DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2012–0029; 4500030113]

RIN 1018–AX70

Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service, determine the following six west Texas aquatic invertebrate species meet the definition of an endangered species under the Endangered Species Act of 1973: Phantom springsnail *(Pyrgulopsis texana),* Phantom tryonia *(Tryonia cheatumi),* diminutive amphipod *(Gammarus hyalleloides),* Diamond tryonia *(Pseudotryonia adamantina),* Gonzales tryonia *(Tryonia circumstriata),* and Pecos amphipod *(Gammarus pecos).* This final rule implements the Federal protections provided by the Endangered Species Act for these species. The effect of this regulation is to add these species to the lists of Endangered and Threatened Wildlife under the Endangered Species Act.

DATES: This rule becomes effective August 8, 2013.

ADDRESSES: This final rule and other supplementary information are available on the Internet at *http://www.regulations.gov* (Docket No. FWS–R2–ES–2012–0029) and also at *http://www.fws.gov/southwest/es/AustinTexas/.* These documents are also available for public inspection, by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Road, Suite 200, Austin, TX 78758; by telephone 512–490–0057; or by facsimile 512–490–0974.

FOR FURTHER INFORMATION CONTACT: Adam Zerrenner, Field Supervisor, U.S. Fish and Wildlife Service, Austin Ecological Services Field Office (see **ADDRESSES**). Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

This document consists of final rules to list six west Texas aquatic invertebrate species as endangered species. The six west Texas aquatic invertebrate species are: Phantom springsnail *(Pyrgulopsis texana),* Phantom tryonia *(Tryonia cheatumi),* diminutive amphipod *(Gammarus hyalleloides),* Diamond tryonia *(Pseudotryonia adamantina),* Gonzales tryonia *(Tryonia circumstriata),* and Pecos amphipod *(Gammarus pecos).* The current range for the first three species is limited to spring outflows in the San Solomon Springs system near Balmorhea in Reeves and Jeff Davis Counties, Texas. The current range of the latter three species is restricted to spring outflow areas within the Diamond Y Spring system north of Fort Stockton in Pecos County, Texas.

Why we need to publish a rule. On August 16, 2012, we published proposed rules to list the six west Texas aquatic invertebrates as endangered species. In these rules we are finalizing our determinations to list these six species as endangered species under the Endangered Species Act. The Act requires that a final rule be published in order to add species to the lists of endangered and threatened wildlife to provide protections under the Act. The table below summarizes the status of each species:

Species	Present range	Status of species
Phantom springsnail	San Solomon Spring system (four springs)	common in a very restricted range.
Phantom Lake springsnail	San Solomon Spring system (four springs)	very rare in a very restricted range.
diminutive amphipod	San Solomon Spring system (four springs)	common in a very restricted range.
Diamond tryonia	Diamond Y Spring system (two springs)	very rare in a very restricted range.
Gonzales tryonia	Diamond Y Spring system (two springs)	very rare in a very restricted range.
Pecos amphipod	Diamond Y Spring system (two springs)	common in a very restricted range.

These rules will result in all six of these species being listed as endangered under the Act. By listing these six species of aquatic invertebrates from west Texas as endangered, we are extending the full protections of the Act to these species.

The Endangered Species Act provides the basis for our action. Under the Endangered Species Act, we can determine that a species is endangered or threatened based on any of 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.

We have determined that all six species meet the definition of endangered species due to the combined effects of:

- Habitat loss and degradation of aquatic resources, particularly the current and ongoing decline in spring flows that support the habitat of all the species, and the potential for future water contamination at the Diamond Y Spring system.
- Other natural or manmade factors, including the presence of nonnative snails and the small, reduced ranges of the species.

Peer review and public comment. With the publication of our August 16, 2012, proposed rules, we sought comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We received comments from four knowledgeable individuals with scientific expertise to review our technical assumptions, analysis, and whether or not we had used the best available information. These peer reviewers generally concurred with our methods and conclusions and provided additional information, clarifications, and suggestions to improve this final rule. We also considered all comments and information received during two comment periods.

Previous Federal Actions

We proposed all six species be listed as endangered on August 16, 2012 (77 FR 49602). We also reopened the public comment on the proposed rules on February 5, 2013 (78 FR 8096). A complete description of the previous Federal actions for these species can be found in the Previous Federal Actions section of the August 16, 2012, proposed rules (77 FR 49602).

Summary of Comments and Recommendations

In the proposed rules published on August 16, 2012 (77 FR 49602), we requested that all interested parties submit written comments by October 15, 2012. We also contacted appropriate Federal and State agencies, scientific experts and organizations, and other interested parties and invited them to comment on the proposal. We reopened the comment period on February 5, 2013 (78 FR 8096), for these proposed rules and to accept additional public comment. This second comment period closed on March 22, 2013. We received a request for a public hearing, and one was held on February 22, 2013, at Balmorhea State Park in Toyahvale, Texas. Newspaper notices inviting general public comment were published in the *Alpine Avalanche* and *Fort Stockton Pioneer* newspapers on February 14, 2013.

During the comment period for the proposed rule, we received 27 comments addressing the proposed listing and critical habitat for the west Texas invertebrates. During the February 22, 2013, public hearing, one individual made a comment on the proposed rules. All substantive information provided during comment periods has either been incorporated directly into our final determinations or addressed below in our response to comments. Elsewhere in today's **Federal Register**, we have published a final rule that addresses additional comments on the designation of critical habitat for these species.

Peer Review

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinion from five knowledgeable individuals with scientific expertise that included familiarity with the species or their habitats, biological needs, and threats. We received comments from four peer reviewers.

The peer reviewers generally concurred with our methods and conclusions and provided additional information, clarifications, and suggestions to improve the final rule. Information received from peer reviewers has been incorporated into our final rules, and comments are addressed in our response to comments below.

(1) Comment: The common (or vernacular) names applied to the four species of snails are not in accord with the ''standardized'' English names for North American mollusks as provided in Turgeon *et al.* (1988, 1998).

Our Response: We agree and have revised the common names of the four snails throughout the final rules. See ''Summary of Changes from Proposed Rule'' sections of the final rules for a list of the changes to the common names.

(2) Comment: We received a number of comments from peer reviewers, State agencies, and the public regarding the groundwater origins of the spring outflows at Diamond Y Spring. We originally indicated that the Rustler Aquifer was the likely source of flows at Diamond Y Spring, recognizing a fair amount of uncertainty. We received new information from a peer reviewer (U.S. Geological Survey hydrogeologist) indicating that, while the Rustler Aquifer may be contributing flow to the Edwards–Trinity (Plateau) Aquifer, it cannot be considered the source of the spring flow because the spring issues from the Edwards–Trinity geologic formation. The Texas Water Development Board provided seemingly contradictory comments stating that the strata underlying the Edwards–Trinity (Plateau) Aquifer provide most of the spring flow at Diamond Y Spring and that the artesian pressure causing the groundwater to issue at Diamond Y Spring is likely from below the Rustler Aquifer. Finally, the Middle Pecos Groundwater Conservation District also commented that Diamond Y Spring is a mixture of discharge from the Edwards–Trinity (Plateau) Aquifer and leakage from the other Permian-age formations, including the Rustler, Salado, Transill, and Yates formations and possibly even deeper strata.

Our Response: The scientific community has not reached consensus about the source of spring flows for Diamond Y Spring. We carefully reviewed the information provided and substantially revised the appropriate sections in the final rules to reflect the uncertainties around the best available information.

(3) Comment: A peer reviewer commented that the Service does not discuss how pumping in the Edwards–Trinity (Plateau) Aquifer may affect the spring flows at Diamond Y Spring. A related comment from the public stated that the Service has not substantiated that pumping from the Rustler Aquifer is causing declines in spring flow at Diamond Y Spring. The commenter indicates that the Rustler Aquifer levels appear to have risen since heavy irrigation from the Rustler Aquifer ceased decades ago.

Our Response: Given the uncertainties about the source aquifer or aquifers for Diamond Y Spring, we have revised our discussions of this issue to recognize that the source of Diamond Y Spring is unknown. As a result, it is not feasible to estimate how pumping from any particular aquifer may have affected the spring flows in the past or how future pumping will affect future spring flows. However, if substantial groundwater is removed in the future from the source aquifer or aquifers, wherever they may be, spring flows at Diamond Y Spring are very susceptible to loss because they have such a small discharge rate.

(4) Comment: A peer reviewer commented that spring flows in the San Solomon Springs and Diamond Y Spring systems, though they lack sufficient studies, are protected by Groundwater Management Area 3 or 4's desired future conditions, as well as by the groundwater conservation districts in the area. A number of other comments from State agencies and the public made similar comments indicating that our assessment of the ''inadequacy of existing regulatory mechanisms'' was not accurate because of the existing groundwater protection provided by the groundwater conservation districts and groundwater management areas.

Our Response: We agree that groundwater management areas and groundwater conservation districts are vital mechanisms to protect and conserve groundwater resources in Texas. We recognize these substantial efforts are critical for maintaining future groundwater conditions to support both human uses of the groundwater and the ecological communities that depend on the outflows from the aquifers. The lack of regulatory mechanisms for groundwater conservation is not the only reason these species are in danger of extinction. Their extreme rarity makes the species particularly vulnerable to all of the threats discussed. However, due in part to their extreme rarity, the loss of spring flows is a primary concern that contributes to the risk of extinction for these species.

For the San Solomon Spring species, we found that the existing regulations from groundwater conservation districts are not serving to alleviate or limit the threats to the species because it is uncertain whether the planned groundwater declines will allow for maintenance of the spring flows that provide habitat for the species. We assume that, absent more detailed studies, the large levels of anticipated declines in the presumed supporting aquifers are likely to result in continuing declines of spring flows in the San Solomon Spring system. We revised the final rule discussion under Factor D for the San Solomon Spring species with this further explanation.

For the Diamond Y Spring species, we found three reasons why the existing regulatory mechanisms provided by the groundwater conservation districts and groundwater management areas are inadequate to sufficiently reduce the threats of spring flow loss to the six species. First, the lack of conclusive science on the groundwater systems and sources of spring flow for Diamond Y Spring means that we cannot be sure which aquifers are the most important to protect. Until we can reliably determine the sources of spring flows, it is impossible to know if existing regulations are adequate to ensure long-term spring flows. Second, and similarly, due to the lack of understanding about the relationships between aquifer levels and spring flows, we cannot know if the current or future desired future conditions adopted by the groundwater management areas are sufficient to provide for the species' habitats. To our knowledge, none of the desired future conditions, which include large reductions in aquifer levels in 50 years, have been used to predict future spring flows at Diamond Y Spring. Finally, other sources of groundwater declines outside of the control of the current groundwater conservation districts could lead to further loss of spring flows. These sources include groundwater pumping not regulated by a local groundwater conservation district or climatic changes that alter recharge or underground flow paths between aquifers. Therefore, although important regulatory mechanisms are in place, such as the existence of groundwater conservation districts striving to meet desired future conditions for aquifers, we find that the mechanisms may not be able to sufficiently reduce the identified threats related to future habitat loss. We revised the final rule discussion under Factor D for the Diamond Y Spring species with this further explanation.

(5) Comment: Why did the Service include East Sandia Spring as part of the San Solomon Spring System since the spring discharges in the alluvial sand and gravel from a shallow groundwater source that is different from the other three springs included in this system?

Our Response: We acknowledge that the East Sandia Spring has a different source from the other three springs referred to as the San Solomon Spring System. However, we use this term as a common reference for the four springs, which are geographically close together and which contain similar biological communities. We have clarified our discussion of this issue in the final rules.

(6) Comment: The Service dismisses the potential for contamination from agricultural contaminants to the springs because there is currently limited agriculture upgradient of the springs and there is an informal agreement for continued limitation. The Service might include the potential for contamination from agricultural return flows based on the hydrogeologic setting if the informal agreement is not honored.

Our Response: Based on the best available information, we found no indication of any agricultural activities in areas that could result in contamination in return flows impacting the springs in either the Diamond Y Spring System or the San Solomon Spring System. Because the agricultural areas are such a large distance from the springs, we conclude the chances of effects to the species are remote. The informal agreement to avoid use of potential contaminants in the area immediately near San Solomon Spring is in areas with limited or no agricultural activity so the risk of contamination is remote there as well. Therefore, based on the best available information at this time, we do think that a significant potential exists for water contamination from agricultural sources.

(7) Comment: The discussion of using toxicants for the management of nonnative fish at Diamond Y Spring seems to downplay the likely damage that was inflicted upon the invertebrate communities at Diamond Y Spring. The possible damage is presented only in terms of the species being proposed for listing. However, the entire invertebrate community, and its proper functioning, was impacted by the application of fish toxicants. Therefore, the damage done may be more at the community or even ecosystem level, rather than just the species level.

Our Response: While there could have been effects that were not detectable, monitoring data collected before and after the treatment on the target species and other invertebrate species did not find a significant effect past the short-term response.

State Agencies

We received a number of comments from Texas State agencies, including the Texas Governor's Office, the Texas Parks and Wildlife Department, the Texas Comptroller's Office, the Texas Water Development Board, the Texas Commission on Environmental Quality, the Texas Land Commission, and the Texas Department of Agriculture.

