, p. 350).

Ecology

Baumann and Olson (1984, pp. 489–492) is the only published paper describing the Redrock stonefly. This paper does not provide any specific habitat or ecology information on this species. However, the following ecological information is available from published reports on other *Anacroneuria* species. We presume that the information generally applies to Redrock stonefly.

At early ages and small sizes, *Anacroneuria* nymphs are primarily detrivorous, meaning they feed on decayed leaves, algae, and other organic matter. Older larger nymphs are predaceous, feeding entirely on other aquatic insects including Dipteran (true fly) larvae and Ephemeropteran (mayfly) nymphs, and other smaller stonefly nymphs. North American Perlidae stonefly nymphs, in addition to foraging in riffle (shallow, flowing water) habitats, often forage within leaf packs (Femenella and Stewart 1986, pp. 535–536). Neotropical *Anacroneuria* nymphs forage in leaf litter as predators (Baptista *et al.* 2001, p. 251; Wantzen and Wagner 2006, p. 220); we assume that leaf litter provides an important foraging habitat for Redrock stonefly nymphs. Leaf litter availability varies in southwestern U.S. streams (Schade and Fisher 1997, p. 612). Leaf litter can accumulate behind large rocks, behind logs, along the stream margins where the current is slower, and behind other obstructions in high-gradient streams (Hoover *et al.* 2006, pp. 443–444). Intense local thunderstorms generate severe flash floods, which may reduce leaf litter availability for that season (Schade and Fisher 1997, pp. 612, 624). Predaceous stoneflies, including the Redrock stonefly, must then be able to forage in riffle areas outside of leaf litter when it is not available in their habitat. Adult *Anacroneuria* do not eat; they apparently rely on the predaceous diet of their late nymphal stages for reproductive organ and egg development (Fenoglio 2003, pp. 2, 16).

Neotropical *Anacroneuria* have a multivoltine life cycle (more than one life cycle, from egg to adult, occurs during a year) (Jackson and Sweeney 1995, p. 122). Because multivoltine life cycles are unknown in stoneflies from temperate climates (United States and Canada) (Brittain 1990, p. 4), we anticipate that the Redrock stonefly would have a univoltine life cycle (only one life cycle from egg to adult per year).

Stoneflies use egg or nymphal diapause (a period of suspended growth or development) during harsh summer conditions to allow them to survive seasonally poor water conditions and low stream flows (Snellen and Stewart 1979, p. 663; Brittain 1990, p. 8; Favret and DeWalt 2002, p. 37). During summer diapause, stonefly eggs or nymphs suspend development and remain buried in the moist stream bottom sediment until optimal growth conditions return. Stoneflies, including Perlidae, also use this summer diapause to survive in intermittent streams (streams that only flow as a response to snowmelt or rain storm runoff and have insufficient groundwater contribution to provide surface flow during the summer) (Snellen and Stewart 1979, p.

1; Feminella 1996, p. 659; Miller and Golladay 1996, p. 685). The Redrock stonefly may be expected to use diapauses during dry periods when water conditions and quantity are low.

Aquatic macroinvertebrates drift, or move downstream in their habitats, under different circumstances. Catastrophic drift occurs when large flood events carry macroinvertebrates downstream (Brittain and Eikland 1988, pp. 82–83). All aquatic macroinvertebrates are likely to experience this drift event if they are unable to find suitable protection during a flood event. This may also include drift from substrate disturbance from other means such as hikers, livestock, or vehicles moving across the stream. Aquatic macroinvertebrates may behaviorally drift to colonize new habitats to reduce competition for food and space (Brittain and Eikland 1988, p. 84). Predator-induced drift may occur when they are disturbed by a foraging predator and escape by allowing the water current to carry them away (Malmqvist and Sjostrom 1987, p. 402). Intentional drifting, as in behaviorally or predator-induced cases, is only practiced by those macroinvertebrates that are capable swimmers (such as Baetid and Amelitid mayflies) and can control when, where, and how far they drift (Malmqvist and Sjostrom 1987, p. 402). Drifting insects are very susceptible to fish predation; they are out in the open water column where they are easily seen. Intentional drift often occurs at night to avoid fish predation (Flecker 1992, p. 438). Aquatic macroinvertebrates that are poor swimmers, such as predaceous stoneflies, are less likely to purposely drift because they would be susceptible to fish predation (Radar and McArthur 1995, p. 8). However, in some cases, predaceous stoneflies may drift when suitable foraging sites are separated by areas, such as sand-bottom streams, with little hiding cover to crawl across. Large crawling stoneflies, like the Redrock stonefly, are also susceptible to fish predation where there is little cover. In contrast, areas of continuous cover, such as cobble-bed streams, provide protection from fish predation when stoneflies move from one area to another (Radar and McArthur 1995, p. 1). The known Redrock stonefly sites are continuous cobble-bedded streams, which reduces the need to drift to new areas.

Distribution

The Redrock stonefly is known to only occur in Arizona, and it was initially described from specimens collected at two sites: Redrock Crossing at Red Rock State Park and Page Springs on Oak Creek, Yavapai County, Arizona (Baumann and Olson 1984, p. 492; AGFD 2004, p. 1). Additional stonefly surveys were conducted to determine the Redrock stonefly's current status and distribution (Service 2010a, p. 1). During surveys in May and June 2010, adult Redrock stoneflies were found at the Page Spring Fish Hatchery on Oak Creek and Wet Beaver Creek, and near an Arizona Department of Environmental Quality (ADEQ) Bear Flats sampling site on Tonto Creek (Service 2010, p. 1). Surveys on West Clear Creek, east of Camp Verde in Yavapai County, did not identify any Redrock stoneflies. Identification of adult specimens was confirmed by stonefly experts (Kondratieff pers. comm. 2010, p. 1; Baumann pers. comm. 2010, p. 1; Stark pers. comm. 2010, p. 1).

The ADEQ had previously collected *Anacroneuria* nymphs during water quality monitoring on Campbell Blue Creek in Apache County in 2000; four sites on Upper Tonto Creek in Gila County from 1995 to 2008; Spring Creek in Gila County in 1998; and Wet Beaver Creek (upstream of the Service's survey location) in 1995 (Spindler 2010a, p. 1). Species identification was not possible because only *Anacroneuria* nymphs were collected. However, because there are no other stonefly species in that genus known from Arizona, we presume these nymphs represent collections of Redrock stonefly.

In total, we now believe the Redrock stonefly occupies at least 10 sites within five different streams in central Arizona. As a result the only known change in distribution of the species is the increase from 2 sites, from which it was initially described, to 10 sites where additional surveys found it. The increased range is a result of increased survey efforts. We suspect that if additional survey efforts were employed for this species, its known range and number of occurrences would likely expand as well. This is because the adult flying form of the Redrock stonefly has the ability to easily disperse into available habitats, and there are numerous other habitats in this region of Arizona that would appear suitable to support Redrock stoneflies. The species does not appear to be a habitat specialist, and so we would expect to find it in other similar stream habitats if more survey efforts were undertaken.

The current sites where the Redrock stonefly occurs span about 180 miles (mi) (288 kilometers (km)) east to west across the Central Highlands Physiographic Region in Arizona and include the Verde and Salt Rivers and Tonto Creek headwaters. Because of the high elevations and associated higher rainfall and snowfall, these watersheds contain the highest concentration of perennial streams (water present throughout the year) in Arizona (Arizona Department of Water Resources (ADWR) 2009a, p. 4). The Redrock stonefly may also occupy other un-surveyed water bodies (for example, East Verde River, Dude and Canyon Creeks, and numerous sites on the White Mountain Apache Indian Reservation) located in this physiographic region. The Redrock stonefly sites or their watersheds are found on the Coconino, Tonto, and Apache-Sitgreaves National Forests. Descriptions of occupied areas on each National Forest are provided below.

To date, the Redrock stonefly has been found only in perennial streams. All sites are in moderate gradient (approximately 2 percent slope), cobble-bedded streams, with overhanging streambank vegetation including willow (*Salix sp.*), velvet ash (*Fraxinus velutina*), Arizona alder (*Alnus oblongifolia*), and blackberry (*Rubus sp.*) (Service 2010a, p. 1).

There is substantial variation in the stream size, elevation, and water temperature in areas occupied by the Redrock stonefly, making this species more of a generalist than most other stonefly species (Brittain 1990, p. 2). Stream sizes range from Campbell Blue Creek (47 square-mi (122 square-km) watershed and 160 cubic-feet-per-second (cfs) (4.5 cubic-meters-per-second (cms)) bankfull channel discharge) to Oak Creek at Page Springs (355 square-mi (919 square-km) watershed and 1,400 cfs (39.6 cms) bankfull channel discharge). Bankfull channel discharge relates to the relative frequent flow (occurs 2 out of every 3 years) that fills the river channel to the point of inundating the floodplain (Rosgen 1996, p. 2–2). Elevations at Redrock stonefly sites range from 3,460 feet (ft) (1,055 meters (m)) on Oak Creek below Page Springs to 6,670 ft (2,033 m) on Campbell Blue Creek. Adjacent upland vegetation ranges from mixed paloverde and cactus desert (Oak Creek at Page Springs) to ponderosa pine (*Pinus ponderosa*) and mixed conifer (Campbell Blue Creek). The majority of sites are located between 3,900 and 5,100 ft (1,190 and 1,555 m) in elevation. Seven of the 10 Redrock stonefly sites are considered warm-water streams (streams located below 5,000 ft (1,524 m) elevation): Oak Creek (two sites), Wet Beaver Creek (two sites), Spring Creek, and the two lower Tonto Creek sites (Spindler 2010c, p. 1). The remaining three sites (streams above

5,000 ft (1,524 m)), Campbell Blue Creek and the two higher Tonto Creek sites, are considered cold-water streams.

Coconino National Forest

Oak Creek is a perennial stream in Coconino and Yavapai Counties in central Arizona. Average annual precipitation in Oak Creek Canyon is 28 in (71 cm) (ADWR 2009a, p. 247). Its two main tributaries are the West Fork of Oak Creek and Pumphouse Wash on the Coconino National Forest. Oak Creek base flow is maintained by springs at Indian Gardens, by Page Springs, and from its Spring Creek tributary. Oak Creek, upstream and downstream of the Redrock stonefly sites, flows through Coconino National Forest, private lands, and State-owned lands. Redrock Crossing, the farthest upstream Redrock stonefly site in Redrock State Park, is located approximately 4.7 river miles (7.6 km) downstream from the city of Sedona. The Page Spring site, at the Page Springs Fish Hatchery which is owned and operated by the AGFD, is approximately 18.7 river miles (30 km) downstream of Sedona.