(8) Comment: The Texas Parks and Wildlife Department, while indicating they strongly encourage the use of incentive-based conservation programs for private land stewardship in Texas, indicated they had no additional information beyond what we referenced in the proposed rule and agreed that the most significant threat to the species' continued survival is the potential failure of spring flow due to unmanaged groundwater pumping thresholds, which do not consider surface flow and wildlife needs, and prolonged drought.

Our Response: We concur with the comments and information provided.

(9) Comment: The Texas Governor's office was concerned that our proposal is largely based on conflicting reports, inconclusive data, hypothetical scenarios, various assumptions and vast speculation about species populations, water quantity and quality, the effect of existing regulatory mechanisms and other potential threats. Such information fails to provide any sound scientific foundation on which to justify the listing and critical habitat designation of these species.

Our Response: Under the standards of the Act, we are to base our determinations of species status on the best available scientific information. Often times, scientific data are limited, studies are conflicting, or results are seemingly inconclusive. Our review of the best available scientific information, including both published publications and unpublished scientific reports, supports our determinations that these species meet the definition of endangered species under the Act. As such we are finalizing critical habitat designations for these species as well.

(10) Comment: Several State and local agencies pointed out that the scientific information regarding the groundwater flow systems in this region are complex and in need of additional study. This uncertainty makes it difficult to predict the responses of spring flows to pumping or other stressors on the aquifer.

Our Response: We agree that more information on the hydrogeology of the areas around these spring systems would be very helpful in further refining the relationships between pumping, groundwater levels, and spring flows. This information will be particularly helpful as we work toward conservation of these species in the future. However, the uncertainty surrounding these relationships do not alter the facts that the habitats of the species are completely dependent upon spring flows and that spring flows are dependent upon groundwater levels. These groundwater levels, wherever the spring sources may be, are at risk of decline through pumping or other stressors such as prolonged drought due to climate change. These facts put the species in danger of extinction. This reasoning is based on the best available information and supports our determinations.

(11) Comment: One State agency pointed out that the data and measurements of flow at Diamond Y Spring are lacking and that our speculation that the Diamond Y Spring could undergo a similar decline as the Leon Springs does not account for the different sources of groundwater supplying the two springs.

Our Response: We did not intend to imply that the Diamond Y Spring and Leon Spring are from the same groundwater source. We only intended to demonstrate that, should groundwater pumping occur in the source aquifer of Diamond Y Spring, the spring could be affected. Leon Springs is simply a nearby example of this cause and effect relationship. We have revised the final rule to clarify our intent.

(12) Comment: A State agency suggested that, although data are lacking and measurements poorly documented, discharge from Diamond Y Spring has been rather constant. Since 1993 they have not observed any discernible change in flow at Diamond Y Spring. Another commenter suggested that a highly probable cause of decreased extent of the shallow water pools at Diamond Y Spring is the proliferation of mesquite trees, bulrush, and other water-intensive invasive species that have invaded the area.

Our Response: We agree that data on discharge levels at Diamond Y Spring over time are lacking. Because the flow rates are so low, observing changes in flow rates without empirical data is very difficult; however, we would disagree with the conclusion that flow at Diamond Y Spring has undergone no discernible change since 1993. Our own field observations and those reported by other researchers have noted that the longitudinal extent of surface waters has receded. For example, surface flow previously regularly extended downstream of the State Highway 18 crossing, but in recent years has not regularly extended this far.

The increase in nearby vegetation could be another contributing factor to decreased surface water available at Diamond Y Spring. We are not aware of any study evaluating this source of surface water loss, so determining the extent of this relationship is difficult. Regardless of the reason, any further decline in the spring flows at Diamond Y Spring, which are highly susceptible to impact due to their very small flow rate, will heighten the risk of extinction of the endemic species due to habitat loss.

(13) Comment: One State agency commented that, while oil and gas exploration, extraction, transportation, and processing is active in the area, no pollutant or contaminant has ever been found to have harmed the aquatic invertebrates that dwell in the springs. Other public commenters added that no evidence supports a future catastrophic event severely impacting the Diamond Y Spring species. The mere speculation of possible future adverse effects cannot be used to support a listing determination.

Our Response: The comment is correct that we are not aware of any past contaminant spill that has impacted the species at Diamond Y Spring. However, the area is extremely active with oil and gas activities; some active wells are immediately adjacent to the springs, and some pipelines cross the habitat. This presence of pollutants in high quantities presents a constant risk of impact to the species either through groundwater or surface water impacts. While we are not aware of a formal analysis of the risks posed by the proximity of oil and gas operations, to assume that a large magnitude spill is possible, even with existing conservation measures in place, and that such a spill could have substantial negative impacts on the endemic species is reasonable. With only one known location of these species, any possible negative impact heightens their risk of extinction. Further, the threat from oil and gas activity is only one of several threats that together result in these species in danger of extinction.

(14) Comment: A State agency and others commented that the Service did not adequately consider the existing conservation measures and Federal and State regulations currently in place to prevent contamination from oil and gas activities at Diamond Y Spring.

Our Response: We understand that existing regulations oversee oil and gas activities in Texas. However, the risk of a contaminant event that would affect the species at Diamond Y Spring cannot be ruled out by the existing conservation efforts and regulations. Because of the extremely limited range of these species and their complete dependence on the aquatic environment, the potential impacts of contamination will remain an ongoing concern at Diamond Y Spring.

(15) Comment: The Texas Commission on Environmental Quality recently issued a statewide general permit (TPDES General Permit No. TXG8700000) for point source discharges of pesticide or herbicide made into or over surface water. This regulation ensures the protection of surface water quality in accordance with applicable State and Federal law.

Our Response: This general permit is helpful to regulate pesticide or herbicide use in Texas, and it could provide some limited benefits to these invertebrates and other aquatic species in these spring systems. However, pesticides and herbicides are not a primary concern to these species because of the limited agricultural activities that could affect their habitats. Therefore, while we acknowledge this statewide permit, we have not revised the final rules to include a discussion of this issue relative to the species in this final rule.

(16) Comment: Because the San Solomon Spring system is in a rural, lightly populated area, and exposure to pollutants has been found to be limited, no threat to the system's water quality is apparent.

Our Response: We agree; we did not find substantial concerns for water quality at the San Solomon Spring system.

(17) Comment: The two instances of nonnative snails in the San Solomon Spring system have not conclusively been found to have a negative impact on the species at issue, and the potential for the introduction of other nonnative species is extraordinarily low.

Our Response: We agree that evidence is not conclusive that the nonnative snails are negatively impacting the native species. However, to assume that at least some competition for space and resources exists between the native and nonnative species is reasonable. We disagree with the characterization of the potential for the introduction of other nonnative species as extraordinarily low. To the contrary, we think the potential is very real of new nonnative species being introduced at San Solomon Spring because of the high volume of public visitors at Balmorhea State Park. Although the State prohibits the release of plants or animals into the Park, people will release unwanted aquarium species into natural waters rather than disposing of them. The potential for the release of nonnative species is a constant risk at San Solomon Spring.

(18) Comment: Two State agencies and a number of others were concerned about the impacts of listing these species and designating critical habitat on private property rights, oil and gas development, and agricultural activities.

Our Response: Although the Act does not allow us to consider the economic impacts of our listing decisions, we did consider the potential economic impacts regarding the designation of critical habitat. Critical habitat only directly affects actions funded, permitted, or carried out by a Federal agency, and Federal activities that could affect the habitat in these areas are very limited. As a result, we found only extremely small potential indirect effects from the proposed designation of critical habitat. For critical habitat, our economic analysis found the incremental administrative economic impacts related to consultations on the critical habitat of the six west Texas invertebrates are expected to amount to an estimated $41,000 over 20 years ($3,600 on an annualized basis), assuming a discount rate of seven percent.

In addition, at this time we do not anticipate noticeable impacts to private property rights, oil and gas development, or agricultural activities from either the listing or the designation of critical habitat for these species. Other listed species have been in these areas for more than 30 years with very few, if any, conflicts with economic development. However, if future conflicts arise, we will work closely with the potentially affected parties to find cooperative solutions for conservation of these species while striving to minimize potential effects on economic activities.

Summary of Changes from Proposed Rule

One important change we made in this final rule is the revision to the common names of the four species of snails to conform to scientifically accepted nomenclature (Turgeon *et al.* 1998, pp. 75–76). These changes were suggested by a peer reviewer of the proposed rule. Table 1 lists the names used in the proposed rules and the revised names used in the final rules. We have used the revised names of all the snails throughout these final rules. No changes were made to the scientific names.

TABLE 1—REVISED COMMON NAMES FOR THE SIX WEST TEXAS INVERTEBRATES

Scientific name	Common name used in proposed rules	Revised common name used in final rules
Pyrgulopsis texana	Phantom cave snail	Phantom springsnail.
Tryonia cheatumi	Phantom springsnail	Phantom tryonia.
Gammarus hyalleloides	Diminutive amphipod	No change.
Pseudotryonia adamantina	Diamond Y Spring snail	Diamond tryonia.
Tryonia circumstriata	Gonzales springsnail	Gonzales tryonia.
Gammarus pecos	Pecos amphipod	No change.

Other minor changes were made in the **SUPPLEMENTARY INFORMATION** section of these final rules to correct and update discussions of issues raised by peer and public commenters. No changes were made to the 50 CFR Part 17 section of the rules.

Background

We intend to discuss below only those topics directly relevant to the listing of the six west Texas aquatic invertebrates as endangered species. We have organized this Background section into three parts. The first part is a general description of the two primary spring systems where the six species occur. The second part is a general description of the life history and biology of the four snail species, followed by specific biological information on each of the four snail species. The third part is a general description of the life history and biology of the two amphipod species, followed by specific biological information on each of the two amphipod species.

Description of Chihuahuan Desert Springs Inhabited by Invertebrate Species

The six west Texas aquatic invertebrate species (Phantom springsnail, Phantom tryonia, diminutive amphipod, Diamond tryonia, Gonzales tryonia, and Pecos amphipod) occur within a relatively small area of the Chihuahuan Desert of the Pecos River drainage basin of west Texas. The habitats of these species are now isolated spring systems in expansive carbonate (limestone) deposits. The region includes a complex of aquifers (underground water systems) where the action of water on soluble rocks (like limestone and dolomite) has formed abundant ''karst'' features such as sinkholes, caverns, springs, and underground streams. These hydrogeological formations provide unique settings where a diverse assemblage of flora and fauna has evolved at the points where the aquifers discharge waters to the surface through spring openings. The isolated limestone and gypsum springs, seeps, and wetlands located in this part of west Texas provide the only known habitats for several endemic species of fish, plants, mollusks, and crustaceans, including the six endemic aquatic invertebrate species addressed in these final rules.

Both spring systems associated with San Solomon Spring and Diamond Y Spring represent discharge from groundwater flow systems that have little modern recharge and were formed in the Pleistocene when the climate was cooler and wetter than today (French 2013, p. 1). Both groundwater systems are not well understood, especially at the local scale, because they include both lateral and vertical flow between multiple aquifers (French 2013, p. 1).

In the Chihuahuan Desert, spring-adapted aquatic species are distributed in isolated, geographically separate populations. They likely evolved into distinct species from parent species that once enjoyed a wider distribution during wetter, cooler climates of the Pleistocene epoch (about 10,000 to 2.5 million years before present). As ancient lakes and streams dried during dry periods (since the Late Pleistocene, within about the last 100,000 years), aquatic species in this region became patchily distributed across the landscape as geographically isolated populations exhibiting a high degree of endemism (species found only in a particular region, area, or spring). Such speciation through divergence has been reported for these species (Gervasio *et al.* 2004, p. 521; Brown *et al.* 2008, pp. 486–487; Seidel *et al.* 2009, p. 2304).

San Solomon Spring System

In these final rules we reference the San Solomon Spring system to include four different existing spring outflows: San Solomon Spring, Giffin Spring, Phantom Lake Spring, and East Sandia Spring. The springs in this area are also commonly referred to by some authors as Toyah Basin springs or Balmorhea area springs. All of the springs historically drained into Toyah Creek, an intermittent tributary of the Pecos River that is now dry except following large rainfall events. All four springs are located in proximity to one another; the farthest two (East Sandia Spring and Phantom Lake Spring) are about 13 kilometers (km) (8 miles (mi)) apart, and all but East Sandia Spring likely originate from the same groundwater source (see discussion below). Brune (1981, pp. 258–259, 382–386) provides a brief overview of each of these springs and documents their declining flows during the early and middle twentieth century.

The San Solomon Spring system is located in the Chihuahuan Desert of west Texas at the foothills of the Davis Mountains near Balmorhea, Texas. Phantom Lake Spring is in Jeff Davis County (on the county boundary with Reeves County), while the other major springs in this system are in Reeves County. In addition to being an important habitat for rare aquatic fauna, area springs have served for centuries as an important source of irrigation water for local farming communities. They are all located near the small town of Balmorhea (current population of less than 500 people) in west Texas. The area is very rural with no nearby metropolitan centers. Land ownership in the region is mainly private, except as described below around the spring openings, and land use is predominantly dry-land ranching with some irrigated farmland using either water issued from the springs or pumped groundwater.

The base flows from these springs are thought to ultimately originate from a regional groundwater flow system. Studies show that groundwater moves through geologic faults from the Salt Basin northwest of the Apache and Delaware Mountains, located 130 km (80 mi) or more to the west of the springs (Sharp 2001, pp. 42–45; Angle 2001, p. 247; Sharp *et al.* 2003, pp. 8–9; Chowdhury *et al.* 2004, pp. 341–342; Texas Water Development Board 2005, p. 106). The originating groundwater and spring outflow are moderately to highly mineralized and appear to be of ancient origin, with the water being estimated at 10,000 to 18,000 years old (Chowdhury *et al.* 2004, p. 340; Texas Water Development Board 2005, p. 89).