Wet Beaver Creek is located east of Interstate Highway 17 and north of the city of Camp Verde in Yavapai County, Arizona. It is a tributary to Beaver Creek, which eventually flows into the Verde River at Camp Verde. The Redrock stonefly was collected at two sites on Wet Beaver Creek. The ADEQ collected nymphs upstream of the U.S. Geological Survey (USGS) stream gage and adults were also collected at the Beaver Creek Ranch (Service 10a, p. 1). Both sites are located on the National Forest; the downstream site is adjacent to private land.

Tonto National Forest

Tonto Creek originates on the edge of the Mogollon Rim at about 7,600 ft (2,300 m) in elevation in mixed conifer forest, dominated by ponderosa pine. Average annual precipitation for the Upper Tonto Creek watershed ranges from 22 to 30 in (56 to 76 cm) (ADWR 2009a, p. 173). There are 10 different springs that produce more than 10 gallons per minute (gpm) (38 liters per minute (lpm)) that contribute to Tonto Creek (ADWR 2009a, p. 182). Tonto Spring at the headwaters of Tonto Creek is the largest spring in the Tonto Creek Basin with a measured discharge of 1,291 gpm (4,887 lpm) (ADWR 2009a, p. 180).

The ADEQ collected Redrock stonefly nymphs at four sites on Tonto Creek: above Bear Flats; below the Christopher Creek confluence; below the Haigler Creek confluence; and below Bear Flats, south of Kohls Ranch (Spindler 2010a, p. 1). Two adult female Redrock stoneflies were also collected at the Bear Flats Campground in June 2010. All Redrock stonefly sites on Tonto Creek are on the Tonto National Forest. This portion of Tonto Creek is predominantly U.S. Forest Service land, with the exception of a private development at Bear Flats and Kohl's Ranch. The Redrock stonefly sites downstream of Bear Flats and downstream of the Haigler Creek confluence are located within the Hells Gate Wilderness and managed by the U.S. Forest Service.

Spring Creek is located on the Tonto National Forest near the town of Young, Gila County, Arizona. The Redrock stonefly site on Spring Creek is downstream of the Brady Canyon confluence and has an 88 square-mi (228 square-km) watershed. Spring Creek eventually flows 11 mi (17.6 km) from this site into Tonto Creek. Annual precipitation averages 24 in (61 cm) (ADWR 2009b, p. 173). Spring Creek is an interrupted flow system with perennial water disappearing in wider alluvial valleys (gently sloping areas with deep sediment deposits) then resurfacing in narrow canyons. It is mapped as an intermittent stream below its confluence with Walnut Creek (ADWR 2009a, p. 182, Figure 5.3–6). There are no springs along Spring Creek or located within its watershed that produce stream flows greater than 1 gpm (3.8 lpm) (ADWR 2009b, p. 182). ADWR (2009, p. 187) does not record any wells located within the Spring Creek watershed.

Apache-Sitgreaves National Forests

Campbell Blue Creek originates southwest of Alpine, Apache County, in eastern Arizona, and flows southeasterly for 17 river miles (27 km) to its confluence with Dry Blue Creek in New Mexico. Perennial flow initiates downstream of the Coleman Creek/Campbell Blue Creek confluence. Campbell Blue Creek has one spring that produces at least 10 gpm (38 L pm), located downstream of the Redrock stonefly site (ADWR 2009b, pp. 351–352). All of the tributaries that drain into Campbell Blue Creek are intermittent (ADWR 2009b, p. 352). The area receives an average of 21 inches (53 cm) of precipitation per year (ADWR 2009b, p. 342).

Summary of Factors Affecting the Redrock Stonefly

Section 4 of the Act and its implementing regulations (50 CFR 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered (in danger of extinction throughout all or a significant portion of its range) or threatened (likely to become an endangered species within the foreseeable future throughout all or a significant portion of it range) based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

In making this finding, information pertaining to the Redrock stonefly in relation to the five factors provided in section 4(a)(1) of the Act is discussed below. In making our 12-month finding, we considered and evaluated the best available scientific and commercial information.

In considering what factors might constitute threats, we must look beyond the mere exposure of the species to the factor to determine whether the species responds to the factor in a way that causes actual impacts to the species. If there is exposure to a factor, but no response, or only a positive response, that factor is not a threat. If there is exposure and the species responds negatively, the factor may be a threat and we then attempt to determine how significant a threat it is. If the threat is significant, it may drive or contribute to the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined by the Act. This does not necessarily require empirical proof of a threat. The combination of exposure and some corroborating evidence of how the species is likely impacted could suffice. The mere identification of factors that could impact a species negatively is not sufficient to compel a finding that listing is appropriate; we require evidence that these factors are operative threats that act on the species to the point that the species meets the definition of endangered or threatened under the Act.

A. The Present or Threatened, Destruction, Modification, or Curtailment of the Species' Habitat or Range

Under Factor A, we will discuss a variety of potential impacts to Redrock stonefly habitat including: (1) Water quality, (2) livestock grazing, (3) crayfish, (4) wildfires, (5) prescribed fires, (6) recreation, and (7) urban and rural development. The potential impacts of nonnative crayfish are discussed here related to habitat alterations, and other impacts from crayfish are discussed under Factor C below.

Water Quality

Impacts to aquatic habitats, especially from pollution, have been identified as a concern for the Redrock stonefly (AGFD 2004, p. 2). Most stonefly species are restricted to cold-water environments because their small external gills require water with high dissolved oxygen levels (Surdick and Gaufin 1978, p. 3; Covich 1988, p. 365; Brittain 1990, p. 2). In unpolluted, cold-water streams and rivers, dissolved oxygen concentrations usually remain high, well above 80 percent saturation, because oxygen solubility (ability to be absorbed in water) increases as temperature decreases (Hauer and Hill 1996, p. 96). High organic nutrient levels can also be detrimental because they cause excessive microbial (microscopic organisms) growth. These organisms consume oxygen from the water (Hauer and Hill 1996, pp. 96–97). Organic pollution can also cause excessive algae growth, which can decrease dissolved oxygen when the algae respires or absorbs oxygen at night (Hauer and Hill 1996, p. 97) or when the vegetation dies and decomposes (Jewell 1971, p. 1457). Because Plecoptera are considered sensitive to low dissolved oxygen levels in water, their presence is often used for monitoring water quality (Surdick and Gaufin 1978, p. 1; Udo *et al.* 1984, p. 189). However, stoneflies in the genus *Anacroneuria* are an exception to this standard practice, because species in this genus are well-established in warm-water neotropic regions of Central and South America and can withstand lower dissolved oxygen levels (Stark and Kondratieff 2004, p. 1; Fenoglio 2007, p. 220; Nelson 2008, p. 184; Springer 2008, p. 274). *Anacroneuria* are often found in streams with warm-water temperatures ranging from 75 to 78 degrees Fahrenheit (24 to 26 degrees Celsius) (Froehlich and Oliveira 1997, p. 1882; Fenoglio and Rosciszewska 2003, p. 163), which limits available dissolved oxygen. *Anacroneuria* are adapted to low dissolved oxygen levels by having egg capsules with tiny, thin canals oriented perpendicularly to the surface of the shell that enhance oxygen uptake compared to other stoneflies (Fenoglio and Rosciszewska 2003, p. 163). As a result of these adaptations, the Redrock stonefly may be tolerant of impaired water quality, particularly elevated water temperature and excessive nutrients that can lead to low dissolved oxygen.

Several researchers have reported that *Anacroneuria* are tolerant of poor water quality conditions. In fact, due to its tolerance for low dissolved oxygen and poor water quality, Tomanova and Tedesco (2007, p. 69) determined that *Anacroneuria* may not be a good indicator of water quality. Baptista *et al.* (2007, p. 92) noted that in tropical streams, *Anacroneuria* was an exception to the rule that Plecoptera are considered sensitive to environmental degradation. In addition, *Anacroneuria* were documented in numerous bioassessment reviews and studies in South America in waters with high organic (nutrients) levels, although less so than in unpolluted waters (Froelich and Oliveria 1997, p. 183; Bispo *et al.* 2002, p. 413; Bispo and Oliveria 2007, p. 287). Bobot and Hamada (2002, p. 300) found that *Anacroneuria* densities did not respond to suspended sediment caused by deforestation in streams in central Brazil. In another study, *Anacroneuria* were the only stoneflies found in streams under strong anthropogenic (human-caused) influences (Bispo *et al.* 2002, p. 413). We presume that the Redrock stonefly is similar to other species of stoneflies in the *Anacroneuria* genus and would, therefore, be tolerant of poor quality conditions, should these types of conditions be present in their habitat.

The ADEQ is required by the Clean Water Act (33 U.S.C. 1251 *et seq.*) to conduct a comprehensive analysis of water quality data associated with Arizona's surface waters to determine whether State water quality standards are being met and designated uses (such as human contact, aquatic, and wildlife) are being supported. Since 1992, the ADEQ has evaluated water quality at eight sites currently known to be occupied by Redrock stonefly nymphs (Spindler 2010b, p. 1). The ADEQ rated five of the eight sites, Oak Creek (two sites) and Tonto Creek (three sites), as having impaired water quality as a result of *Escherichia coli* (*E. coli*) bacteria level exceedance in 2006 and 2008 (Avila *et al.* 2009, pp. VR–33, VR–35, SR–64, SR–65). The ADEQ notes that high *E.coli* levels, on their own, do not affect aquatic invertebrates (Spindler 2010b, p. 1), and we do not expect them to affect Redrock stoneflies. This parameter is measured for safety thresholds for the human contact designated use (Marsh 2009, p. G–22). The ADEQ found no other water quality concerns during these surveys. Our review found no other information indicating water quality concerns in the streams where Redrock stoneflies are known to occur.

Based on the results of ADEQ water quality analyses and the Redrock stonefly's wide range of habitats and presumed tolerance to higher levels of sedimentation and nutrient enrichment, we conclude that water quality conditions in Arizona are not a significant threat to the Redrock stonefly or its habitat.

Livestock Grazing

If livestock grazing is not well-managed, aquatic insects can be negatively impacted by decreased riparian vegetation, stream bank destabilization, and increases in sedimentation and water temperature (Braccia and Voshell 2006, p. 269; McIver and McInnis 2007, p. 294). Improper grazing use levels may lead to soil erosion from riparian and upland vegetation removal, soil litter removal, increased soil compaction from trampling, and increased bare ground (Kauffman and Krueger 1984, p. 434; Schulz and Leininger 1990, pp. 297–298; Belsky *et al.* 1999, p. 30). Excessive livestock grazing in upland watersheds can also lead to bare, compacted soils, which in turn allow less water infiltration, which generates increased rates of surface runoff and can contribute to soil erosion as well as flooding and stream bank alterations (Abdel-Magid *et al.* 1987, pp. 304–305; Orodho *et al.* 1990, pp. 9–11). Increased soil erosion leads to higher sediment loads in nearby waters, which can degrade instream and riparian habitat and increase water turbidity. Perlidae stoneflies, like Redrock stoneflies, may experience reduced respiratory ability when their gills are covered by sediment (Lemly 1982, pp. 238–239). Sediment that becomes embedded in the interstitial spaces around large substrate can smother insect (such as stonefly) eggs and larvae, reduce forage for the nymphal stage, and limit suitable egg depositing sites (Brusven and Prather 1974, p. 31; Waters 1995, pp. 65–66).

The ADEQ (Spindler 2010c, p. 1) classified the Redrock stonefly sites as moderate gradient based on riffle-dominated cobble or gravel or both substrate streams (Rosgen Stream Classification B3 channel types) (Rosgen 1994, p. 174; Rosgen 1996, pp. 5–68, 5–72). The B3 stream types are moderately entrenched systems with channel gradients of 2 to 4 percent. The channel bottom materials are composed primarily of cobble (2.5 to 10 in (64 to 256 mm) intermediate axis diameter) with a few boulders and lesser amounts of sands and gravels. Rosgen (1994, p. 194) determined that B3 stream types have low sensitivity to disturbance and low streambank erosion potential. The large cobble substrate that is resistant to movement during frequent flood events is also resilient to livestock disturbance. Given the energy required to initiate movement of large cobbles, these stream channel types do not rely on vegetation for stability; the substrate size in itself provides stabilization.

Recent ADEQ water quality data do not show that livestock are having a negative impact on water condition at any of the Redrock stonefly sites, in the form of excess sediment or nutrients that are contributing to impairment (Avila *et al.* 2009, pp. SR–64, SR–65, VR–33, VR–35, VR–61, VR–62). The ADEQ sites that are impaired and the causes of impairment are discussed above in the Water Quality section.

One reason that grazing is not affecting streams that provide habitat for the Redrock stonefly is that many of the streams are in areas with well-managed grazing or no grazing. In Coconino National Forest, the Oak Creek sites are not on livestock grazing allotments. Almost the entire Oak Creek corridor is excluded from livestock grazing. The Wet Beaver Creek stonefly sites are also excluded from livestock grazing. In the Apache–Sitgreaves National Forest, Campbell Blue Creek is also excluded from livestock grazing within the downstream segment where Redrock stoneflies were collected by ADEQ (USDA 2009, p. 87).

In the Tonto National Forest, the five Upper Tonto Creek sites are located on two livestock grazing allotments: Christopher Mountain/Ellinwood and Diamond Butte. The Redrock stonefly sites in the Christopher and Tonto Creeks are excluded from grazing due to their topography (they are in very steep terrain), or they are located in pastures that are not grazed. The Spring Creek site is not located on a grazing allotment, but is used for the Heber-Reno Sheep Driveway on the Tonto and Apache-Sitgreaves National Forests. Two permitted livestock operators are authorized to use the driveway as part of their 10-year grazing permits. The permitted sheep herding is currently managed through Annual Operating Instructions that are prepared for the Long Tom and Beehive/Sheep Springs allotments in coordination with the livestock operators and six ranger districts on the two forests. The Sheep Driveway is used to access summer grazing allotments on the Apache-Sitgreaves National Forest from winter grazing lands located on private property in Phoenix, Arizona. Approximately 8,000 permitted sheep, plus 7 pack animals per band for the sheep herders and camp tender, are authorized on the Sheep Driveway (USDA 2010a, pp. 1–2). Sheep are kept out of all riparian areas except when crossing and watering (USDA 2010a, p. 11). All riparian areas are excluded from use as bedding grounds. The limited sheep grazing at established stream channel crossings does not likely affect the Redrock stonefly. These stream crossing sites have little to no riparian vegetation and no potential to produce riparian vegetation because they are dry washes or road surfaces, or they consist of large cobble and boulder substrate (USDA 2010a, p. 3).

Livestock grazing is not threatening the habitat of the Redrock stonefly, because the habitat has limited exposure to the effects of grazing. Livestock are excluded from the Oak, Wet Beaver, and Campbell Blue Creeks Redrock stonefly sites due to decisions of land managers or property owners. The Tonto Creek Redrock stonefly sites are located in areas difficult for livestock to access. Only one area is used as a travel corridor for moving sheep (Spring Creek), and the stream crossing sites are not likely to affect Redrock stoneflies. Therefore, we find that grazing is not a significant threat to the Redrock stonefly or its habitat.

Crayfish

Crayfish are not native to Arizona. The red swamp crayfish (*Procambarus clarkii*) and the green or northern crayfish (*Orconectes virilis*) were introduced in Arizona in the 1970s (Taylor *et al.* 1996, p. 27; Inman *et al.* 1998, p. 3). The red swamp crayfish is not currently found in any of the Redrock stonefly sites (Sorensen 2010, p. 1; USGS 2010a, p. 1). The northern crayfish, however, is found throughout Arizona, including the following Redrock stonefly sites: Tonto Creek drainage; Oak Creek drainage (Holycross *et al.* 2006, pp. 23, 40–44, 59); Verde River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 14, 20–28, 54–56); Salt River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 15, 29–44, 56–60); and Spring Creek drainage and Campbell Blue Creek drainage (Holycross *et al.* 2006, pp. 25, 46, 55, 60).

Crayfish are known to affect aquatic macroinvertebrate habitat in three ways: (1) By increasing leaf litter decomposition rates; (2) by feeding on aquatic plants; and (3) by increasing turbidity and sedimentation from bioturbation when crayfish are physically moving through fine substrates. The following discussion addresses each of these three mechanisms. Crayfish can also prey on macroinvertebrates, and this is discussed under *Factor C.*

First, crayfish may reduce the amount of leaf litter in streams and reduce the amount of forage and foraging habitat available to Redrock stonefly nymphs. The nymphs feed on detritus when young; they then prey upon other aquatic macroinvertebrates found in the leaf litter (Fenoglio 2003, pp. 2, 16). Forested streams receive a large portion of their energy input from allochthonous litter (mainly plant material from terrestrial sources) (Minshall 1967, p. 147; Vannote *et al.* 1980, p. 132; Wallace *et al.* 1997, p. 102). This litter, in the form of leaves and wood, is an important food source and foraging area for stream invertebrates (Wallace and Webster 1996, p. 120; Usio 2000, p. 608). Invertebrates that feed on leaf litter are called shredders and consume course particulate organic matter in the stream channel. Shredders convert coarse particulate organic matter into fine particulate organic matter, which breaks down litter and provides additional food sources for stream macroinvertebrates. In their native range, crayfish serve an important function by shredding coarse particulate organic matter into fine matter in litter-based food webs (Usio 2000, p. 612; Creed and Reed 2004, p. 225).

However, nonnative crayfish feeding on leaf litter can significantly reduce the time it would otherwise take to break down leaf litter and may lower the amount of foraging area available to native macroinvertebrates (Usio 2000, p. 612; Creed and Reed 2004, p. 231; Bobeldyk and Lamberti 2010, pp. 648, 652). Nonnative crayfish are typically the largest invertebrate shredder in streams (Usio 2000, p. 609; Parkyn *et al.* 2001, p. 641). Studies show that reduced terrestrial litter amounts in streams resulted in decreased abundance of invertebrates (and their predators) that feed on large and fine particulate organic matter (Wallace *et al.* 1997, p. 102; Bobeldyk and Lamberti 2010, pp. 649, 652). Neotropical *Anacroneuria* nymphs feed on the small invertebrates that occur in association with leaf litter and leaf packs (accumulated piles of leaf litter) (Benstead 1996, p. 371; Mathuriau and Chauvet 2002, p. 390; Wantzen and Wagner 2006, p. 220). Redrock stonefly nymphs are expected to use leaf packs as foraging habitat when leaf packs are available and have not been removed from the site by flooding (Schade and Fisher 1997, p. 624). Redrock stonefly nymphs could have less available food and foraging habitat as a result of nonnative crayfish feeding on the leaf litter and increasing the rate of leaf breakdown. However, because leaf litter availability is also affected by flood events, the Redrock stonefly would be expected to be adaptable and to satisfy its foraging needs in other habitats such as riffle areas. Therefore, the potential loss of some leaf litter due to crayfish is not expected to impact Redrock stoneflies.

Second, crayfish may reduce the amount of living aquatic vegetation in streams. Crayfish feed heavily on living aquatic plants (Chambers *et al.* 1990, p. 90; Creed 1994, p. 2098; Nystrom and Strand 1996, pp. 678, 680). The northern crayfish feeds on and reduces aquatic vegetation available in streams, removing food sources for herbaceous invertebrates, which reduces macroinvertebrate habitat, and may cause a decrease in available prey items as food for the Redrock stonefly. In one example, Creed (1994, p. 2098) found that a filamentous alga (*Cladophora glomerata*), an aquatic plant commonly fed upon by crayfish, was at least 10-fold greater in aquatic habitats without crayfish in Michigan streams. Filamentous alga is an important component of aquatic vegetation that provides cover and food for macroinvertebrates that predatory stoneflies may feed on.

However, we believe that crayfish feeding on aquatic plants is not likely to impact the Redrock stonefly. This is because Redrock stonefly nymphs occur in moderately steep-gradient streams with cobble substrates that do not provide many areas with fine substrates or low water velocities for herbaceous vegetation to establish and persist. The three factors that limit aquatic vegetation growth in stream channels are shade, large cobble substrate, and high water velocity, and they are all present at all Redrock stonefly sites (Vannote *et al.* 1990, p. 132; Biggs 1996, p. 135; Riis and Biggs 2003, pp. 1495–1496; O'Hare *et al.* 2010, pp. 6–7; Service 2010a, p. 1). We presume that Redrock stoneflies, like most *Anacroneuria,* feed in leaf litter and gravel and cobble substrates rather than in aquatic vegetation (Tamaris-Turizo 2007, p. 1). Therefore, crayfish herbivory does not significantly impact stonefly foraging habitat or prey availability.

Third, crayfish can increase turbidity (suspended sediment in the water column) in wetlands and lakes as they move and forage for prey in fine sediments (Statzner *et al.* 2000, p. 1039; Dorn and Wojdak 2004, p. 157). Many aquatic invertebrates depend upon open interstitial spaces (small openings between rocks) in channel substrate (gravels and cobbles). Excessive sediments in streams can fill the interstitial spaces and reduce aquatic invertebrate habitat (Waters 1995, pp. 65–68). Crayfish bioturbation (the mobilizing of sediments by crayfish activity) can impact lakes, ponds, and wetlands, but it is not likely to significantly affect high-gradient streams, such as the sites where Redrock stoneflies are present, because the small amounts of suspended sediment would be carried by stream flow through the water column until they are deposited downstream at lower gradient and lower velocity sites.