The Salt Basin Bolson aquifer is part of the larger West Texas Bolsons and is made up of connected sub-basins underlying Wild Horse, Michigan, Lobo, and Ryan Flats, in the middle and southern Salt Basin Valley in Texas (Angle, 2001, p. 242). (The term bolson is of Spanish origin and refers to a flat-floored desert valley that drains to a playa or flat.) These aquifers, which support the base flows (flows not influenced by seasonal rainfall events) of the San Solomon Spring system, receive little to no modern recharge from precipitation (Scanlon *et al.* 2001, p. 28; Beach *et al.* 2004, pp. 6–9, 8–9). Studies of the regional flow system indicate groundwater may move from south to north through the Salt Basin from Ryan to Lobo to Wild Horse Flats before being discharged through the Capitan Formation, into the Lower Cretaceous rocks (older than Pleistocene) via large geologic faults then exiting to the surface at the springs (LaFave and Sharp 1987, pp. 7–12; Angle 2001, p. 247; Sharp 2001, pp. 42–45; Chowdhury *et al.* 2004, pp. 341–342; Beach *et al.* 2004, Figure 4.1.13, p. 4–19, 4–53). Chemical analysis and hydrogeological studies support this hypothesis, and the water elevations throughout these parts of the Salt Basin Bolson aquifer are higher in elevation than the discharge points at the springs (Chowdhury *et al.* 2004, p. 342). Substantial uncertainty exists about the precise nature of this regional groundwater flow system and its contribution to the San Solomon Spring system.

In contrast to the base flows, the springs also respond with periodic short-term increases in flow rates following local, seasonal rainstorms producing runoff events through recharge areas from the Davis Mountains located to the southwest of the springs (White *et al.* 1941, pp. 112–119; LaFave and Sharp 1987, pp. 11–12; Chowdhury *et al.* 2004, p. 341). These stormwater recharge events provide very temporary increases in spring flows, sometimes resulting in flow spikes many times larger than the regular base flows. The increased flows are short-lived until the local stormwater recharge is drained away and spring flows return to base flows supported by the distant aquifers. Historically, many of the springs in this spring system were likely periodically interconnected following storm events with water flowing throughout the Toyah Creek watershed. In recent times, however, manmade structures altered the patterns of spring outflows and stormwater runoff, largely isolating the springs from one another except through irrigation canals.

San Solomon Spring is by far the largest single spring in the Toyah Basin (Brune 1981, p. 384). The artesian spring issues from the lower Cretaceous limestone at an elevation of about 1,008 meters (m) (3,306 feet (ft)). Brune (1981, p. 385) reported spring flows in the range of 1.3 to 0.8 cubic meters per second (cms) (46 to 28 cubic feet per second (cfs)) between 1900 and 1978 indicating an apparent declining trend. Texas Water Development Board (2005, p. 84) studies reported an average flow rate of about 0.85 cms (30 cfs) from data between 1965 to 2001 with a calculated slope showing a slight decline in discharge.

San Solomon Spring now provides the water for the large, unchlorinated, flow-through swimming pool at Balmorhea State Park and most of the irrigation water for downstream agricultural irrigation by the Reeves County Water Improvement District No. 1 (District). The swimming pool is concrete on the sides and natural substrates on the bottom and was originally constructed in 1936. Balmorhea State Park is owned and managed by Texas Parks and Wildlife Department and encompasses about 19 hectares (ha) (46 acres (ac)) located about 6 km (4 mi) west of Balmorhea in the historic community of Toyahvale. The Park provides recreational opportunities of camping, wildlife viewing, and swimming and scuba diving in the pool. The District holds the water rights for the spring, which is channeled through an extensive system of concrete-lined irrigation channels, and much of the water is stored in nearby Lake Balmorhea and delivered through canals for flood irrigation on farms down gradient (Simonds 1996, p. 2).

Balmorhea State Park's primary wildlife resource focus is on conservation of the endemic aquatic species that live in the outflow of San Solomon Spring (Texas Parks and Wildlife Department 1999, p. 1). Texas Parks and Wildlife Department maintains two constructed ciénegas that are flow-through, earth-lined pools in the park to simulate more natural aquatic habitat conditions for the conservation of the rare species, including the Phantom springsnail, Phantom tryonia, and diminutive amphipods. (Ciénega is a Spanish term that describes a spring outflow that is a permanently wet and marshy area.) San Solomon Spring is also inhabited by two federally listed fishes, Comanche Springs pupfish *(Cyprinodon elegans)* and Pecos gambusia *(Gambusia nobilis).* No nonnative fishes are known to occur in San Solomon Spring, but two nonnative aquatic snails, red-rim melania *(Melanoides tuberculata)* and quilted melania *(Tarebia granifera),* do occur in the spring outflows and are a cause for concern for the native aquatic invertebrate species.

Giffin Spring is on private property less than 1.6 km (1.0 mi) west of Balmorhea State Park, across State Highway 17. The spring originates from an elevation similar to San Solomon Spring. Brune (1981, p. 385) reported flow from Giffin Spring ranged from 0.07 to 0.17 cms (2.3 to 5.9 cfs) between 1919 and 1978, with a gradually declining trend. During calendar year 2011, Giffin Spring flow rates were recorded between 0.10 and 0.17 cms (3.4 and 5.9 cfs) (U.S. Geological Survey 2012, p. 1). Giffin Spring water flows are captured in irrigation earthen channels for agricultural use. Giffin Spring is also inhabited by the federally listed Comanche springs pupfish and Pecos gambusia, and the only nonnative aquatic species of concern there is the red-rim melania.

Phantom Lake Spring is at the base of the Davis Mountains about 6 km (4 mi) west of Balmorhea State Park at an elevation of 1,080 m (3,543 ft). The outflow originates from a large crevice on the side of a limestone outcrop cliff. The 7-ha (17-ac) site around the spring and cave opening is owned by the U.S. Bureau of Reclamation. Prior to 1940 the recorded flow of this spring was regularly exceeding 0.5 cms (18 cfs). Outflows after the 1940s were immediately captured in concrete-lined irrigation canals and provided water for local crops before connecting to the District's canal system in Balmorhea State Park. Flows declined steadily over the next 70 years until ceasing completely in about the year 2000 (Brune 1981, pp. 258–259; Allan 2000, p. 51; Hubbs 2001, p. 306). The aquatic habitat at the spring pool has been maintained by a pumping system since then. Phantom Lake Spring is also inhabited by the two federally listed fishes, Comanche Springs pupfish and Pecos gambusia, and the only nonnative aquatic species of concern there is the red-rim melania.

East Sandia Spring is the smallest spring in the system located in Reeves County in the community of Brogado approximately 3 km (2 mi) northeast of the town of Balmorhea and 7.7 km (4.8 mi) northeast of Balmorhea State Park. The spring is within a 97-ha (240-ac) preserve owned and managed by The Nature Conservancy—a private nonprofit conservation organization (Karges 2003, pp. 145–146). In contrast to the other springs in the San Solomon Spring system that are derived directly from a deep underground regional flow system, East Sandia Spring discharges from alluvial sand and gravel from a shallow groundwater source at an elevation of 977 m (3,224 ft) (Brune 1981, p. 385; Schuster 1997, p. 92). Water chemistry at East Sandia Spring indicates it is not directly hydrologically connected with the other springs in the San Solomon Spring system in the nearby area (Schuster 1997, pp. 92–93). Historically there was an additional, smaller nearby spring outlet called West Sandia Spring. Brune (1981, pp. 385–386) reported the combined flow of East and West Sandia Springs as declining, with measurements ranging from 0.09 to 0.02 cms (3.2 to 0.7 cfs) between 1932 and 1976. In 1976 outflow from East Sandia was 0.01 cms (0.5 cfs) of the total 0.02 cms (0.7 cfs) of the two springs. In 1995 and 1996 Schuster (1997, p. 94) reported combined flow rates from both springs, which ranged from 0.12 to 0.01 cms (4.07 cfs to 0.45 cfs), with an average of 0.05 cms (1.6 cfs). The outflow waters from the spring discharge to an irrigation canal within a few hundred meters from its source. East Sandia Spring is also inhabited by two federally listed fishes, Comanche Springs pupfish and Pecos gambusia, as well as the federally endangered Pecos assiminea *(Assiminea pecos)* snail and the federally threatened Pecos sunflower *(Helianthus paradoxus).* No nonnative aquatic species of concern are known from East Sandia Spring.

Historically there were other area springs along Toyah Creek that were part of the San Solomon Spring system. Saragosa and Toyah Springs occurred in the town of Balmorhea along Toyah Creek. Brune (1981, p. 386) reported historic base flows of about 0.2 cms (6 cfs) in the 1920s and 1940s, declining to about 0.06 cms (2 cfs) in the 1950s and 1960s, and no flow was recorded in 1978. Brune (1981, p. 385) reported that the flow from West Sandia Spring was about 0.01 cms (0.2 cfs) in 1976, after combined flows from East and West Sandia Springs had exceeded 0.07 cms (2.5 cfs) between the 1930s and early 1960s. The Texas Water Development Board (2005, p. 12) reported West Sandia and Saragosa Springs did not discharge sufficient flow for measurement. Karges (2003, p. 145) indicated West Sandia has only intermittent flow and harbors no aquatic fauna. Whether the six aquatic invertebrates discussed in this document occurred in these now dry spring sites is unconfirmed, but, given their current distribution in springs located upstream and downstream of these historic springs, we assume that they probably did. However, because these springs have been dry for many decades, they no longer provide habitat for the aquatic invertebrates.

Diamond Y Spring System

The Diamond Y Spring system is within the tributary drainage of Diamond Y Draw/Leon Creek that drains northeast to the Pecos River. Diamond Y Spring (previously called Willbank Spring) is located about 80 km (50 mi) due east of San Solomon Spring and about 12 km (8 mi) north of the City of Fort Stockton in Pecos County. The Diamond Y Spring system is composed of disjunct upper and lower watercourses, separated by about 1 km (0.6 mi) of dry stream channel.

The upper watercourse is about 1.5 km (0.9 mi) long and starts with the Diamond Y Spring head pool, which drains into a small spring outflow channel. The discharge from Diamond Y Spring is extremely small; between 2010 and 2013, the U.S. Geological Survey measured flows from Diamond Y Spring ranging from 0.0009 to 0.002 cms (0.03 to 0.09 cfs) (U.S. Geological Survey 2013, p. 1). The channel enters a broad valley and braids into numerous wetland areas and is augmented by numerous small seeps. The Diamond Y Spring outflow converges with the Leon Creek drainage and flows through a marsh-meadow, where it is then referred to as Diamond Y Draw; farther downstream the drainage is again named Leon Creek. All of the small springs and seeps and their outflow comprise the upper watercourse. These lateral water features, often not mapped, are spread across the flat, seasonally wetted area along Diamond Y Draw. Therefore, unlike other spring systems that have a relatively small footprint, aquatic habitat covers a relatively large area along the Diamond Y Draw.

The lower watercourse of Diamond Y Draw has a smaller head pool spring, referred to as Euphrasia Spring, with a small outflow stream as well as several isolated pools and associated seeps and wetland areas. The total length of the lower watercourse is about 1 km (0.6 mi) and has extended below the bridge at State Highway 18 during wetter seasons in the past. The upper watercourse is only hydrologically connected to the lower watercourse by surface flows during rare large rainstorm runoff events. The lower watercourse also contains small springs and seeps laterally separated from the main spring outflow channels.

All of the Diamond Y Spring area (both upper and lower watercourses and the area in between) occurs on the Diamond Y Spring Preserve, which is owned and managed by The Nature Conservancy. The Diamond Y Spring Preserve is 1,603 ha (3,962 ac) of contiguous land around Diamond Y Draw. The surrounding watershed and the land area over the contributing aquifers are all privately owned and managed as ranch land and have been extensively developed for oil and gas extraction. In addition, a natural gas gathering and treating plant is located within 0.8 km (0.5 mi) upslope of the headpool in the upper watercourse of Diamond Y Spring (Hoover 2013, p. 2). Diamond Y Spring is also inhabited by two federally listed fishes, Leon Springs pupfish *(Cyprinodon bovinus)* and Pecos gambusia, as well as the federally endangered Pecos assiminea snail and the federally threatened Pecos sunflower. The only nonnative species of concern at Diamond Y Spring is the red-rim melania, which is only known to occur in the upper watercourse.