In some situations, crayfish bioturbation may actually improve macroinvertebrate habitat in the stream environment by removing fine sediments from interstitial spaces. For example, Statzner *et al.* (2000, p. 1039) observed that crayfish bioturbation removed fine sediments and benefited gravel-spawning salmonids. Also, Creed and Reed (2004, p. 234) found that mayfly (Ephemeroptera) numbers increased when crayfish bioturbation removed fine sediments from gravel streambeds in Maryland. This may be particularly important for the recovery of stream bottom habitats after silt deposition following floods or other upstream disturbances (Parkyn *et al.* 1997, p. 689). The Redrock stonefly sites are stable stream channels that are moderately steep and dominated by cobbles. These sites usually have little soft or fine sediments to be disturbed and enter the water column. Therefore, crayfish bioturbation is not likely to impact Redrock stoneflies.

In summary, we considered three mechanisms by which nonnative crayfish could alter the habitat of the Redrock stonefly: (1) Increasing leaf litter decomposition rates; (2) feeding on aquatic plants; and (3) increasing turbidity and sedimentation from bioturbation when crayfish are physically moving through fine substrates. Our analysis of the biology of the stonefly and known ecology of the crayfish finds that crayfish are not likely a significant threat to the Redrock stonefly or its habitat.

Wildfires

Wildfires, through alterations of the terrestrial environment, can cause many physical disturbances to streams (Gresswell 1999, p. 194). Low-intensity fire, which is cooler burning and does not result in major changes in the vegetation community in which it occurs, has been a natural disturbance factor in forested landscapes for centuries, and low-intensity fires were common in Southwestern forests and grasslands prior to European settlement (Harrington and Sackett 1990, p. 122). Fire suppression and wildfire control during the past decades have changed this natural fire regime, resulting in unnatural fuel build-up by increased understory vegetation and stand density of large trees, which increases fire severity (Harrington and Sackett 1990, p. 122; Schoennagel *et al.* 2004, p. 661; Westerling *et al.* 2006, p. 940). This increased wildfire severity can result in large increases in the magnitude and frequency of floods resulting from vegetation removal by fire that did not likely occur prior to wildfire suppression and control efforts (Neary *et al.* 2003, p. 30). Moody and Martin (2001, p. 2990) and Viera *et al.* (2004, p. 1254) each noted increased soil erodibility and reduced infiltration after severe fires, which resulted in dramatic increases in peak flow and sediment load in streams draining burned catchments. In Southwestern montane watersheds, flood events may occur during the July–August monsoon period immediately following the May–June fire season (Rinne 1996, p. 653).

Wildfires have occurred in the past within watersheds that contain the Redrock stonefly sites (for example, the Picture Fire above Spring Creek, the Brady Fire above Wet Beaver Creek, and the Brins Fire and Division Fire above Oak Creek). The Brady Fire burned approximately 4,000 acres (ac) (1,620 hectares (ha)) in the upper Wet Beaver Creek watershed in 2009 (U.S. Forest Service 2010b, p. 1). Two USGS stream gages are near the Oak Creek and Wet Beaver Creek Redrock stonefly sites. Wet Beaver Creek stream flow data do not show that there has been a significantly higher peak flow event after the fire. The nearest Oak Creek stream gage, immediately upstream of Page Springs, began functioning in October 1981. The Division Fire burned approximately 650 ac (260 ha) on the slopes above Oak Creek at Page Springs in August 1980, and the Brins Fire burned 4,317 ac (1,744 ha) north of Sedona in June 2006 (U.S. Forest Service 2010b, p. 1). The USGS stream flow data do not show any significantly higher peak flows after the two fires (USGS 2010).

The direct effects of fire on stream macroinvertebrate communities generally are minor or indiscernible (Rinne 1996, p. 655; Minshall *et al.* 1997, p. 2519; Minshall 2003, p. 155). However, important exceptions may include intense heating in areas of small water volume (for example, small first-or second-order streams or shallow, sluggish margins of larger streams) and extended exposure to toxins from dense smoke and errant retardant drops (Minshall 2003, p. 156). Redrock stoneflies may only experience limited exposure to these effects in the swifter flowing water they inhabit. Toxins and heated water may be transported through their habitat before cumulative adverse effects result.

Instead, adverse effects of wildfire on stream macroinvertebrates are largely the result of physical changes in habitat due to increased runoff after the fire (Minshall *et al.* 1989, p. 712). This higher runoff can scour, transport, and redistribute sediments and organic matter, and it can restructure the physical stream environment (Herbst and Cooper 2010, p. 1355). Aquatic macroinvertebrates are somewhat resilient to flood events. High numbers may be removed after floods, but their numbers quickly recover (Molles 1985, p. 281; Hering *et al.* 2004, p. 454). However, aquatic macroinvertebrates showed low resistance and resilience to the effects of repeated, large, post-fire flood events (Viera *et al.* 2004, p. 1253). Macroinvertebrate taxa richness and densities in general were reduced after the first large post-fire flood events, then recovered until the next large flood event (Viera *et al.* 2004, pp. 1247–1248). In one example, a 3-year study from central Arizona, Rinne (1996, p. 655) found large flood events reduced macroinvertebrate densities by 85 to 90 percent after the Dude Fire.

Primary consumers, organisms that feed on plants, such as blackfly and midge larvae (Diptera), and Baetid mayflies, quickly recolonized and dominated the community after wildfire (Minshall *et al.* 1997, p. 2523; Viera *et al.* 2004, p. 1255). Many of these primary consumers are filter feeders, which are able to take advantage of increased organic matter entering the stream after a fire (Minshall *et al.* 1989, p. 713; Herbst and Cooper 2010, p. 1363). They also disperse easily from upstream areas through drift (Minshall *et al.* 1997, p. 2523) or from adult dispersal from adjacent undisturbed habitats (Hughes *et al.* 2003, p. 2151). Because of the increased availability of prey species (primary consumers), large stonefly nymphs and other predatory macroinvertebrates can dramatically increase in abundance after a fire (Viera *et al.* 2004, pp. 1253–1254; Herbst and Cooper 2010, p. 1360; Malison and Baxter 2010, p. 1335). For example, Viera *et al.* (2004, p. 1251) found the predaceous stonefly, *Isoperla* (Perlodidae), had recovered in the first post-fire year that did not experience a significant flood event. We would, therefore, anticipate that under most circumstances, if fires resulted in a decrease in the availability of primary consumer prey species for food of Redrock stoneflies, such an effect would be short-term in nature.

Because of the limited exposure of the species to the effects of wildfires and the expected resiliency of the species to recover following any short-term habitat alteration resulting from wildfires, we find the wildfires are not a significant threat to the Redrock stonefly or its habitat.

Prescribed Fires

To avoid the detrimental effects of large, high-severity fires and to restore more natural fire disturbance patterns in forest ecosystems of the western United States, prescribed fires and mechanical forest thinnings (selected removal of trees) are being used as management tools, particularly near wildland-urban interfaces (Arkle and Pilliod 2010, p. 893). Prescribed fires are often intentionally excluded from, or near, riparian forests to avoid fire-associated increases in sediment levels and other habitat changes that could be detrimental to ecologically sensitive habitats and aquatic taxa (Arkle and Pillirod 2010, pp. 893–894). Therefore, prescribed fires in Arizona are usually designed to avoid impacting riparian and stream habitats. For example, the U.S. Forest Service has formally consulted with the Service under section 7 of the Act on two prescribed fires that they determined would have an adverse effect on two listed species, Gila topminnow (*Poeciliopsis occidentalis*) and loach minnow (*Tiaroga cobitis*), in a riparian or stream community in Arizona: the Quien Sabe Fire Management Treatment (Service 1991, pp. 8–9) and the Robinson Mesa Prescribed Fire Project (Service 1999, pp. 22–23). Both consultations included mandatory terms and conditions to reduce the adverse effects of project implementation to listed species. We anticipate that the exclusion of prescribed fire from riparian areas, along with conservation measures put in place during prescribed fire planning for other species, is adequate to minimize impacts to the Redrock stonefly. The Redrock stonefly's resilience to wildfire, discussed above, would also reduce the effects of prescribed fire. Therefore, we find that prescribed fires are not a significant threat to the Redrock stonefly or its habitat.

Recreation

The Redrock stonefly sites or their watersheds occur on private, State, and Federal lands. The Federal lands are managed for recreation and other purposes, and some level of recreation occurs on every stream occupied by the Redrock stonefly. A study of outdoor recreation trends in the United States found increases in participation in most of the activities surveyed, which included bicycling, primitive or developed-area camping, bird watching, hiking, backpacking, and snowmobiling (Cordell *et al.* 1999, pp. 221–321). Human population growth trends are expected to continue into the future throughout the Southwest, leading to higher demand for outdoor recreational opportunities. In the arid Southwest, the human desire to recreate in or near water, and the relative scarcity of such recreational opportunities, tends to focus recreation impacts on riparian areas (Winter 1993, p. 155; Briggs 1996, p. 36).

Streams are popular hiking destinations in Arizona. While there are hiking opportunities at each of the Redrock stonefly sites, actual use is limited by their location in remote rugged canyons with poor access or due to land ownership restrictions (State and private lands). Spring Creek and the three lower Tonto Creek sites are located in areas without easy road access. The upper Tonto Creek site is difficult to access because of private land downstream of its location. The Campbell Blue Creek site is located along a forest road, leading to a private ranch in a remote area in eastern Arizona. The Redrock stonefly is not affected by hiking in Oak Creek. The Page Springs Oak Creek site, at the Page Springs Hatchery, has hiking trails on the adjacent uplands. The AGFD allows very limited creek access from their property, due to concerns of fish disease transmission from the creek to the hatchery. Redrock State Park only allows visitor access along designated trails; swimming or wading is prohibited in Oak Creek. The Beaver Creek Ranch is a private high school that limits public access to the east side of the creek. Recreational use is primarily hiking through the area along the west side of the creek.

Hiking in streams can be a source of disturbance to stream invertebrates. Aquatic invertebrates can be induced to drift as a result of disturbance by hikers within the stream. In one study, increased numbers of hikers resulted in increased densities of drifting aquatic invertebrates (Caires *et al.* 2010, p. 555). However, this is not likely to be a significant effect, because aquatic invertebrates are adapted to flash floods, which cause a similar, but larger, disturbance (Caires *et al.* 2010, p. 555).