Substantial scientific uncertainty exists regarding the aquifer sources that provide the source water to the Diamond Y Springs. Preliminary studies by Boghici (1997, p. *v*) indicate that the spring flow at Diamond Y Spring originates chiefly from the Rustler aquifer waters underlying the Delaware Basin to the northwest of the spring outlets (Boghici and Van Broekhoven 2001, p. 219). The Rustler aquifer underlies an area of approximately 1,200 sq km (480 sq mi) encompassing most of Reeves County and parts of Culberson, Pecos, Loving, and Ward Counties (Boghici and Van Broekhoven 2001, p. 219). Much of the water contains high total dissolved solids (Boghici and Van Broekhoven 2001, p. 219) making it difficult for agricultural or municipal use; therefore, the aquifer has experienced only limited pumping in the past (Mace 2001, pp. 7–9). However, more recent studies by the U.S. Geological Survey suggest that the Rustler Aquifer only contributes some regional flow mixing with the larger Edwards–Trinity (Plateau) Aquifer in this area through geologic faulting and artesian pressure, as the Rustler Aquifer is deeper than the Edwards–Trinity Aquifer (Bumgarner 2012, p. 46; Ozuna 2013, p. 1). In contrast, the Texas Water Development Board indicates that the strata underlying the Edwards–Trinity (Plateau) Aquifer provide most of the spring flow at Diamond Y Spring and that the artesian pressure causing the groundwater to issue at Diamond Y Spring is likely from below the Rustler Aquifer (French 2013, pp. 2–3). The Middle Pecos Groundwater Conservation District suggested that Diamond Y Spring is a mixture of discharge from the Edwards–Trinity (Plateau) Aquifer and leakage from the other Permian-age formations, including the Rustler, Salado, Transill, and Yates formations and possibly even deeper strata below the Edwards–Trinity (Plateau) Aquifer (Gershon 2013, p. 6). Obviously, substantial uncertainty exists as to the exact nature of the groundwater sources for Diamond Y Spring.

Other springs in the area may have once provided habitat for the aquatic species but limited information is generally available on historic distribution of the invertebrates. Leon Springs, a large spring that historically occurred about 14 km (9 miles) upstream along Leon Creek, historically discharged about 0.7 cms (25 cfs) in 1920, 0.5 cms (18 cfs) in the 1930s, 0.4 cms (14 cfs) in the 1940s, and no discharge from 1958 to 1971 (Brune 1981, p. 359). Nearby groundwater pumping to irrigate farm lands began in 1946, which lowered the contributing aquifer by 40 m (130 feet) by the 1970s and resulted in the loss of the spring. The only circumstantial evidence that any of the three invertebrates that occur in nearby Diamond Y Spring may have occurred in Leon Springs is that the spring is within the same drainage and an endemic fish, Leon Springs pupfish, once occurred in both Diamond Y and Leon Springs.

Comanche Springs is another large historic spring located in the City of Fort Stockton. Prior to the 1950s, this spring discharged more than 1.2 cms (42 cfs) (Brune 1981, p. 358) and provided habitat for rare species of fishes and invertebrates. As a result of groundwater pumping for agriculture, the spring ceased flowing by 1962 (Brune 1981, p. 358), eliminating all aquatic-dependent plants and animals (Scudday 1977, pp. 515–518; Scudday 2003, pp. 135–136). Although we do not have data confirming that Comanche Springs was inhabited by all of the Diamond Y Spring species, we have evidence that at least the two snails (Diamond tryonia and Gonzales tryonia) occurred there at some time in the past (see *Taxonomy, Distribution, Abundance, and Habitat of Snails,* below).

Life History and Biology of Snails

The background information presented in this section applies to all four species of snails in these final rules: Phantom springsnail (*P. texana*), Phantom tryonia (*T. cheatumi*), Diamond tryonia (*P. adamantina*), and Gonzales tryonia (*T. circumstriata*). The Phantom springsnail is classified in the family Hydrobiidae (Hershler 2010, p. 247), and the other three snails are in the family Cochliopidae (Hershler *et al.* 2011, p. 1), formerly a subfamily of Hydrobiidae. All of the snails are strictly aquatic with respiration occurring through an internal gill. These type of snails (snails in the former family Hydrobiidae) typically reproduce several times during the spring to fall breeding season (Brown 1991, p. 292) and are sexually dimorphic (males and females are shaped differently), with females being characteristically larger and longer-lived than males. Snails in the genus *Pyrgulopsis* (Phantom springsnail) reproduce through laying a single small egg capsule deposited on a hard surface (Hershler 1998, p. 14). The other three snail species are ovoviviparous, meaning the larval stage is completed in the egg capsule, and upon hatching, the snails emerge into their adult form (Brusca and Brusca 1990, p. 759; Hershler and Sada 2002, p. 256). The lifespan of most aquatic snails is thought to be 9 to 15 months (Taylor 1985, p. 16; Pennak 1989, p. 552).

All of these snails are presumably fine-particle feeders on detritus (organic material from decomposing organisms) and periphyton (mixture of algae and other microbes attached to submerged surfaces) associated with the substrates (mud, rocks, and vegetation) (Allan 1995, p. 83; Hershler and Sada 2002, p. 256; Lysne *et al.* 2007, p. 649). Dundee and Dundee (1969, p. 207) found diatoms (a group of single-celled algae) to be the primary component in the digestive tract, indicating they are a primary food source.

These snails from west Texas occur in mainly flowing water habitats such as small springs, seeps, marshes, spring pools, and their outflows. Proximity to spring vents, where water emerges from the ground, plays a key role in the life history of springsnails. Many springsnail species exhibit decreased abundance farther away from spring vents, presumably due to their need for stable water chemistry (Hershler 1994, p. 68; Hershler 1998, p. 11; Hershler and Sada 2002, p. 256; Martinez and Thome 2006, p. 14). Several habitat parameters of springs, such as temperature, substrate type, dissolved carbon dioxide, dissolved oxygen, conductivity, and water depth have been shown to influence the distribution and abundance of other related species of springsnails (O'Brien and Blinn 1999, pp. 231–232; Mladenka and Minshall 2001, pp. 209–211; Malcom *et al.* 2005, p. 75; Martinez and Thome 2006, pp. 12–15; Lysne *et al.* 2007, p. 650). Dissolved salts such as calcium carbonate may also be important factors because they are essential for shell formation (Pennak 1989, p. 552). Hydrobiid snails as a group are considered sensitive to water quality changes, and each species is usually found within relatively narrow habitat parameters (Sada 2008, p. 59).

Native fishes have been shown to prey upon these snails (Winemiller and Anderson 1997, pp. 209–210; Brown *et* *al.* 2008, p. 489), but it is unknown to what degree predatory pressure may play a role in controlling population abundances or influencing habitat use. Currently no nonnative fishes occur in the springs where the species occur, so no unnatural predation pressure from fish is suspected.

Because of their small size and dependence on water, significant dispersal (in other words, movement between spring systems) does not likely occur, although on rare occasions aquatic snails have been transported by becoming attached to the feathers and feet of migratory birds (Roscoe 1955, p. 66; Dundee *et al.* 1967, pp. 89–90). In general, the species have little capacity to move beyond their isolated aquatic environments.

Taxonomy, Distribution, Abundance, and Habitat of Snails

Phantom Springsnail, *Pyrgulopsis texana* (Pilsbry 1935)

The Phantom springsnail was first described by Pilsbry (1935, pp. 91–92) as *Cochliopa texana.* It is a very small snail, measuring only 0.98 to 1.27 millimeters (mm) (0.04 to 0.05 inches (in)) long (Dundee and Dundee 1969, p. 207). Until 2010, the species was classified in the genus *Cochliopa* (Dundee and Dundee 1969, p. 209; Taylor 1987, p. 40). Hershler *et al.* (2010, pp. 247–250) reviewed the systematics of the species and transferred Phantom springsnail to the genus *Pyrgulopsis* after morphological and mitochondrial DNA analysis. Hershler *et al.* (2010, p. 251) also noted some minimal differences in shell size (individuals were smaller at East Sandia Spring) and mitochondrial DNA sequence variation among populations of Phantom springsnails in different springs. The low level of variation (small differences) among the populations did not support recognizing different conservation units for the species. Hershler *et al.* (2010, p. 251) expected this small difference among the populations because of their proximity (separated by 6 to 13 km (4 to 8 mi)) and the past connectedness of the aquatic habitats by Toyah Creek that would have allowed mixing of the populations before human alterations and declining flows. Based on these published studies we conclude that Phantom springsnail meets the definition of a species under the Act.

The Phantom springsnail occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs). Hershler *et al.* (2010, p. 250) did not include Giffin Spring in this species distribution, but unpublished data from Lang (2011, p. 5) confirms that the species is also found in Giffin Spring outflows as well as the other three springs in the San Solomon Spring system. The geographic extent of the historic range for the Phantom springsnail was likely not larger than the present range, but the species may have occurred in additional small springs contained within the current range of the San Solomon Spring system, such as Saragosa and Toyah Springs. It likely also had a larger distribution within Phantom Lake Spring and San Solomon Spring before the habitat there was modified and reduced in conversion of spring outflow channels into irrigation ditches.

Within its current, limited range, Phantom springsnails can exist in very high densities. Dundee and Dundee (1969, pp. 207) described the abundance of the Phantom springsnails at Phantom Lake Spring in 1968 as persisting ‘‘in such tremendous numbers that the bottom and sides of the canal appear black from the cover of snails.’’ Today the snails are limited to the small pool at the mouth of Phantom Cave and cannot be found in the irrigation canal downstream. At San Solomon Spring, Taylor (1987, p. 41) reported the Phantom springsnail was abundant and generally distributed in the canals from 1965 to 1981. Density data and simple population size estimates based on underwater observations indicate there may be over 3.8 million individuals of this species at San Solomon Spring (Bradstreet 2011, p. 55). Lang (2011) also reported very high densities (not total population estimates) of Phantom springsnails (with ± standard deviations): San Solomon Spring from 2009 sampling in the main canal, 71,740 per sq m (6,672 per sq ft; ±47,229 per sq m, ±4,393 per sq ft); Giffin Spring at road crossing in 2001, 4,518 per sq m (420 per sq ft; ±4,157 per sq m, ±387 per sq ft); East Sandia Spring in 2009, 41,215 per sq m (3,832 per sq ft; ±30,587 per sq m, ±2,845 per sq ft); and Phantom Lake Spring in 2009, 1,378 per sq m (128 per sq ft; ±626 per sq m, ±58 per sq ft). From these data, it is evident that when conditions are favorable, Phantom springsnails can reach tremendous population sizes in very small areas.

Phantom springsnails are found concentrated near the spring source (Hershler *et al.* 2010, p. 250) and can occur as far as a few hundred meters downstream of a large spring outlet like San Solomon Spring. Despite its common name, it has not been found within Phantom Cave proper, but only within the outflow of Phantom Lake Spring. Bradstreet (2011, p. 55) found the highest abundances of Phantom springsnails at San Solomon Spring outflows in the high-velocity areas in the irrigation canals and the lowest abundances in the San Solomon Ciénega. The species was not collected from the newest constructed ciénega in 2010. Habitat of the species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41). They are also commonly found attached to plants, particularly in dense stands of submerged vegetation *(Chara* sp.). Field and laboratory experiments have suggested Phantom springsnails prefer substrates harder and larger in size (Bradstreet 2011, p. 91).

Phantom Tryonia, *Tryonia cheatumi* (Pilsbry 1935)

The Phantom tryonia was first described by Pilsbry (1935, p. 91) as *Potamopyrgus cheatumi.* The species was later included in the genus *Lyrodes* and eventually placed in the genus *Tryonia* (Taylor 1987, pp. 38–39). It is a small snail measuring only 2.9 to 3.6 mm (0.11 to 0.14 in) long (Taylor 1987, p. 39). Systematic studies of *Tryonia* snails in the Family Hydrobiidae using mitochondrial DNA sequences and morphological characters confirms the species is a ‘‘true *Tryonia,*’’ in other words, it is appropriately classified in the genus *Tryonia* (Hershler *et al.* 1999, p. 383; Hershler 2001, p. 6; Hershler *et al.* 2011, pp. 5–6). Based on these published studies, we conclude that Phantom tryonia meets the definition of a species under the Act.

The Phantom tryonia occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs) (Taylor 1987, p. 40; Allan 2011, p. 1; Lang 2011, entire). The historic range for the Phantom tryonia was likely not larger than present, but the species may have occurred in other springs within the San Solomon Spring system, such as Saragosa and Toyah Springs. It likely also had a wider distribution within Phantom Lake Spring and San Solomon Spring before the habitat there was modified and reduced.

Within its current, limited range, Phantom tryonia can have moderate densities of abundance, but have never been recorded as high as the Phantom springsnail. In the 1980s, Taylor (1987, p. 40) described Phantom tryonia as abundant in the outflow ditch several hundred meters downstream of Phantom Lake Spring. The snails are now limited to low densities in the small pool at the mouth of Phantom Cave and cannot be found in the irrigation canal downstream as it does not have water (Allan 2009, p. 1). Density data and simple population size estimates based on underwater observations indicate that more than 460,000 individuals of this species may be at San Solomon Spring (Bradstreet 2011, p. 55). Lang (2011) reports the following densities (not population estimates) of Phantom tryonia (with ± standard deviations): San Solomon Spring from 2009 sampling in the main canal, 11,681 per sq m (1,086 per sq ft; ±11,925 per sq m, ±1,109 per sq ft); Giffin Spring at road crossing in 2001, 3,857 per sq m (358 per sq ft; ±6,110 per sq m, ±568 per sq ft); East Sandia Spring in 2009, 65,845 per sq m (6,123 per sq ft; ±60,962 per sq m, ±5,669 per sq ft); and Phantom Lake Spring in 2009, 31,462 per sq m (2,926 per sq ft; ±20,251 per sq m, ±1,883 per sq ft). Phantom tryonia can reach high population sizes in very small areas with favorable conditions.