Caires *et al.* (2010, p. 555) found that aquatic invertebrates areas disturbed by hikers quickly recolonized from upstream. Redrock stoneflies do not intentionally drift, but if hiking causes then to enter the water column, they would be susceptible to fish predation until they settled back down to the stream bed. Future flood events could carry Redrock stoneflies downstream to unoccupied habitats. Because of the limited opportunity for hikers in streams occupied by the Redrock stonefly and the likely, but short-term, effects of hiking, this type of recreational activity is not a significant threat to the Redrock stonefly or its habitat.

Off-road vehicle (ORV) use is another form of recreation that can increase sedimentation in streams by damaging riparian vegetation and stream banks. However, most Redrock stonefly sites are either inaccessible or minimally impacted by ORV use. The Oak Creek sites are not accessible to ORV use. The Page Springs site, at the Page Springs Fish Hatchery, limits visitors to walking trails on both sides of Oak Creek, fish hatchery tours, and fishing. Also, ORV use is prohibited at the Redrock Crossing site at Red State Park. The Wet Beaver Creek sites are inaccessible to ORVs because the U.S. Forest Service road leading to the site upstream of the USGS gage is closed to all vehicular traffic. The lower Wet Beaver Creek site, near the Beaver Creek Ranch, is protected by private land on the east side and the closed U.S. Forest Service road on the west side. Similarly, the three Tonto Creek sites are either located in a narrow canyon or have private land at Bear Flats that blocks access. The lower site is located in the Hells Gate Wilderness, where mechanized and motorized vehicle uses are prohibited. The Spring Creek site is located in a steep-walled canyon without any road access. The Campbell Blue Creek site is the only habitat that may experience some ORV use because there is a road paralleling the creek that provides vehicle access into the area. Therefore, due to the lack of access to all but one of the known occupied sites, we do not consider ORV use a threat to the Redrock stonefly or its habitat.

In summary, we considered the potential impacts to Redrock stonefly habitat from recreational activities primarily associated with hiking and ORV use. We found there is limited access to Redrock stonefly habitats for these activities and very minor effects when they occur. Therefore, we find that recreation is not a significant threat to the Redrock stonefly or its habitat.

Urban and Rural Development

The effects of urban and rural development on natural habitats are expected to increase as human populations increase. Consumer interest in second home and retirement real estate investments has increased significantly in recent times within the southwestern United States. Medina (1990, p. 351) points out that many real estate investors are looking for scenic areas with mild climates to develop properties that are within, or adjacent to, riparian areas, due to their aesthetic appeal and available water, especially in the southwestern United States. Arizona's population increased by 28 percent from 2000 to 2009 (U.S. Census Bureau 2010, p. 1). Over the same time period, population increases in the Arizona counties where Redrock stoneflies occur are as follows: Yavapai County (28 percent); Gila County (1.8 percent); and Apache County (1.8 percent) (U.S. Census Bureau 2010, p. 1).

Increased urbanization and population growth results in increased demands for water development projects. Collier *et al.* (1996, p. 16) mentions that water development projects are one of two main causes of decline of native fish in the Salt and Gila Rivers of Arizona, and municipal water use in central Arizona increased by 39 percent over 8 years (American Rivers 2006, p. 1). Water for development and urbanization is often supplied by groundwater pumping and surface water diversions from sources that include reservoirs and the Central Arizona Project's allocations from the Colorado River. The hydrologic connection between groundwater and surface flow of intermittent and perennial streams is becoming better understood as a result of new research. Groundwater pumping creates a cone of depression within the affected aquifer that slowly extends outward from the well site. When the cone of depression intersects the hyporheic zone of a stream (the transition zone between surface water and groundwater), the surface water flow may decrease, and the subsequent drying of riparian and wetland vegetative communities may result (Webb and Leake 2006, p. 308).

Streamflow reduction from increased groundwater use and surface water diversion can have a dramatic impact on stream habitat and associated macroinvertebrate communities. Artificial flow reductions frequently lead to negative changes in aquatic ecosystems, such as decreased water depth, increased sedimentation, and altered water temperatures and chemistry; all of these can reduce or influence macroinvertebrate numbers, richness, competition, predation, and other interactions (Dewson *et al.* 2007, pp. 401–411). Twenter and Metzger (1963, p. 29) determined that permeable sandstone beds are the primary source of water for springs in the Page Springs (also referred to as Cave Springs) and Spring Creek areas, and much of the perennial flow in Oak Creek is from these springs. Twenter and Metzger (1963, p. 14) determined that the average base flow of Oak Creek just above the springs complex during winter months was 40 cfs (1.13 cms). After adding the 36 cfs (1.01 cms) inflow from springs and 16 cfs (0.45 cms) from Spring Creek, the base flow increased to 92 cfs (2.6 cms) near the mouth of the creek. There are six springs, not including Page Springs, immediately upstream of the Page Springs Redrock stonefly site that produces more than 10 gpm (37.8 lpm) (ADWR 2009a, p. 268). Page Springs is the second highest discharging spring in the Verde River watershed, flowing at 29 cfs (0.82 cms) (Flora 2004, p. 38). These springs and seeps in the Page Springs area provide a large volume of water to Oak Creek, where the Redrock stonefly occurs (Mitchell 2001, p. 4). An analysis of the Page Springs flow rate between January 1, 1996, and February 9, 2000, detected a 15 percent decline in flow (Mitchell 2001, p. 5). This analysis period coincided with a severe to extreme drought, and with the drilling of three new wells upstream of Page Springs (Mitchell 2001, p. 6). The ADWR's records show that three wells have been drilled in close proximity and up gradient of Cave Springs (Mitchell 2001, p. 6). Two of these wells pump between 1,200 gpm (4,542 lpm) and 1,500 gpm (5,678 lpm), and are within 0.75 mi (1.2 km) of Page Springs. Given their proximity, production rate, and hydrological connectivity, groundwater withdrawal by these wells could have a direct impact on flow at Page Springs (Mitchell 2001, p. 6). However, the extent of the impact of these wells on the spring cannot be determined without long-term aquifer tests and simultaneous discharge monitoring at Cave Springs (Mitchell 2001, p. 6).

Wet Beaver Creek, upstream of the USGS stream gage, is not affected by diversions or wells, because the watershed above this site is on the Coconino National Forest. The Beaver Creek Ranch, adjacent to the lower Wet Beaver Creek site, has a small pond that is filled by a diversion from the creek. This pond is not large enough to impact

Wet Beaver Creek base flow (Hedwall 2011, p. 1).

The Upper Tonto Creek headwaters are fed by numerous springs, the largest of which is Tonto Springs. Long-term flow records from Tonto Springs show little fluctuation in baseflow over a 20-year period (Parker *et al.* 2005, p. 73). There are numerous small wells located on private lands and at U.S. Forest Service campgrounds upstream of the Redrock stonefly site. The ADWR (2009a, p. 187) does not monitor water depth in these wells, nor address the wells' impact to Tonto Creek baseflow.

The Redrock stonefly site on Spring Creek is not affected by groundwater wells as ADWR does not identify any wells in the vicinity (2009a, p. 197). The Campbell Blue Creek Redrock stonefly site is located in an undeveloped watershed with only two small parcels of private land upstream of two ADWR-registered wells at the Blue River Ranch. There are no other ADWR-registered wells on Campbell Blue Creek (ADWR 2010, p. 1). There will likely be continued human population growth in the foreseeable future in some areas around Redrock stonefly habitats that could result in increased groundwater usage. However, we do not have sufficient information to reasonably determine whether any future groundwater would result in declines to stream flows in Redrock stonefly habitats. Overall, because of the low level of water development currently occurring within the watersheds that support the species, water development associated with urban and rural development does not appear to threaten the Redrock stonefly or its habitat.

Summary of Factor A

Overall, our review found that the best available scientific and commercial information indicates that the Redrock stonefly is not threatened by the destruction, modification, or curtailment of its habitat or range either now or in the foreseeable future. The Redrock stonefly spends most of its life in a nymph stage in gravel and cobble substrates of perennial streams. Therefore, water quality and streamflow are important habitat factors in assessing the status of the species. In considering potential threats due to the degradation of water quality, we first found that the Redrock stonefly, unlike other species of stoneflies, is not known to be particularly sensitive to changes in water quality. This is due to anatomical adaptations of the genus that allow it to persist in warmer water with lower oxygen levels compared to other stoneflies. Because of these adaptations, any potential changes in water quality are likely to have minimal impacts to the Redrock stonefly. In addition, studies by the State of Arizona, ADEQ, at eight sites near Redrock stonefly habitat found no water quality problems that would be a concern for the stonefly. We also considered the potential impacts to water quality, particularly increased sedimentation, from livestock grazing in watersheds where the Redrock stonefly occurs. Our analysis found that grazing is not a significant source of sedimentation because most of the sites where the stoneflies occur have either adequately managing grazing programs or no grazing activity. In addition, water quality assessments by ADEQ did not indicate increased levels of sediments or other pollutants of concern.

We also considered the possible habitat concerns related to the presence of nonnative crayfish in streams inhabited by the Redrock stonefly. We found that while crayfish may increase leaf litter decomposition rates and reduce foraging habitat for Redrock stoneflies, the availability of this habitat is naturally limited by flood events. Redrock stoneflies have other foraging habitats available to them in the stream channel, such as in gravel and cobble substrates. Crayfish could also reduce foraging habitat for stoneflies by feeding on aquatic plants, if they served as stonefly feeding substrate. However, as Redrock stoneflies likely feed in leaf litter and gravel and cobble substrates (rather than on aquatic vegetation), and their streams do not contain much habitat for aquatic vegetation, this change would not impact the stoneflies. Finally, the potential for crayfish to increase turbidity of the water through foraging was not found to be a problem because the stream habitats where the stonefly occurs are high gradient with fast velocity that flushes most mobilized sediments downstream. Thus, the nature of the Redrock stonefly's feeding strategies and habitat (fast-flowing water over riffles of gravel and cobble substrates) reduces the potential impacts of nonnative crayfish.

We next considered the potential impacts from wildfires and prescribed fires to Redrock stonefly habitats. We found that the species has limited exposure to the effects of wildfires and is expected to show high resiliency to recover following any short-term habitat alteration resulting from wildfires. In addition, for prescribed fires, we anticipate that the exclusion of riparian areas, along with other conservation measures, will likely be adequate to minimize any potential impacts to the Redrock stonefly or its habitat.

We evaluated the potential impacts to Redrock stonefly habitat from recreational activities primarily associated with hiking and ORV use, because many of the streams where the species occurs are popular recreational destinations. However, we found there is limited access for these activities to the actual Redrock stonefly habitats, and very minor effects are expected when recreational activities occur near Redrock stonefly habitat. This limits the likelihood of any potential impacts to the species associated with recreational activities. We also assessed the risk of stream flow declines as a consequence to increases in human development and associated groundwater use. While there are potential effects to stream flows in some areas, we found no indication that groundwater withdrawals either currently, or in the foreseeable future, are likely to impact Redrock stonefly habitats.

Finally, there has been no reduction in the known range of the Redrock stonefly (see discussion under Distribution section above). The only change in the distribution of Redrock stonefly is the increase in the number of known locations that resulted from a recent increase in survey efforts. Therefore, in conclusion, we find that the best scientific and commercial information available indicates that the Redrock stonefly is not now, or in the foreseeable future, threatened by the destruction, modification, or curtailment of its habitat or range to the extent that listing under the Act as an endangered or threatened species is warranted at this time.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no information available indicating that overutilization is a threat to Redrock stonefly. Because of limited access, collection of the species is not likely to occur with any frequency. The Redrock stonefly is currently known to occur at 10 sites. Access to three, Tonto Creek above Bear Flats, Page Springs, and Redrock Crossing, is limited by private land, State park, or State fish hatchery. The two Wet Beaver Creek sites have limited access due to closed roads and private land. The three sites on Tonto Creek, below the Bear Flat Campground and the Spring Creek site, have limited access due to rugged terrain and poor road conditions. There is no commercial or recreational use for Redrock stoneflies. Further, even though small collections for scientific and educational purposes may occasionally occur, we do not believe these collections are large enough in magnitude to constitute a threat to the species. Therefore, we conclude that the best scientific and commercial information available indicates that Redrock stonefly is not threatened now or in the foreseeable future from overutilization for commercial, recreational, scientific, or educational purposes.

C. Disease or Predation

We have no information that disease may be a threat to Redrock stonefly. However, potential impacts from predation by native fish, nonnative fish, and nonnative crayfish are discussed below.

Predation by Native Fish

Native fish species, found in some or all of the Redrock stonefly sites, that may feed on Redrock stoneflies include: Roundtail chub (*Gila robusta*), Gila chub (*G. intermedia*), headwater chub (*G. nigra*), longfin dace (*Agosia chrysogaster*), speckled dace (*Rhinichthys osculus*), and Sonoran sucker (*Catostomus insignis*) (Rinne 1992, p. 39; Pilger *et al.* 2010, p. 307). The Oak Creek sites are also considered historical Gila trout (*Oncorhynchus gilae*) habitat (Service 2003, p. 6), and the Campbell Blue River site, although outside their historical range, may contain introduced Apache trout (*Oncorhynchus apache*) (Service 2009b, p. 12). These two trout feed upon Redrock stonefly and other aquatic insects (Behnke 1992, p. 43).

Native fish predation is not likely to negatively impact Redrock stoneflies. Aquatic macroinvertebrates, like Redrock stonefly, have adapted over time to fish predation (including small body size, cryptic coloration, and nocturnal activity) so that they are affected little by changes in fish density (Allan 1982, p. 1454). Two studies found that when fish numbers were reduced (Allan 1982, p. 1454) or increased (Culp 1986, p. 146), there were no significant effects on stoneflies and other macroinvertebrates. The stonefly, *Hesperaperla* (Perlidae), experienced decreased sculpin (*Cottus sp.*) predation when hiding cover was available (Brusven and Rose 1981, p. 1447). Flecker and Allan (1984, p. 311) found that fish predation had very little effect on macroinvertebrate taxa and individuals regardless of substrate size (embedded or un-embedded gravel and cobble substrate). Fish predation may be negligible if fish are feeding primarily on ''surplus'' secondary production of macroinvertebrates that exceeds the local carrying capacity.

The vulnerability of large predatory stonefly to fish predation is largely a function of their exposure, large size, and active foraging habits (Meissner and Muotka 2006, p. 428). However, most Perlidae stoneflies, including *Anacroneuria,* forage at night to avoid predators that seek prey visually (Zanetell and Peckarsky 1996, p. 574). Where focused predation on predatory stoneflies occurs, it can decrease stonefly density in two ways: Direct consumption by predatory fish, or apparent emigration to an area with fewer fish (Feltmate and Williams 1989, p. 1579). Stoneflies also modify habitat use to avoid predation by selecting larger substrate on which they are less vulnerable (Brusven and Rose 1981, p. 1447; Feltmate *et al.* 1986, p. 1587).

Because of the findings of past studies showing a lack of effect of predation on stoneflies and the ability of stoneflies to avoid exposure to predation, we find that predation by native fish is not a significant threat to Redrock stonefly.

Predation by Nonnative Fish

Nonnative fish are found in the majority of aquatic communities in Arizona, including the Redrock stonefly sites. Holycross *et al.* (2006, pp. 14–15) found nonnative fish species in 64 percent of the sample sites in the Agua Fria watershed, 85 percent of the sample sites in the Verde River watershed, 75 percent of the sample sites in the Salt River watershed, and 56 percent of the sample sites in the Gila River watershed. In total, nonnative fish were observed at 41 of the 57 sites surveyed (72 percent) across the Mogollon Rim in Arizona (Holycross *et al.* 2006, p. 14).

Several studies have been conducted that analyzed the effects of nonnative fish predation on predaceous aquatic invertebrates like the Redrock stonefly. Pilger *et al.* (2010, pp. 306–307, 311, 319–321) found the nonnative brown trout (*Salmo trutta*), rainbow trout, flathead catfish (*Pylodictis olivaris*), green sunfish (*Lepomis cyanellus*), smallmouth bass (*Micropterus dolomieu*), and yellow bullhead (*Ameiurus natalis*) preyed more frequently on predaceous aquatic invertebrates than did native fish species. The study also found stonefly remains in rainbow trout and yellow bullhead stomach contents (Pilger *et al.* 2010, pp. 316–317). Other studies (Nystrom *et al.* 2003, p. 603; Meissner and Muotka 2006, pp. 428–429; Herbst *et al.* 2009, pp. 1336–1337) also found that trout prefer large active prey such as predatory invertebrates, which may include the Redrock stonefly. In Argentina, Molineri (2008, p. 111) found *Anacroneuria* densities lower in streams with introduced rainbow trout than in streams with a single native fish species. In a second study, introduced trout were also found to decrease invertebrate predaceous stonefly abundance when compared with paired fishless streams (Herbst *et al.* 2009, p. 1330). Herbst *et al.* (2009, p. 1337) also found that two of the three abundant predaceous stoneflies declined with trout introductions, whereas the third species was unaffected.

In streams where a previously nonexistent feeding guild (a group of organisms that feed on resources in similar ways) has become established by the presence of a nonnative fish, macroinvertebrate community-level effects are likely to be more detectable. For example, introduced brown trout in the Shag River, New Zealand, occupy the diurnal invertebrate drift feeder niche (species that feed on drifting macroinvertebrates during the day), which was not previously filled by native fish (Flecker and Townsend 1994, p. 805; Nystrom and McIntosh 2003, p. 280). Macroinvertebrate numbers and densities were lowest in the brown trout-occupied channels (Flecker and Townsend 1994, pp. 801–802). The effects of introduced trout on the macroinvertebrate community of previously fishless streams was also studied by Flecker (1992, p. 443), who compared differences in invertebrate drift timing between streams with an introduced drift feeder (rainbow trout) and nearby fishless streams. Where trout were introduced, invertebrate drift peaked at night, whereas the drift occurred at all times in the fishless streams. These studies indicate some potential impacts of nonnative fishes on stream invertebrates.

The studies described above involved nonnative fish that were stocked into previously fishless streams or streams with extremely low native fish diversity. None of the streams occupied by the Redrock stonefly were fishless prior to nonnative fish establishment. As a result of evolving in habitat already containing native predatory fish, the Redrock stonefly has likely developed effective anti-predator behavior (Sih *et al.* 2010, p. 610). Also, in North America introduced nonnative trout co-exist with, or have replaced, native trout, rather than being released into streams without trout. So the introduced trout are not a novel predatory threat that Redrock stoneflies, in Oak, Wet Beaver, and the Campbell Blue Creeks, have not experienced (Flecker and Townsend 2003, p. 805). Tonto and Spring Creeks are not considered historic native trout habitat (Service 2003, p. 4). Therefore, we conclude that the anti-predatory behaviors of Redrock stoneflies are likely sufficient to prevent nonnative trout from being a significant threat to the Redrock stonefly.

Yellow bullheads, a nonnative fish species, do represent a previously nonexistent feeding guild in Arizona. They are nocturnal tactile feeders that forage along the stream bottom (Reynolds and Casterlin 1977, p. 132). Yellow bullheads are found in Oak, Wet Beaver, Tonto, and Spring Creeks, and are likely present in the Redrock stonefly sites. However, the Redrock stonefly may have specific behaviors to avoid predation by fish. For example, Moore and Williams (1990, p. 52) found that when the stonefly *Pteranarcys dorsata* was touched by sculpin and suckers feeding along the stream bottom, it froze and, if attacked, feigned death by curling up and extending its cerci (paired appendages on the posterior body segment) as spines. This reduced handling success or feeding ability by fish. Otto and Sjöström (1983, p. 203) also found that the stonefly *Dinocras cephalotes* used this anti-predator strategy to avoid trout predation. We do not know if this anti-predator strategy is used by Redrock stoneflies to avoid yellow bullhead predation, but we expect that this or other anti-predatory behaviors likely diminish any potential threat to the species posed by yellow bullheads.

Predation by Crayfish

Predatory activities by introduced crayfish can affect aquatic macroinvertebrates by direct predation and increased macroinvertebrate drift as escaped prey escape and incidental dislodgment by crayfish foraging. Research indicates that crayfish are primarily carnivorous as juveniles before becoming omnivorous or even herbivorous as they mature (Bondar *et al.* 2005, p. 2633; Flinders and Magoulick 2007, p. 775). However, Momot (1995, pp. 34, 38) states that the crayfish's role as a predator has been greatly underestimated.

Fernandez and Rosen (1996, p. 3) studied the effects of crayfish on a low-elevation semi-desert stream and a high-mountain stream in Arizona. They concluded that crayfish predation can noticeably reduce aquatic vertebrate and macroinvertebrate species diversity and destabilize food chains in riparian and aquatic ecosystems. However, specific information on nonnative crayfish predation on macroinvertebrates, or specifically stoneflies, is less conclusive. Some studies suggest that slow-moving organisms (unlike the Redrock stonefly) kept in enclosures with crayfish (for example, leeches (Hirudinea), dragonflies (Odonata), caddisflies (Trichoptera), isopods, and mollusks) are preyed on by crayfish, whereas more mobile prey or prey living in sediments (for example, trout fry, chironomids, and stoneflies) were less affected by crayfish (Hanson *et al.* 1990, p. 78; Stenroth and Nystrom 2003, p. 472). For example, Fernandez and Rosen (1996, p. 10) found significantly lower macroinvertebrate numbers and biomass (primarily slow-moving caddisflies, snails, and mussels) in crayfish-occupied sites than in unoccupied sites in the White Mountains, Arizona. Crayfish reduced slow or immobile invertebrate numbers and biomass in other studies as well (Hanson *et al.* 1990, p. 78; Perry *et al.* 1997, p. 124; Stenroth and Nystrom 2003, p. 472; Olsson *et al.* 2009, p. 1735).