Phantom tryonia are usually found concentrated near the spring source but once occurred as far as a few hundred meters downstream when Phantom Lake Spring was a large flowing spring (Dundee and Dundee 1969, p. 207; Taylor 1987, p. 40). The species is most abundant in the swimming pool at Balmorhea State Park, but has not been found in either of the constructed ciénegas at the Park in 2010 and 2011 (Allan 2011, p. 3; Bradstreet 2011, p. 55). The species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41), and they are also commonly found attached to plants, particularly in dense stands of submerged vegetation (*Chara* sp.).

Diamond Tryonia, *Pseudotryonia adamantina* (Taylor 1987)

The Diamond tryonia was first described by Taylor (1987, p. 41) as *Tryonia adamantina.* It is a small snail measuring only 2.9 to 3.6 mm (0.11 to 0.14 in) long (Taylor 1987, p. 41). Systematic studies (Hershler *et al.* 1999, p. 377; Hershler 2001, pp. 7, 16) of these snails have been conducted using mitochondrial DNA sequences and morphological characters. These analyses resulted in the Diamond tryonia being reclassified into the new genus *Pseudotryonia* (Hershler 2001, p. 16). Based on these published studies, we conclude that Diamond tryonia meets the definition of a species under the Act.

Taylor (1985, p. 1; 1987, p. 38) was the earliest to document the distribution and abundance of aquatic snails in the Diamond Y Spring system, referencing surveys from 1968 to 1984. In 1968, the Diamond tryonia was considered abundant in the outflow of Diamond Y Spring in the upper watercourse for about 1.6 km (1 mi) downstream of the spring head pool, but by 1984 the species was present in only areas along stream margins (near the banks) (Taylor 1985, p. 1). Average density estimates in 1984 at 12 of 14 sampled sites in the upper watercourse ranged from 500 to 93,700 individuals per sq m (50 to 8,700 per sq ft), with very low densities in the upstream areas near the headspring (Taylor 1985, p. 25). However, the Diamond tryonia was largely absent from the headspring and main spring flow channel where it had been abundant in 1968 surveys (Taylor 1985, p. 13). Instead it was most common in small numbers along the outflow stream margins and lateral springs (Taylor 1985, pp. 13–15). Over time, the distribution of the Diamond tryonia in the upper watercourse has continued to recede so that it is no longer found in the outflow channel at all but may be restricted to small lateral spring seeps disconnected from the main spring flow channel (Landye 2000, p. 1; Echelle *et al.* 2001, pp. 24–25). Surveys by Lang (2011, pp. 7–8) in 2001 and 2003 found only 2 and 7 individuals, respectively, in the outflow channel of Diamond Y Spring. Additional surveys in 2009 and 2010 (Ladd 2010, p. 18; Lang 2011, p. 12) did not find Diamond tryonia in the upper watercourse. However, neither researcher surveyed extensively in the lateral spring seeps downstream from the main spring outflow.

The Diamond tryonia was not previously reported from the lower watercourse until first detected there in 2001 at the outflow of Euphrasia Spring (Lang 2011, p. 6). It was confirmed there again in 2009 (Lang 2011, p. 13) and currently occurs within at least the first 50 m (160 feet) in the outflow channel of Euphrasia Spring (Ladd 2010, p. 18). Ladd (2010, p. 37) roughly estimated the total number of Diamond tryonia in the lower watercourse to be about 35,000 individuals with the highest density reported as 2,500 individuals per sq m (230 per sq ft). Lang (2011, p. 13) estimated densities of Diamond tryonia in 2009 at 16,695 per sq m (1,552 per sq ft; ±18,212 per sq m, ±1,694 per sq ft) in Euphrasia Spring outflow, which suggests a much larger population than that estimated by Ladd (2010, p. 37).

In summary, the Diamond tryonia was historically common in the upper watercourse and absent from the lower watercourse. Currently it is very rare in the upper watercourse and limited to small side seeps (and may be extirpated), and it occurs in the lower watercourse in the outflow of Euphrasia Spring. The historic distribution of this species may have been larger than the present distribution. Other area springs nearby such as Leon and Comanche Springs may have harbored the species. There is one collection of very old, dead shells of the species that was made from Comanche Springs in 1998 (Worthington 1998, unpublished data) whose identification was recently confirmed as Diamond tryonia (Hershler 2011, pers. comm.). However, because these springs have been dry for more than four decades and shells can remain intact for thousands of years, it is impossible to know how old the shells might be. Therefore, we are unable to confirm if the recent historic distribution included Comanche Springs.

Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush *(Scirpus americanus)* and saltgrass *(Distichlis spicata)* (Taylor 1987, p. 38; Echelle *et al.* 2001, p. 5).

Gonzales Tryonia, *Tryonia circumstriata* (Leonard and Ho 1960)

The Gonzales tryonia was first described as a late Pleistocene fossil record, *Calipyrgula circumstriata,* from the Pecos River near Independence Creek in Terrell County, Texas (Leonard and Ho 1960, p. 126). The snail from Diamond Y Spring area was first described as *Tryonia stocktonensis* by Taylor (1987, p. 37). It is a small snail, measuring only 3.0 to 3.7 mm (0.11 to 0.14 in) long. Systematic studies later changed the name to *Tryonia circumstriata,* integrating it with the fossilized snails from the Pecos River (Hershler 2001, p. 7), and confirming the species as a ‘‘true *Tryonia,*’’ in other words, it is appropriately classified in the genus *Tryonia* (Hershler *et al.* 2011, pp. 5–6). Based on these published studies, we conclude that Gonzales tryonia meets the definition of a species under the Act.

Taylor (1985, pp. 18–19; 1987, p. 38) found Gonzales tryonia only in the first 27 m (90 ft) of the outflow from Euphrasia Spring. The species has been consistently found in this short stretch of spring outflow channel since then (Echelle *et al.* 2001, p. 20; Lang 2011, pp. 6, 13). Ladd (2010, pp. 23–24) reported that Gonzales tryonia no longer occurred in the lower watercourse and had been replaced by Diamond tryonia. However, reevaluation of voucher specimens collected by Lang (2011, p. 13) concurrently in 2009 with those by Ladd (2010, p. 14) confirmed the species is still present in the Euphrasia Spring outflow channel of the lower watercourse.

Gonzales tryonia was first reported in the upper watercourse in 1991 during collections from one site in the Diamond Y Spring outflow and one small side seep near the spring head (Fullington and Goodloe 1991, p. 3). The species has since been collected from this area (Lang 2011, pp. 7–9), and Echelle *et al.* (2001, p. 20) found it to be the most abundant snail for the first 430 m (1,400 ft) downstream from the spring head. Ladd (2010, p. 18) also found Gonzales tryonia in the outflow of Diamond Y Spring, but only from 125 to 422 m (410 to 1,384 ft) downstream of the spring head (Ladd 2011, pers. comm.). The Gonzales tryonia appears to have replaced the Diamond tryonia in some of the habitat in the upper watercourse (Brown 2008, p. 489) since 1991.

Taylor (1985, p. 19) calculated densities for Gonzales tryonia in the outflow of Euphrasia Spring in the range of 50,480 to 85,360 individuals per sq m (4,690 to 7,930 individuals per sq ft) and estimated the population size in that 27-m (90-ft) stretch to be at least 162,000 individuals and estimated the total population of over one million individuals as a reasonable estimate. Lang (2011, p. 13) estimated the density of Gonzales tryonia in the Euphrasia Spring outflow to be 3,086 individuals per sq m (287 per sq ft; ±5,061 per sq m, ±471per sq ft). Ladd (2010, p. 37) estimated the population of Gonzales tryonia in the upper watercourse to be only about 11,000 individuals.

As with the Diamond tryonia, the historic distribution of the Gonzales tryonia may have been larger than the present distribution. Other area springs nearby such as Leon and Comanche Springs may have harbored the species. The identification of one collection of dead shells of the species that was made from Comanche Springs in 1998 (Worthington 1998, unpublished data) was recently confirmed as Gonzales tryonia (Hershler 2011, pers. comm.). However, because these springs have been dry for more than four decades and shells can remain intact for thousands of years, it is impossible to know how old the shells might be. Therefore, we are unable to confirm if the recent historic distribution included Comanche Springs.

Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush and saltgrass (Taylor 1987, p. 38; Echelle *et al.* 2001, p. 5).

Life History, Biology, and Habitat of Amphipods

The background information presented here applies to both species of amphipods in these final rules: Diminutive amphipod and Pecos amphipod. These amphipods, in the family Gammaridae, are small freshwater inland crustaceans sometimes referred to as freshwater shrimp. Gammarids commonly inhabit shallow, cool, well-oxygenated waters of streams, ponds, ditches, sloughs, and springs (Smith 2001, p. 574). These bottom-dwelling amphipods feed on algae, submergent vegetation, and decaying organic matter (Smith 2001, p. 572). Amphipod eggs are held within a marsupium (brood pouch) within the female's exoskeleton (Smith 2001, p. 573). Most amphipods complete their life cycle in 1 year and breed from February to October, depending on water temperature (Smith 2001, p. 572). Amphipods form breeding pairs that remain attached for 1 to 7 days at or near the substrate while continuing to feed and swim (Bousfield 1989, p. 1721). They can produce from 15 to 50 offspring, forming a ''brood.'' Most amphipods produce one brood, but some species produce a series of broods during the breeding season (Smith 2001, p. 573).

These two species, diminutive amphipod and Pecos amphipod, are part of a related group of amphipods, referred to as the *Gammarus pecos* species complex, that are restricted to desert spring systems from the Pecos River Basin in southeast New Mexico and west Texas (Cole 1985, p. 93; Lang *et al.* 2003, p. 47; Gervasio *et al.* 2004, p. 521). Similar to the snails, these freshwater amphipods are thought to have derived from a widespread ancestral marine amphipod that was isolated inland during the recession of the Late Cretaceous sea, about 66 million years ago (Holsinger 1967, pp. 125–133; Lang *et al.* 2003, p. 47). They likely evolved into distinct species during recent dry periods (since the Late Pleistocene, about 100,000 years ago) through allopatric speciation (that is, speciation by geographic separation) following separation and isolation in the remnant aquatic habitats associated with springs (Gervasio *et al.* 2004, p. 528).

Amphipods in the *Gammarus pecos* species complex occur only in desert spring outflow channels on substrates, often within interstitial spaces on and underneath rocks and within gravels (Lang *et al.* 2003, p. 49) and are most commonly found in microhabitats with flowing water. They are also commonly found in dense stands of submerged vegetation (Cole 1976, p. 80). Because of their affinity for constant water temperatures, they are most common in the immediate spring outflow channels, usually only a few hundred meters downstream of spring outlets.

Amphipods play important roles in the processing of nutrients in aquatic ecosystems and are also considered sensitive to changes in aquatic habitat conditions (for example, stream velocities, light intensity, zooplankton availability, and the presence of heavy metals) and are often considered ecological indicators of ecosystem health and integrity (Covich and Thorpe 1991, pp. 672–673, 679; Lang *et al.* 2003, p. 48). Water chemistry parameters, such as salinity, pH, and temperature, are also key components to amphipod habitats (Covich and Thorpe 1991, pp. 672–673).

Taxonomy, Distribution, and Abundance of Amphipods

Diminutive Amphipod, *Gammarus hyalleloides* Cole 1976

W.L. Minckley first collected the diminutive amphipod from Phantom Lake Spring in the San Solomon Spring system in 1967, and the species was first formally described by Cole (1976, pp. 80–85). The name comes from the species being considered the smallest of the known North American freshwater *Gammarus* amphipods. Adults generally range in length from 5 to 8 mm (0.20 to 0.24 in).

The literature has some disparity regarding the taxonomic boundaries for the amphipods from the San Solomon Spring system. In Cole's (1985, pp. 101–102) description of the *Gammarus pecos* species complex of amphipods based solely on morphological measurements, he considered the diminutive amphipod to be endemic only to Phantom Lake Spring, and amphipods from San Solomon and Diamond Y Springs were both considered to be the Pecos amphipod *(G. pecos).* This study did not include samples of amphipods from East Sandia or Giffin Springs. However, allozyme electrophoresis data on genetic variation strongly support that the populations from the San Solomon Spring system form a distinct group from the Pecos amphipod at Diamond Y Spring (Gervasio *et al.* 2004, pp. 523–530). Based on these data, we consider the Pecos amphipod to be limited to the Diamond Y Spring system.

The results of these genetic studies also suggested that the three *Gammarus* amphipod populations from San Solomon, Giffin, and East Sandia Springs are a taxonomically unresolved group differentiated from the diminutive amphipod at Phantom Lake Spring (Gervasio *et al.* 2004, pp. 523–530). Further genetic analysis using mitochondrial DNA (mtDNA) by Seidel *et al.* (2009, p. 2309) also indicates that the diminutive amphipod may be limited to Phantom Lake Spring and the *Gammarus* species at the other three springs should be considered a new and undescribed species. However, the extent of genetic divergence measured between these populations is not definitive. For example, the 19-base pair divergence between the population at Phantom Lake Spring and the other San Solomon Spring system populations (Seidel *et al.* 2009, Figure 3, p. 2307) represents about 1.7 percent mtDNA sequence divergence (of the 1,100 base pairs of the mitochondrial DNA sequenced (using the cytochrome c oxidase I (COI) gene). This is a relatively low level of divergence to support species separation, as a recent review of a multitude of different animals (20,731 vertebrates and invertebrates) suggested that the mean mtDNA distances (using the COI gene) between subspecies is 3.78 percent (±0.16) divergence and between species is 11.06 percent (±0.53) divergence (Kartavtsev 2011, pp. 57–58).