One study found a negative relationship between crayfish numbers and invertebrates, such as stoneflies, as a result of crayfish predation. Charlebois and Lamberti (1996, pp. 556, 560) found lower macroinvertebrate numbers, including Perlid stoneflies, in areas with both low and high crayfish densities in a Michigan stream. They concluded that invasive crayfish can significantly affect macroinvertebrate numbers. However, when Bobeldyk and Lamberti (2008, pp. 268–269) returned 10 years later, they found that, while macroinvertebrate numbers were still significantly higher in areas without crayfish, areas with high and intermediate crayfish densities were dominated by highly mobile stoneflies and mayflies. This later study substantiates the conclusion from studies discussed above: more mobile aquatic macroinvertebrate species, such as the Redrock stonefly, may not be significantly impacted by crayfish predation.

Crayfish predation on macroinvertebrates may be more pronounced in coldwater streams that lack crayfish predators, such as largemouth bass (*Micropterus salmoides*) and smallmouth bass (Hill and Lodge 1995, p. 310; Charlebois and Lambertii 1996, p. 560). Hill and Lodge (1994, p. 2122; 1995, p. 310) found higher macroinvertebrate numbers in enclosures that contained both bass and crayfish and attributed this to decreased crayfish feeding on vegetative cover and less foraging time in the presence of bass predation. In the cool-water streams occupied by the Redrock stonefly (the two uppermost Tonto Creek sites and the Campbell Blue Creek site), crayfish may not experience a high degree of fish predation; therefore, crayfish may not be limiting their foraging time. In contrast, green sunfish and yellow bullhead are found in the lower three Tonto Creek and Spring Creek Redrock stonefly sites. These species are crayfish predators (Pilger *et al.* 2010, pp. 319, 321). Wet Beaver Creek and Oak Creek contain smallmouth bass and yellow bullhead. These crayfish predators may decrease crayfish-predation on macroinvertebrates, such as the Redrock stonefly in Oak, Wet Beaver, the lower three Tonto, and Spring Creek sites.

Crayfish are tactile predators and some stonefly nymphs have evolved appropriate defenses from predation such as retreat, deflection of an attack by reflex bleeding (fluid is forcibly expelled from pores on the legs), and spacing. Sedentary prey have been found to be more vulnerable than mobile prey to tactile predators (Allan and Flecker 1988, p. 502); therefore, upon encountering a crayfish, stoneflies rapidly retreat rather than freezing to minimize the risk of being caught (Moore and Williams 1990, p. 53). Reflex bleeding or auto-hemorrhaging is known to be used by at least four Plecoptera genera in two families: Pteronarcidae (*Pteronarcys* (Moore and Williams 1990, p. 50) and *Peltoperla* (Benfield 1974, p. 740)), and Perlidae (*Agnetina* and *Acroneuria* (Bukantis and Peckarsky 1985, p. 202)). This is used as a defense only when retreat from the predator fails and capture occurs. Crayfish that are sprayed immediately drop the stonefly and clean their antennae and mouthparts before continuing to forage (Moore and Williams 1990, p. 50). The spacing of nymphs may also serve as a deterrent to predation. Some stonefly nymphs display aggressive behavior towards each other when they come in close contact (Moore and Williams 1990, p. 54). By avoiding close contact and high densities, Redrock stoneflies may reduce their susceptibility to predation by decreasing the time and exposure to predators (Tinbergen *et al.* 1967, p. 308; Moore and William 1990, p. 55).

Crayfish may also cause macroinvertebrate drift or movement within the water column indirectly by incidentally dislodging them during foraging, or directly by attempted predation (Charlebois and Lamberti 1996, p. 557). As discussed earlier, predator-induced drift is a predator-avoidance mechanism used by macroinvertebrates that swim well, whereas poor swimming invertebrates (which would include Redrock stoneflies) crawl rather than drift, when approached by predators (Malmqvist and Sjostrom 1987, p. 401; Peckarsky 1996, p. 1902). Poor swimmers would be susceptible to fish predation if crayfish were to induce their drift up into the water column, especially during the day (Flecker 1992, pp. 1–12; Radar and MacArthur 1995, pp. 7–8). Therefore, Redrock stoneflies crawl rather than drift to avoid crayfish predation, and so reduce the likelihood of predation by crayfish.

In conclusion, because of the expected limited exposure of the Redrock stoneflies to crayfish and the stonefly's ability to avoid predation, we conclude that nonnative crayfish do not threaten the Redrock stonefly.

Summary of Factor C

Disease is not known to be a threat to Redrock stonefly. Native fish, nonnative fish, and nonnative crayfish are found in Redrock stonefly habitat and likely prey on all available food resources, including the Redrock stonefly. However, we have no evidence to suggest that predation has been, or will be, a threat to the Redrock stonefly. The species has numerous morphological and behavioral adaptations that may be used to avoid predation by fish or crayfish. Aquatic macroinvertebrates and, presumably, Redrock stoneflies are well-adapted to fish predation, whether from native or nonnative species. While crayfish do feed on other aquatic macroinvertebrates, because of its mobility to avoid exposure to crayfish predation, the Redrock stonefly is not expected to be significantly affected. Consequently, we conclude that the best commercial and scientific information available indicates that the Redrock stonefly is not now, or in the foreseeable future, threatened by disease or predation to the extent that listing under the Act as an endangered or threatened species is warranted at this time.

D. The Inadequacy of Existing Regulatory Mechanisms

The Arizona Department of Agriculture has the primary authority to manage insects in the State of Arizona. They currently do not provide any regulatory protection for the Redrock stonefly. Because we have not found any existing or future threats to the Redrock stonefly, we believe this lack of direct regulatory protection is acceptable. However, several mechanisms exist that provide some indirect protection for the Redrock stonefly and its habitat from various forms of disturbance and habitat loss, and these are described below.

Redrock stoneflies may derive some indirect conservation benefit from their co-occurrence with other species listed as endangered or threatened under the Act and their critical habitat in Arizona. For example, the Campbell Blue Creek was designated as loach minnow critical habitat in 2007 (72 FR 13355; March 21, 2007). The Service is currently reevaluating loach minnow critical habitat and is proposing approximately 709 mi (1,141 km) of streams as critical habitat (75 FR 66482; October 28, 2010). The Service has also proposed 726 mi (1,168 km) of streams as critical habitat for spikedace (*Meda fulgida*) (75 FR 66482; October 28, 2010). These proposed critical habitat segments overlap the Redrock stonefly sites on Oak, Campbell Blue, Wet Beaver, and Spring Creeks. The Wet Beaver Creek site upstream of the USGS gage and the Upper Tonto Creek sites upstream of Houston Creek were not proposed for critical habitat designation. If the proposed areas are included in critical habitat for one or both endangered fishes, some limited benefits for the Redrock stonefly may occur. Critical habitat only applies to Federal actions and would only consider the impacts to habitat for the fishes; however, there is sufficient overlap in habitats with the Redrock stonefly, so some conservation benefits could occur.

The National Wild and Scenic Rivers System (NWSR System) was created by Congress in 1968 (Pub. L. 90–542; 16 U.S.C. 1271 *et seq.*) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. This NWSR System is notable for safeguarding the special character of these rivers, while also recognizing the potential for their appropriate use and development. It encourages river management that crosses political boundaries and promotes public participation in developing goals for river protection. The U.S. Forest Service's policy at FSH 1909.12, Chapter 8.12 states that management prescriptions for eligible rivers should provide the following protection:

(1) Free-flowing characteristics cannot be modified.

(2) Outstandingly remarkable values must be protected, and to the extent practicable, enhanced.

(3) Management and development of the river and its corridor cannot be modified to the degree that eligibility or classification would be affected.

The Apache-Sitgreaves National Forest recently submitted an eligibility report, which recommended that Campbell Blue Creek be included in the NWSR System (USDA 2010, pp. 83–87). This Redrock stonefly site is located in Eligible Segment 3, which has the proposed classification as ''Recreational.'' 'Recreational'' river sections are readily accessible by road or railroad, may have some development along their shorelines, and may have undergone some impoundment or diversion in the past (USDA 2010, p. 1). During the interim period, until Congress approves the designation, eligible rivers must be managed under the same guidelines as if designated. Therefore, the Redrock stonefly site on Campbell Blue Creek currently receives protection as if the creek was designated part of the NWSR System (USDA 2006, p. 22). This protection entails specifically the Campbell Blue Creek's free-flowing condition and outstanding remarkable values. Free-flowing is defined in part in the NWRS Act as without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway (16 U.S.C. 1286(b)); all of which benefits the Redrock stonefly and its habitat in Campbell Blue Creek.

An Instream Flow Water Right Permit with the ADWR is a surface water right that remains in-situ or ''in-stream,'' is not physically diverted or consumptively used, and is for maintaining the flow of water necessary to preserve wildlife, including fish and recreation (ADWR 2009a, pp. 29–30). The Tonto National Forest has an instream flow water right (permit number 96757) for Christopher Creek, which drains into Tonto Creek at one of the Redrock stonefly sites. The Tonto National Forest also has pending instream flow water right applications for Tonto (application number 33–96684) and Haigler (application number 33–96571) Creeks. Both of these applications are currently being protested (Nelson 2011, p. 1). The Tonto National Forest is also compiling an instream flow water right application for Spring Creek (application number 33–96815). The Coconino National Forest has an instream flow water right permit on Spring Creek, an important perennial tributary to Oak Creek (permit number 90114) and a pending instream flow water right for Oak Creek (application number 33–90106). Once in place, these instream water rights will protect enough flow to provide for Redrock stonefly habitat in perpetuity.

Because we have found no other existing or future threats that warrant listing the Redrock stonefly, and some conservation mechanisms are currently in place, we conclude that the best scientific and commercial information available indicates that the Redrock stonefly is not now, or in the foreseeable future, threatened by the inadequacy of existing regulatory mechanisms to the extent that listing under the Act as an endangered or threatened species is warranted at this time.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Climate Change and Drought

Projected future climate change is most likely to affect aquatic species in the southwestern United States, like the Redrock stonefly, through reduced surface water availability resulting from lower water flows from decreased precipitation. Periods of drought in the Southwest are common, but the frequency and duration of dry periods may be altered by future climate change. Global climate change, and associated effects on regional climatic regimes, is not well understood, but the predictions for the Southwest indicate less overall precipitation and longer periods of drought. Seager *et al.* (2007, p. 1181) predict, based on broad consensus among 19 climate models, that the Southwest will become drier in the 21st century and that the transition to this drier state is already underway. The increased aridity associated with the current ongoing drought will become the norm for the Southwest within a timeframe of years to decades, if the models are correct (Jacobs *et al.* 2005, p. 438; Shaw *et al.* 2005, p. 280; Seager *et al.* 2007, p. 1183).