Recent evaluations of species boundaries of amphipods from China suggest mtDNA genetic distances of at least 4 percent were appropriate to support species differentiation, and the species they described all exceeded 15 percent divergence (Hou and Li 2010, p. 220). In addition, no species descriptions using morphological or ecological analysis have been completed for these populations, which would be important information in any taxonomic revision (Hou and Li 2010, p. 216). Therefore, the data available does not currently support taxonomically separating the amphipod population at Phantom Lake Spring from the populations at San Solomon, Giffin, and East Sandia Springs into different listable entities under the Act. So, for the purposes of these final rules, based on the best available scientific information, we are including all four populations of *Gammarus* amphipods from the San Solomon Spring system as part of the *Gammarus hyalleloides* species (diminutive amphipod), and we consider diminutive amphipod to meet the definition of a species under the Act. We recognize that the taxonomy of these populations could change as additional information is collected and further analyses are published.

The diminutive amphipod occurs only in the four springs from the San Solomon Spring system (Gervasio *et al.* 2004, pp. 520–522). Available information does not indicate that the species' historic distribution was larger than the present distribution, but other area springs (such as Saragosa, Toyah, and West Sandia Springs) may have contained the species. However, because these springs have been dry for many decades, if the species historically occurred there, they are now extirpated. There is no opportunity to determine the full extent of the historic distribution of these amphipods because of the lack of historic surveys and collections.

Within its limited range, diminutive amphipod can be very abundant. For example, in May 2001, Lang *et al.* (2003, p. 51) estimated mean densities at San Solomon, Giffin, and East Sandia Springs of 6,833 amphipods per sq m (635 per sq ft; standard deviation ±5,416 per sq m, ±504 per sq ft); 1,167 amphipods per sq m (108 per sq ft; ±730 per sq m, ±68 per sq ft), and 4,625 amphipods per sq m (430 per sq ft; ±804 per sq m, ±75 per sq ft), respectively. In 2009 Lang (2011, p. 11) reported the density at Phantom Lake Spring as 165 amphipods per sq m (15 per sq ft; ±165 per sq m, ±15 per sq ft).

Pecos Amphipod, *Gammarus pecos* Cole and Bousfield 1970

The Pecos amphipod was first collected in 1964 from Diamond Y Spring and was described by Cole and Bousfield (1970, p. 89). Cole (1985, p. 101) analyzed morphological characteristics of the *Gammarus pecos* species complex and suggested the *Gammarus* amphipod from San Solomon Spring should also be included as Pecos amphipod. However, updated genetic analyses based on allozymes (Gervasio *et al.* 2004, p. 526) and mitochondrial DNA (Seidel *et al.* 2009, p. 2309) have shown that Pecos amphipods are limited in distribution to the Diamond Y Spring system. In addition, Gervasio *et al.* (2004, pp. 523, 526) evaluated amphipods from three different locations within the Diamond Y Spring system and found no significant differences in genetic variation, indicating they all represented a single species. Based on these published studies, we conclude that Pecos amphipod meets the definition of a species under the Act.

The Pecos amphipod is generally found in all the flowing water habitats associated with the outflows of springs and seeps in the Diamond Y Spring system (Echelle *et al.* 2001, p. 20; Lang *et al.* 2003, p. 51; Allan 2011, p. 2; Lang 2011, entire). Available information does not allow us to determine if the species' historic distribution was larger than the present distribution. Other area springs, such as Comanche and Leon Springs, may have contained the same or similar species of amphipod, but because these springs have been dry for many decades (Brune 1981, pp. 256–263, 382–386), there is no opportunity to determine the potential historic occurrence of amphipods. Pecos amphipods are often locally abundant, with reported mean densities ranging from 2,208 individuals per sq m (205 per sq ft; ±1,585 per sq m, ±147 per sq ft) to 8,042 individuals per sq m (748 per sq ft; ±7,229 per sq m, ±672 per sq ft) (Lang *et al.* 2003, p. 51).

Summary of Factors Affecting the Species

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, the Service determines whether a species is endangered or threatened because of 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; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors is discussed below.

Based on the similarity in geographic ranges and threats to habitats, we have divided this analysis into two sections, one covering the three species from the San Solomon Spring system and then a second analysis covering the three species from the Diamond Y Spring system. After each analysis we provide our determinations for each species.

San Solomon Spring Species—Phantom springsnail, Phantom tryonia, and Diminutive Amphipod

The following analysis applies to the three species that occur in the San Solomon Spring system in Reeves and Jeff Davis Counties, Texas: Phantom springsnail, Phantom tryonia, and diminutive amphipod.

A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range (San Solomon Spring Species)

The three species in the San Solomon Spring system are threatened by the past and future destruction of their habitat and reduction in their range. The discussion below evaluates the stressors of: (1) Spring flow declines; (2) water quality changes and contamination; and (3) modification of spring channels.

Spring Flow Declines

The primary threat to the continued existence of the San Solomon Spring species is the degradation and potential future loss of aquatic habitat (flowing water from the spring outlets) due to the decline of groundwater levels in the aquifers that support spring surface flows. Habitat for these species is exclusively aquatic and completely dependent on spring flows emerging to the surface from underground aquifer sources. Spring flows throughout the San Solomon Spring system have and continue to decline in flow rate, and as spring flow declines, available aquatic habitat is reduced and altered. If one spring ceases to flow continually, all habitats for the Phantom springsnail, Phantom tryonia, and diminutive amphipod are lost, and the populations will be extirpated. If all of the springs lose consistent surface flows, all natural habitats for these aquatic invertebrates will be gone, and the species will become extinct.

The springs do not have to cease flowing completely to have an adverse effect on invertebrate populations. The small size of the spring outflows at Phantom, Giffin, and East Sandia Springs makes them particularly susceptible to changes in water chemistry, increased water temperatures during the summer and freezing in the winter. Because these springs are small, any reductions in the flow rates from the springs can reduce the quantity and quality of available habitat for the species, which decreases the number of individuals available and increases the risk of extinction. Water temperatures and chemical factors in springs, such as dissolved oxygen and pH, do not typically fluctuate to a large degree (Hubbs 2001, p. 324), and invertebrates are narrowly adapted to spring conditions and are sensitive to changes in water quality (Hershler 1998, p. 11; Sada 2008, p. 69). Spring flow declines can lead to the degradation and loss of aquatic invertebrate habitat and present a substantial threat to these species.

The precise reason for the declining spring flows remains uncertain, but it is presumed to be related to a combination of groundwater pumping, mainly for agricultural irrigation, and a lack of natural recharge to the supporting aquifers due to limited rainfall and geologic circumstances that prevent recharge. In addition, future changes in the regional climate are expected to exacerbate declining flows. The San Solomon Spring system historically may have had a combined discharge of about 2.8 cms (100 cfs) or 89 million cubic meters per year (cmy) (72,000 acre-feet per year (afy)) (Beach *et al.* 2004, p. 4–53), while today the total discharge is roughly one-third that amount. Some smaller springs, such as Saragosa, Toyah, and West Sandia Springs have already ceased flowing and likely resulted in the extirpation of local populations of these species (assuming they were present there historically). The most dramatic recent decline in flow rates have been observed at Phantom Lake Spring, which is the highest elevation spring in the system and, not unexpectedly, was the first large spring to cease flowing.

Phantom Lake Spring was historically a large desert ciénega with a pond of water more than several acres in size (Hubbs 2001, p. 307). The spring outflow is at about 1,080 m (3,543 ft) in elevation and previously provided habitat for the endemic native aquatic fauna. The outflow from Phantom Lake Spring was originally isolated from the other surface springs in the system, as the spring discharge quickly recharged back underground (Brune 1981, p. 258). Human modifications to the spring outflow captured and channeled the spring water into a canal system for use by local landowners and irrigation by the local water users (Simonds 1996, p. 3). The outflow canal joins the main San Solomon canal within Balmorhea State Park. Despite the significant habitat alterations, the native aquatic fauna (including these three invertebrates) have persisted, though in much reduced numbers of total individuals, in the small pool of water at the mouth of the spring.

Flows from Phantom Lake Spring have been steadily declining since measurements were first taken in the 1930s (Brune 1981, p. 259). Discharge data have been recorded from the spring at least six to eight times per year since the 1940s by the U.S. Geological Survey, and the record shows a steady decline of base flows from greater than 0.3 cms (10 cfs) in the 1940s to 0 cms (0 cfs) in 1999 (Service 2009b, p. 23). The data also show that the spring can have short-term flow peaks resulting from local rainfall events in the Davis Mountains (Sharp *et al.* 1999, p. 4; Chowdhury *et al.* 2004, p. 341). These flow peaks are from fast recharge of the local aquifer system and discharge through the springs. The flow peaks do not come from direct surface water runoff because the outflow spring is within an extremely small surface drainage basin that is not connected to surface drainage basins from the Davis Mountains upslope. However, after each flow increase, the base flow has returned to the same declining trend within a few months.

Exploration of Phantom Cave by cave divers has led to additional information about the nature of the spring and its supporting aquifer. More than 2,440 m (8,000 ft) of the underwater cave have been mapped. Beyond the entrance, the cave is a substantial conduit that transports a large volume of water, in the 0.6 to 0.7 cms (20 to 25 cfs) range, generally from the northwest to the southeast (Tucker 2009, p. 8), consistent with regional flow pattern hypothesis (Chowdhury *et al.* 2004, p. 319). The amount of water measured is in the range of the rate of flow at San Solomon Spring and, along with water chemistry data (Chowdhury *et al.* 2004, p. 340), confirms that the groundwater flowing by Phantom Lake Spring likely discharges at San Solomon Spring. Tucker (2009, p. 8) recorded a 1-m (3-ft) decline in the water surface elevation within the cave between 1996 and 2009 indicating a decline in the amount of groundwater flowing through Phantom Cave.

Phantom Lake Spring ceased flowing in about 1999 (Allan 2000, p. 51; Service 2009b, p. 23). All that remained of the spring outflow habitat was a small pool of water with about 37 sq m (400 sq ft) of wetted surface area. Hubbs (2001, pp. 323–324) documented changes in water quality (increased temperature, decreased dissolved oxygen, and decreased coefficient of variation for pH, turbidity, ammonia, and salinity) and fish community structure at Phantom Lake Spring following cessation of natural flows. In May 2001, the U.S. Bureau of Reclamation, in cooperation with the Service, installed an emergency pump system to bring water from within the cave to the springhead in order to prevent complete drying of the pool and loss of the federally listed endangered fishes and candidate invertebrates that occur there. Habitat for the San Solomon Spring system invertebrates continues to be maintained at Phantom Lake Spring, and in 2011 the small pool was enlarged, nearly doubling the amount of aquatic habitat available for the species (Service 2012, entire).

The three San Solomon Spring species have maintained minimal populations at Phantom Lake Spring despite the habitat being drastically modified from its original state and being maintained by a pump system since 2000. However, because the habitat is sustained with a pump system, the risk of extirpation of these populations continues to be extremely high from the potential for a pump failure or some unforeseen event. For example, the pump system failed several times during 2008, resulting in stagnant pools and near drying conditions, placing severe stress on the invertebrate populations (Allan 2008, pp. 1–2). Substantial efforts were implemented in 2011 to improve the reliability of the pump system and the quality of the habitat (Service 2012, pp. 5–9). However, because the habitat is completely maintained by artificial means, the potential loss of the invertebrate population will continue to be an imminent threat of high magnitude to the populations at Phantom Lake Spring.

Although long-term data for San Solomon Spring flows are limited, they appear to have declined somewhat over the history of record, though not as severely as Phantom Lake Spring (Schuster 1997, pp. 86–90; Sharp *et al.* 1999, p. 4). Some recent declines in overall flow have likely occurred due to drought conditions and declining aquifer levels (Sharp *et al.* 2003, p. 7). San Solomon Spring discharges are usually in the 0.6 to 0.8 cms (25 to 30 cfs) range (Ashworth *et al.* 1997, p. 3; Schuster 1997, p. 86) and are consistent with the theory that the water bypassing Phantom Lake Spring discharges at San Solomon Spring.

In Giffin Spring, Brune (1981, pp. 384–385) documented a gradual decline in flow between the 1930s and 1970s, but the discharge has remained relatively constant since that time, with outflow of about 0.08 to 0.1 cms (3 to 4 cfs) (Ashworth *et al.* 1997, p. 3; U.S. Geological Survey 2012, p. 2). Although the flow rates from Giffin Spring appear to be steady in recent years, its small size makes the threat of spring flow loss imminent and of high magnitude because even a small decline in flow rate may have substantial impacts on the habitat provided by the spring flow. Also, it would only take a small decline in spring flow rates to result in desiccation of the spring.

Brune (1981, p. 385) noted that flows from Sandia Springs (combining East and West Sandia Springs) were declining up until 1976. East Sandia may be very susceptible to overpumping of the local aquifer in the nearby area that supports the small spring. Measured discharges in 1995 and 1996 ranged from 0.013 to 0.12 cms (0.45 to 4.07 cfs) (Schuster 1997, p. 94). Like the former springs of West Sandia and Saragosa, which also originated in shallow aquifers and previously ceased flowing (Ashworth *et al.* 1997, p. 3), East Sandia Spring's very small volume of water makes it particularly at risk of failure from any local changes in groundwater conditions.