Exactly how climate change will affect precipitation patterns is less certain because precipitation predictions are based on continental-scale general circulation models that do not yet account for land use and land-cover-change effects on climate. Consistent with recent observations in changes from climate, the outlook presented for the Southwest predicts warmer, drier, drought-like conditions (Jacobs *et al.* 2005, p. 437; Shaw *et al.* 2005, pp. 280–281; Seager *et al.* 2007, p. 1183; Hoerling and Eischeid 2007, p. 19). A decline in water resources, with or without climate change, will be a significant factor in the watersheds of the desert Southwest.

One predicted effect of climate change is an increase in summer monsoon rains that would seasonally increase stream flows. McGavock (2009, pp. 1–6) describes the effects of increasing air temperatures on base flow of streams within the Verde River watershed, which would apply to the Oak Creek and Wet Beaver Creek Redrock stonefly sites, and likely be applicable to the other sites. Streamflow in Redrock stonefly habitats may increase seasonally as a result of summer monsoon storm runoff. Mitchell *et al.* (2002, p. 2262) defines the onset of the Arizona summer monsoon period as occurring when sea surface temperatures are a minimum of 84 degrees Fahrenheit (29 degrees Celsius) in the Gulf of California. Earlier attainment of this temperature correlates with a stronger summer monsoon, with the opposite being true if the trigger occurs later. Gradual climate warming could result in earlier and stronger monsoons occurring more frequently and leading to larger summer runoff in Arizona streams (McGavock 2009, p. 3). The resiliency of stoneflies, and presumably the Redrock stonefly, to flooding was discussed under wildfires in Factor A. Flecker and Feifarek (1994, p. 139) found that reductions in aquatic macroinvertebrate densities, including *Anacroneuria sp.,* following floods quickly improved in Venezuelan streams. Aquatic macroinvertebrates have several means to persist during and after flood events such as highly developed refuge-seeking behavior, flexible life histories (such as delaying metamorphism from eggs to young or to adults to more favorable periods), and the ability to recolonize flooded areas rapidly (Scrimgeour and Winterbourn 1989, p. 42). We anticipate that given the widely fluctuating occurrence of summer flood events that presently occur in Arizona (Grimm and Fisher 1989, p. 294) the Redrock stonefly is likely to be resilient and persist if stronger summer floods occur in its habitat as a result of global climate warming.

Another potential effect of climate change is increased snowmelt runoff into streams through a reduction in sublimation. Sublimation is the process of snow evaporating into the atmosphere instead of melting, and can remove large amounts of water from snow that would have led to stream runoff (Montesi *et al.* 2004, p. 763). Sublimation occurs under cold temperatures with intense sunlight, especially in forested watersheds where snow is held above the ground in trees, where it can sublimate easier (Montesi *et al.* 2004, p. 763). The Verde River watershed is forested, and during cold winters, can lose large amounts of snow moisture to sublimation. Warmer winter temperatures, as predicted, would reduce sublimation, making more snowmelt available for stream runoff (McGavock 2009, p. 2).

However, if winter temperatures warm too much, winter rains would be expected to increasingly replace snowfall. Snowfall is more conducive to groundwater recharge because water from melting snow has a longer time to infiltrate into the ground than runoff from rainfall. Base flows in these streams that support Redrock stoneflies would be expected to decline later in the summer if groundwater recharge is decreased during future warmer winters (McGavock 2009, p. 5).

Lower summer base flows in streams could result in either the elimination of available surface water (and loss of all habitat), or the reduction in the amount of available surface water. When stream flows are reduced during the summer, water quality generally decreases due to increased water temperature, decreased dissolved oxygen, and concentrated pollutants. Redrock stoneflies would likely use egg or nymphal diapause to survive decreased habitat conditions if climate change or other factors result in reduced flows and degradation of summer habitat conditions.

Climate change may be a significant, long-term source of stress that indirectly exacerbates other potential threats by mechanisms, such as increasing the likelihood of prolonged drought that would reduce groundwater availability and result in future habitat loss. However, we do not currently have sufficient information to determine the potential effects of climate change on the Redrock stonefly. Both the magnitude (the extent of any specific effects) and the imminence (when the effects might occur) of the future effects of climate change remain highly uncertain. Climate change may serve to exacerbate other current or future concerns for habitat loss from other factors. But because we have determined that the Redrock stonefly is not threatened by habitat loss, we cannot predict with any certainty that climate change will exacerbate future habitat concerns sufficiently to consider it a threat to the species. The degree of impact would depend on the intensity and longevity of Redrock stonefly habitat changes that may occur, and these changes cannot be predicted with any certainty in the foreseeable future. In addition, we find that the Redrock stonefly's adaptations to both warm and cold water, low dissolved oxygen, and sediment, discussed above in Factor A, will lessen the potential impacts from climate change. We conclude that the best scientific and commercial information available indicates that the Redrock stonefly is not now, or in the foreseeable future, threatened by other natural or anthropogenic factors affecting its continued existence, or that these factors act cumulatively with other potential threats to the extent that listing under the Act as an endangered or threatened species is warranted at this time.

Finding

As required by the Act, we considered the five factors in assessing whether the Redrock stonefly is endangered or threatened throughout all or a significant portion of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the Redrock stonefly. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized stonefly experts and other Federal agencies.

Our review of all the available information in consideration of the five factors does not support a determination that any current activities or activities in the foreseeable future are threatening the Redrock stonefly or its habitat. Under our Factor A analysis, we found no significant modifications have occurred to the habitats of the Redrock stonefly and none are expected in the foreseeable future. In addition, the species is well-adapted to sustain itself in areas with minor habitat alterations associated with degraded water quality or altered stream habitats. The only known change in the range of the species has been an increase in distribution due to additional survey efforts. Overutilization (Factor B) and disease (Factor C) are not concerns for this species. Predation (Factor C) by both native and nonnative species likely occurs, but the Redrock stonefly has anti-predatory adaptations that are expected to allow it to withstand the anticipated predatory pressures. We find that existing regulatory mechanisms are sufficient (Factor D). Furthermore, there are current management practices and protections in place that limit or prevent possible negative impacts from human activities. The only issue of concern we found under Factor E is the potential effects of climate change. Future climate change could affect the habitat of Redrock stonefly by reduced stream flows and declining water quality. However, the species appears to be adapted to withstand some habitat degradation. At this time, because of the uncertainties of the local, specific effects of climate change, we cannot adequately assess the magnitude of those effects in the foreseeable future, and therefore, find that climate change is not a threat to the Redrock stonefly.

Based on our review of the best scientific and commercial information available pertaining to the five factors, we find that the threats are not of sufficient imminence, intensity, or magnitude to indicate that the Redrock stonefly is in danger of extinction (endangered), or likely to become endangered within the foreseeable future (threatened), throughout all or a significant portion of its range (see ''Significant Portion of the Range'' below). Therefore, we find that listing the Redrock stonefly as an endangered or a threatened species is not warranted at this time.

Significant Portion of the Range

Having determined that the Redrock stonefly is not in danger of extinction or likely to become so within the foreseeable future throughout all of its range, we must next consider whether there are any significant portions of the range where the species is in danger of extinction or is likely to become endangered in the foreseeable future.

The Act defines an endangered species as one ''in danger of extinction throughout all or a significant portion of its range,'' and a threatened species as one ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The term ''significant portion of its range'' is not defined by the statute. For the purposes of this finding, a portion of a species' (Redrock stonefly) range is ''significant'' if it is part of the current range of the species, and it provides a crucial contribution to the representation, resiliency, or redundancy of the species. For the contribution to be crucial, it must be at a level such that, without that portion, the species would be in danger of extinction.

In determining whether a species is endangered or threatened in a significant portion of its range, we first identify any portions of the range of the species that warrant further consideration. The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that are not reasonably likely to be significant and endangered or threatened. To identify only those portions that warrant further consideration, we determine whether there is substantial information indicating that: (1) The portions may be significant, and (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. In practice, a key part of this analysis is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats applies only to portions of the species' range that clearly would not meet the biologically based definition of ''significant'' (*i.e.,* the loss of that portion clearly would not reasonably be expected to increase the vulnerability to extinction of the entire species to the point that the species would then be in danger of extinction), such portions will not warrant further consideration.

If we identify portions that warrant further consideration, we then determine their status (*i.e.,* whether in fact the species is endangered or threatened in a significant portion of its range). Depending on the biology of the species, its range, and the threats it faces, it might be more efficient for us to address the ''significant'' question first, or the status question first. Thus, if we determine that a portion of the range is not ''significant,'' we do not need to determine whether the species is endangered or threatened there; if we determine that the species is not endangered or threatened in a portion of its range, we do not need to determine if that portion is ''significant.''

Applying the process described above for determining whether a species is endangered or threatened in a significant portion of its range, we considered status first to determine if any threat or potential threat acting individually or collectively threaten or endanger the Redrock stonefly in a portion of its range. We have analyzed the potential threats to the species and found that some threats, such as potential habitat alteration from water quality degradation from urban development or decline in stream flows from groundwater use, may be acting only in geographic areas associated with larger human populations. However, based on our threats analysis, we found that none of the potential threats, either individually or collectively, are severe enough to cause the Redrock stonefly to be endangered or threatened in these portions of its range, or in any portions of its range that may meet the biologically based definition of ''significant.''

Conclusion of 12-Month Finding

We do not find that the Redrock stonefly is in danger of extinction now, nor is it likely to become endangered within the foreseeable future, throughout all or a significant portion of its range. Therefore, listing the Redrock stonefly as endangered or threatened under the Act is not warranted at this time.

We request that you submit any new information concerning the status of, or threats to, Redrock stonefly to our Arizona Ecological Services Office (see **ADDRESSES**) whenever it becomes available. New information will help us monitor the stonefly and encourage its conservation. If an emergency situation develops for the Redrock stonefly, or any other species, we will act to provide immediate protection.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Arizona Ecological Services Office (see **ADDRESSES** section).

Authors

The primary authors of this notice are staff members of the Arizona Ecological Services Office.

Authority

The authority for this section is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: July 21, 2011.

Gregory E. Siekaniec,

Acting Director, U.S. Fish and Wildlife Service.

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