The exact causes for the decline in flow from the San Solomon Spring system are unknown. Some of the possible reasons, which are likely acting together, include groundwater pumping of the Salt Basin Bolson aquifer areas west of the springs, long-term climatic changes, or changes in the geologic structure (through opening of fractures or conduits through dissolution, tectonic activity, or changing sediment storage in conduits) that may affect regional flow of groundwater (Sharp *et al.* 1999, p. 4; Sharp *et al.* 2003, p. 7). Studies indicate that the base flows originate from ancient waters to the west (Chadhury *et al.* 2004, p. 340) and that many of the aquifers in west Texas receive little to no recharge from precipitation (Scanlon *et al.* 2001, p. 28) and are influenced by regional groundwater flow patterns (Sharp 2001, p. 41).

Ashworth *et al.* (1997, entire) conducted a brief study to examine the cause of declining spring flows in the San Solomon Spring system. They concluded that declines in spring flows in the 1990s were more likely the result of diminished recharge due to the extended dry period rather than from groundwater pumping (Ashworth *et al.* 1997, p. 5). Although possibly a factor, drought is unlikely the only reason for the declines because the drought of record in the 1950s had no measurable effect on the overall flow trend at Phantom Lake Spring (Allan 2000, p. 51; Sharp 2001, p. 49) and because the contributing aquifer receives virtually no recharge from most precipitation events (Beach *et al.* 2004, pp. 6–9, 8–9). Also, Ashworth *et al.* (1997, entire) did not consider the effects of the regional flow system in relation to the declining spring flows. Further, an assessment of the springs near Balmorhea by Sharp (2001, p. 49) concluded that irrigation pumping since 1945 has caused many springs in the area to cease flowing, lowering water-table elevations and creating a cone of depression in the area (that is, a lowering of the groundwater elevation around pumping areas).

The Texas Water Development Board (2005, entire) completed a comprehensive study to ascertain the potential causes of spring flow declines in the San Solomon Spring system, including a detailed analysis of historic regional groundwater pumping trends. The study was unable to quantify direct correlations between changes in groundwater pumping in the surrounding counties and spring flow decline over time at Phantom Lake Spring (Texas Water Development Board 2005, p. 93). However, they suggested that because of the large distance between the source groundwater and the springs and the long travel time for the water to reach the spring outlets, any impacts of pumping are likely to be reflected much later in time (Texas Water Development Board 2005, p. 92). The authors did conclude that groundwater pumping will impact groundwater levels and spring flow rates if it is occurring anywhere along the flow path system (Texas Water Development Board 2005, p. 92).

Groundwater pumping for irrigated agriculture has had a measurable effect on groundwater levels in the areas that likely support the spring flows at the San Solomon Spring system. For example, between the 1950s and 2000 the Salt Basin Bolson aquifer in Lobo Flat fell in surface elevation in the range of 15 to 30 m (50 to near 100 ft), and in Wild Horse Flat from 6 to 30 m (20 to 50 ft) (Angle 2001, p. 248; Beach *et al.* 2004, p. 4–9). Beach *et al.* (2004, p. 4–10) found significant pumping, especially in the Wild Horse Flat area, locally influences flow patterns in the aquifer system. The relationship of regional flow exists because Wild Horse Flat is located in the lowest part of the hydraulically connected Salt Basin Bolson aquifer, and next highest is Lobo, followed by Ryan Flat, which is at the highest elevations (Beach *et al.* 2004, p. 9–32). This means that water withdrawn from any southern part of the basin (Ryan and Lobo Flats) may affect the volume of water discharging out of Wild Horse Flat toward the springs. Because these bolson aquifers have little to no direct recharge from precipitation (Beach *et al.* 2004, pp. 6–9, 8–9), these groundwater declines can be expected to permanently reduce the amount of water available for discharge in the springs in the San Solomon Spring system. This is evidenced by the marked decline of groundwater flow out of the Wild Horse Flat toward the southeast (the direction of the springs) (Beach *et al.* 2004, p. 9–27). Based on this information, it appears reasonable that past and future groundwater withdrawals in the Salt Basin Bolson aquifers are likely one of the causes of decreased spring flows in the San Solomon Spring system.

Groundwater pumping withdrawals in Culberson, Jeff Davis, and Presidio Counties in the Salt Basin Bolson aquifer are expected to continue in the future mainly to support irrigated agriculture (Region F Water Planning Group 2010, pp. 2–16–2–19) and is expected to result in continued lowering of the groundwater levels in the Salt

Basin Bolson aquifer. The latest plans from Groundwater Management Area 4 (the planning group covering the relevant portion of the Salt Basin Bolson aquifer) expect over 69 million cubic m (56,000 af) of groundwater pumping per year for the next 50 years, resulting in an average drawdown of 22 to 24 m (72 to 78 feet) in the West Texas Bolsons (Salt Basin) aquifer by 2060 (Adams 2010, p. 2; Oliver 2010, p. 7). No studies have evaluated the effects of this level of anticipated drawdown on spring flows. The aquifer in the Wild Horse Flat area (a likely spring source for the San Solomon Spring system) can range from 60 to 300 m (200 to 1,000 ft) thick. So although it is impossible to determine precisely, we anticipate the planned level of groundwater drawdown will likely result in continued future declines in spring flow rates in the San Solomon Spring system. This decline in spring flows will further limit habitat available to the invertebrate species and increase their risk of extinction.

Another reason that spring flows may be declining is from an increase in the frequency and duration of local and regional drought associated with climatic changes. The term ''climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Although the bulk of spring flows appear to originate from ancient water sources with limited recent recharge, any decreases in regional precipitation patterns due to prolonged drought will further stress groundwater availability and increase the risk of diminishment or drying of the springs. Drought affects both surface and groundwater resources and can lead to diminished water quality (Woodhouse and Overpeck 1998, p. 2693) in addition to reducing groundwater quantities. Lack of rainfall may also indirectly affect aquifer levels by resulting in an increase in groundwater pumping to offset water shortages from low precipitation (Mace and Wade 2008, p. 665).

Recent drought conditions may be indicative of more common future conditions. The current, multiyear drought in the western United States, including the Southwest, is the most severe drought recorded since 1900 (Overpeck and Udall 2010, p. 1642). In 2011, Texas experienced the worst annual drought since recordkeeping began in 1895 (NOAA 2012, p. 4), and only one other year since 1550 (the year 1789) was as dry as 2011 based on tree-ring climate reconstruction (NOAA 2011, pp. 20–22). In addition, numerous climate change models predict an overall decrease in annual precipitation in the southwestern United States and northern Mexico.

Future global climate change may result in increased magnitude of droughts and further contribute to impacts on the aquatic habitat from reduction of spring flows. There is high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to ongoing climate change (IPCC 2007b, p. 7; Karl *et al.* 2009, pp. 129–131), as a result of less annual mean precipitation. Milly *et al.* (2005, p. 347) also project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Even under lower greenhouse gas emission scenarios, recent projections forecast a 10 percent decline in precipitation in western Texas by 2080 to 2099 (Karl *et al.* 2009, pp. 129–130). Assessments of climate change in west Texas suggest that the area is likely to become warmer and at least slightly drier (Texas Water Development Board 2008, pp. 22–25).

The potential effects of future climate change could reduce overall water availability in this region of western Texas and compound the stressors associated with declining flows from the San Solomon Spring system. As a result of the effects of increased drought, spring flows could decline indirectly as a result of increased pumping of groundwater to accommodate human needs for additional water supplies (Mace and Wade 2008, p. 664; Texas Water Development Board 2012c, p. 231).

In conclusion, the Phantom springsnail, Phantom tryonia, and diminutive amphipod all face significant threats from the current and future loss of habitat associated with declining spring flows. Some springs in the San Solomon Spring system have already gone dry, and aquatic habitat at Phantom Lake Spring has not yet been lost only because of the maintenance of a pumping system. While the sources of the stress of declining spring flows are not known for certain, the best available scientific information indicates that it is the result of a combination of factors including past and current groundwater pumping, the complex hydrogeologic conditions that produce these springs (ancient waters from a regional flow system), and climatic changes (decreased precipitation and recharge). The threat of habitat loss from declining spring flows affects all four of the remaining populations, as all are at risk of future loss from declining spring flows. All indications are that the source of this threat will persist into the future and will result in continued degradation of the species' habitats, putting the Phantom springsnail, Phantom tryonia, and diminutive amphipod at a high risk of extinction.

Water Quality Changes and Contamination

Another potential factor that could impact habitat of the San Solomon Spring species is the potential degradation of water quality from point and nonpoint pollutant sources. This pollution can occur either directly into surface water or indirectly through contamination of groundwater that discharges into spring run habitats used by the species. The main source for contamination in these springs comes from herbicide and pesticide use in nearby agricultural areas. There are no oil and gas operations in the area around the San Solomon Spring system.

These aquatic invertebrates are sensitive to water contamination. Hydrobiid snails as a group are considered sensitive to water quality changes, and each species is usually found within relatively narrow habitat parameters (Sada 2008, p. 59). Amphipods generally do not tolerate habitat desiccation (drying), standing water, sedimentation, or other adverse environmental conditions; they are considered very sensitive to habitat degradation (Covich and Thorpe 1991, pp. 676–677).

The exposure of the spring habitats to pollutants is limited because most of the nearby agricultural activity mainly occurs in downstream areas where herbicide or pesticide use would not likely come into contact with the species or their habitat in upstream spring outlets. To ensure these pollutants do not affect these spring outflow habitats, their use has been limited in an informal protected area in the outflows of San Solomon and Giffin Springs (Service 2004, pp. 20–21). This area was developed in cooperation with the U.S. Environmental Protection Agency and the Texas Department of Agriculture and has little to no agricultural activities. While more agricultural activities occur far upstream in the aquifer source area, available information does not lead to concern about contaminants from those sources.

In addition, the Texas Parks and Wildlife Department completed a Habitat Conservation Plan and received an incidental take permit (Service 2009a, entire) in 2009 under section 10(a)(1)(B) (U.S.C. 1539(a)(1)(B)) of the Act for management activities at Balmorhea State Park (Texas Parks and Wildlife Department 1999, entire). The three aquatic invertebrate candidate species from the San Solomon Spring system were all included as covered species in the permit (Service 2009a, pp. 20–22). This permit authorizes ''take'' of the invertebrates (which were candidates at the time of issuance) in the State Park for ongoing management activities while minimizing impacts to the aquatic species. The activities included in the Habitat Conservation Plan are a part of Texas Parks and Wildlife Department's operation and maintenance of the State Park, including the drawdowns associated with cleaning the swimming pool and vegetation management within the refuge canal and ciénega. The Habitat Conservation Plan also calls for restrictions and guidelines for chemical use in and near aquatic habitats to avoid and minimize impacts to the three aquatic invertebrate species (Service 2009a, pp. 9, 29–32).

Because the use of potential pollutants is very limited within the range of the San Solomon Spring species, at this time we do not find that the Phantom springsnail, Phantom tryonia, and diminutive amphipod are at a heightened risk of extinction from water quality changes or contamination.

Modification of Spring Channels

The natural ciénega habitats of the San Solomon Spring system have been heavily altered over time primarily to accommodate agricultural irrigation. Most significant was the draining of wetland areas and the modification of spring outlets to develop the water resources for human use. San Solomon and Phantom Lake Springs have been altered the most severely through capture and diversion of the spring outlets into concrete irrigation canals. Giffin Spring appears to have been dredged in the past, and the outflow is now immediately captured in high-banked, earthen-lined canals. The outflow of East Sandia Spring does not appear to have been altered in an appreciable way, but it may have been minimally channelized to connect the spring flow to the irrigation canals.

The Reeves County Water Improvement District No. 1 maintains an extensive system of about 100 km (60 mi) of irrigation canals that now provide only minimal aquatic habitat for the invertebrate species near the spring sources. Most of the canals are concrete-lined with high water velocities and little natural substrate available. Many of the canals are also regularly dewatered as part of the normal water management operations. Before the canals were constructed, the suitable habitat areas around the spring openings, particularly at San Solomon Spring, were much larger in size. The conversion of the natural aquatic mosaic of habitats into linear irrigation canals represents a past impact resulting in significant habitat loss and an increase in the overall risk of extinction by lowering the amount of habitat available to the species and, therefore, lowering the overall number of individuals in the populations affected. These reductions in population size result in an increase in the risk of extirpation of local populations and, ultimately, the extinction of the species as a whole. Because the physical conditions of the spring channels have changed dramatically in the past, the species are now at a greater risk of extinction because of the alterations to the ecosystem and the overall lower number of individuals likely making up the populations.

A number of efforts have been undertaken at Balmorhea State Park to conserve and maintain aquatic habitats at some of the spring sites to conserve habitat for the native aquatic species. First, a refuge canal encircling the historic motel was built in 1974 to create habitat for the endangered fishes, Comanche Springs pupfish and Pecos gambusia (Garrett 2003, p. 153). Although the canal was concrete-lined, it had moderate water velocities, and natural substrates covered the wide concrete bottom and provided usable habitat for the aquatic invertebrates. Second, the 1-ha (2.5-ac) San Solomon Ciénega was built in 1996 to create an additional flow-through pond of water for habitat of the native aquatic species (Garrett 2003, pp. 153–154). Finally, during 2009 and 2010, a portion of the deteriorating 1974 refuge canal was removed and relocated away from the motel. The wetted area was expanded to create a new, larger ciénega habitat. This was intended to provide additional natural habitat for the federally listed endangered fishes and candidate invertebrates (Service 2009c, p. 3; Lockwood 2010, p. 3). All of these efforts have been generally successful in providing additional habitat areas for the aquatic invertebrates.

Conservation efforts have attempted to maintain suitable spring habitat conditions at Phantom Lake Spring. Here a pupfish refuge canal was built in 1993 (Young *et al.* 1993, pp. 1–3) to increase the available aquatic habitat that had been destroyed by the irrigation canal. Winemiller and Anderson (1997, pp. 204–213) showed that the refuge canal was used by endangered fish species when water was available. Stomach analysis of the endangered pupfish from Phantom Lake Spring showed that the Phantom springsnail and diminutive amphipod were a part of the fish's diet (Winemiller and Anderson 1997, pp. 209–210), indicating that the invertebrates also used the refuge canal. The refuge canal was constructed for a design flow down to about 0.01 cms (0.5 cfs), which at the time of construction was the lowest flow ever recorded out of Phantom Lake Spring. The subsequent loss of spring flow eliminated the usefulness of the refuge canal because the canal went dry beginning in about 2000.

All the water for the remaining spring head pool at Phantom Lake Spring is being provided by a pump system to bring water from about 23 m (75 ft) within the cave out to the surface. The small outflow pool was enlarged in 2011 (U.S. Bureau of Reclamation 2011, p. 1; Service 2012, entire) to encompass about 75 sq m (800 sq ft) of wetted area. In 2011, the pool was relatively stable, and all three of the San Solomon Spring invertebrates were present (Allan 2011, p. 3; Service 2012, p. 9).

In summary, the modifications to the natural spring channels at San Solomon, Phantom Lake, and Giffin Springs represent activities that occurred in the past and resulted in a deterioration of the available habitat for the Phantom springsnail, Phantom tryonia, and diminutive amphipod. Actions by conservation agencies over the past few decades have mitigated the impacts of those actions by restoring some natural functions to the outflow channels. While additional impacts from modifications are not likely to occur in the future because of land ownership by conservation entities at three of the four spring sites, the past modifications have contributed to the vulnerability of these species by reducing the overall quantity of available habitat and, therefore, reducing the number of individuals of each species that can inhabit the spring outflows. The lower the overall number of individuals of each species and the lower the amount of available habitat, the greater the risk of extinction. Therefore, the modification of spring channels contributes to increased risk of extinction in the future as a consequence of the negative impacts of the past actions.

Other Conservation Efforts

All four of these springs in the San Solomon Spring system are inhabited by two fishes federally listed as endangered—Comanche Springs pupfish (Service 1981, pp. 1–2) and Pecos gambusia (Service 1983, p. 4). Critical habitat has not been designated for either species. In addition, East Sandia Spring is also inhabited by the federally threatened Pecos sunflower (Service 2005, p. 4) and the federally endangered Pecos assiminea snail (Service 2010, p. 5). Both the Pecos sunflower and the Pecos assiminea snail also have critical habitat designated at East Sandia Spring (73 FR 17762, April 1, 2008; 76 FR 33036, June 7, 2011, respectively).

The Phantom springsnail, Phantom tryonia, and diminutive amphipod have been afforded some protection indirectly in the past due to the presence of these other listed species in the same locations. Management and protection of the spring habitats by the Texas Parks and Wildlife Department at San Solomon Spring, U.S. Bureau of Reclamation at Phantom Lake Spring, and The Nature Conservancy at East Sandia Spring have benefited the aquatic invertebrates. However, the primary threat from the loss of habitat due to declining spring flows related to groundwater changes have not been abated by the Federal listing of the fish or other species. Therefore, the conservation efforts provided by the concomitant occurrence of species already listed under the Act have not prevented the past and ongoing habitat loss, nor is it expected to prevent future habitat loss.

Summary of Factor A

Based on our evaluation of the best available information, we conclude that habitat loss and modification of the Phantom springsnail, Phantom tryonia, and diminutive amphipod is a threat that has significant effects on the populations of these species. Some of these impacts occurred in the past from the loss of natural spring flows at several springs likely within the historic range. The impacts are occurring now and are likely to continue in the future throughout the current range as groundwater levels decline and increase the possibility of the loss of additional springs. As additional springs are lost, the number of populations will decline and further increase the risk of extinction of these species. The sources of this threat are not confirmed but are presumed to include a combination of factors associated with groundwater pumping, hydrogeologic structure of the supporting groundwater, and climatic changes. The risk of extinction is also heightened by the past alteration of spring channels reducing the available habitat and the number of individuals in each population.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (San Solomon Spring Species)

Very few people are interested in, or study, springsnails and amphipods, and those who do are sensitive to their rarity and endemism. Consequently, collection for scientific or educational purposes is very limited. We know of no commercial or recreational uses of these invertebrates. For these reasons we conclude that overutilization for commercial, recreational, scientific, or educational purposes is currently not a threat to the Phantom Lake snail, Phantom tryonia, and diminutive amphipod, and we have no indication that these factors will affect these species in the future.

C. Disease or Predation (San Solomon Spring Species)

The San Solomon Spring species are not known to be affected by any disease. These invertebrates are likely natural prey species for fishes and crayfishes that occur in their habitats. Native snails and amphipods have been found as small proportions of the diets of native fishes at San Solomon and Phantom Lake Springs (Winemiller and Anderson 1997, p. 201; Hargrave 2010, p. 10), and various species of crayfishes are known predators of snails (Hershler 1998, p. 14; Dillon 2000, pp. 293–294). Bradstreet (2011, p. 98) assumed that snails at San Solomon Spring were prey for both fishes and crayfishes and suspected that the native snails may be more susceptible than the nonnative snails because of their small body size and thinner shells. In addition, Ladd and Rogowski (2012, p. 289) suggested that the nonnative red-rim melania *(Melanoides tuberculata)* may prey upon native snail eggs of a different species. However, our knowledge of such predation is very limited, and the extent to which the predation might affect native springsnails is unknown. For more discussion about red-rim melania, see ''Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.'' We are not aware of any other information indicating that the San Solomon Spring species are affected by disease or predation factors. For these reasons we conclude that disease or predation are not threats that have a significant effect on the Phantom Lake snail, Phantom tryonia, and diminutive amphipod. We have no indication that this threat will have an increased effect on these species in the future.

D. The Inadequacy of Existing Regulatory Mechanisms (San Solomon Spring Species)

Under this factor, we examine whether existing regulatory mechanisms are inadequate to address the threats to the species discussed under Factors A and E. Section 4(b)(1)(A) of the Endangered Species Act requires the Service to take into account ''those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species. . . .'' We interpret this language to require the Service to consider relevant Federal, State, and Tribal laws or regulations that may minimize any of the threats we describe in threat analyses under the other four factors, or otherwise enhance conservation of the species. An example would be the terms and conditions attached to a grazing permit that describe how a permittee will manage livestock on a BLM allotment. They are nondiscretionary and enforceable, and are considered a regulatory mechanism under this analysis. Other examples include State governmental actions enforced under a State statute or constitution, or Federal action under statute.

Having evaluated the significance of the threat as mitigated by any such conservation efforts, we analyze under Factor D the extent to which existing regulatory mechanisms are inadequate to address the specific threats to the species. Regulatory mechanisms, if they exist, may reduce or eliminate the impacts from one or more identified threats. In this section, we review existing State and Federal regulatory mechanisms to determine whether they effectively reduce or remove threats to the three San Solomon Spring species.

Texas laws provide no specific protection for these invertebrate species, as they are not listed as threatened or endangered by the Texas Parks and Wildlife Department. However, even if they were listed by the State, those regulations (Title 31 Part 2 of Texas Administrative Code) would only prohibit the taking, possession, transportation, or sale of any animal species without the issuance of a permit. The State makes no provision for the protection of the habitat of listed species, which is the main threat to these aquatic invertebrates.

Some protection for the habitat of this species is provided with the land ownership of the springs by Federal (Phantom Lake Spring owned by the

U.S. Bureau of Reclamation) and State (San Solomon Spring owned by Texas Parks and Wildlife Department) agencies, and by The Nature Conservancy (East Sandia Spring). However, this land ownership provides some protection to the spring outflow channels only and provides no protection for maintaining groundwater levels to ensure continuous spring flows.

In the following discussion, we evaluate the existing local regulations related to groundwater management within areas that might provide indirect benefits to the species' habitats through management of groundwater levels.

Local Groundwater Regulations

One regulatory mechanism that provides some protection to the spring flows for these species comes from local groundwater conservation districts. Groundwater in Texas is generally governed by the rule of capture unless there is a groundwater district in place. The rule of capture allows a landowner to produce as much groundwater as he or she chooses, as long as the water is not wasted (Mace 2001, p. 11). However, local groundwater conservation districts have been established throughout much of Texas and are now the preferred method for groundwater management in the State (Texas Water Development Board 2012, pp. 23–258). Groundwater districts ''may regulate the location and production of wells, with certain voluntary and mandatory exemptions'' (Texas Water Development Board 2012, p. 27).

In the area west of the springs, currently four local groundwater districts could possibly manage groundwater to protect spring flows in the San Solomon Spring system (Texas Water Development Board 2011, p. 1). The Culberson County Groundwater Conservation District covers the southwestern portion of Culberson County and was confirmed (established by the Texas legislature and approved by local voters) in 1998. The Jeff Davis County Underground Water Conservation District covers all of Jeff Davis County and was confirmed in 1993. The Presidio County Underground Water Conservation District covers all of Presidio County and was confirmed in 1999. The Hudspeth County Underground Water District No. 1 covers the northwest portion of Hudspeth County and was confirmed in 1957. This area of Hudspeth County manages the Bone Spring-Victoria Peak aquifer (Hudspeth County Underground Water District No. 1 2007, p. 1), which is not known to contribute water to the regional flow that supplies the San Solomon Spring system (Ashworth 2001, pp. 143–144). Therefore, we will not further consider that groundwater district.

In 2010 the Groundwater Management Area 4 established ''desired future conditions'' for the aquifers occurring within the five-county area of west Texas (Adams 2010, entire; Texas Water Development Board 2012a, entire). These projected conditions are important because they guide the plans for water use of groundwater within groundwater conservation districts in order to attain the desired future condition of each aquifer they manage (Texas Water Development Board 2012c, p. 23). In the following discussion we review the plans and desired future conditions for the groundwater conservation districts in Culberson, Jeff Davis, and Presidio Counties relative to the potential regulation of groundwater for maintaining spring flows and abating future declines in the San Solomon Spring system.

The Culberson County Groundwater Conservation District seeks to implement water management strategies to ''prevent the extreme decline of water levels for the benefit of all water right owners, the economy, our citizens, and the environment of the territory inside the district'' (Culberson County Groundwater Conservation District 2007, p. 1). The missions of Jeff Davis County Underground Water District and Presidio County Underground Water Conservation District are to ''strive to develop, promote, and implement water conservation and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the District'' (Jeff Davis County Underground Water Conservation District 2008, p. 1; Presidio County Underground Water Conservation District 2009, p. 1). However, all three management plans specifically exclude addressing natural resources issues as a goal because, ''The District has no documented occurrences of endangered or threatened species dependent upon groundwater resources'' (Culberson County Groundwater Conservation District 2007, p. 10; Jeff Davis County Underground Water Conservation District 2008, p. 19; Presidio County Underground Water Conservation District 2009, p. 14). This lack of acknowledgement of the relationship of the groundwater resources under the Districts' management to the conservation of the spring flow habitat at the San Solomon Spring system, which occur outside the geographic boundaries of the groundwater districts, prevents any direct benefits of their management plans for the three aquatic invertebrates.

We also considered the desired future condition of the relevant aquifer that supports San Solomon Spring system flows. The Culberson County Groundwater Conservation District manages the groundwater where the bulk of groundwater pumping occurs in the Salt Basin Bolson aquifer (part of the West Texas Bolson, the presumed source of the water for the San Solomon Spring system) (Oliver 2010, p. 7). The desired future condition for aquifers within the Culberson County Groundwater Conservation District area includes a 24-m (78-ft) drawdown for the West Texas Bolsons (Salt Basin Bolson aquifer in Wild Horse Flat) over the next 50 years to accommodate an average annual groundwater pumping of 46 million cm (38,000 af) (Adams 2010, p. 2; Oliver 2010, p. 7). The desired future condition for the West Texas Bolsons for Jeff Davis County Underground Water Conservation District includes a 72-ft (22-m) drawdown over the next 50 years to accommodate an average annual groundwater pumping of 10 million cm (8,075 af) (Adams 2010, p. 2; Oliver 2010, p. 7). The desired future condition for the West Texas Bolsons for Presidio County Underground Water District also includes a 72-ft (22-m) drawdown over the next 50 years to accommodate an average annual groundwater pumping of 12 million cm (9,793 af) (Adams 2010, p. 2; Oliver 2010, p. 7). These drawdowns are based on analysis using groundwater availability models developed by the Texas Water Development Board (Beach *et al.* 2004, pp. 10-6–10-8; Oliver 2010, entire). We expect that these groundwater districts will use their district rules to regulate water withdrawals in such a way as to implement these desired future conditions.

The Salt Basin Bolson aquifer in the Wild Horse Flat area (the likely spring source) can range from 60 to 300 m (200 to 1,000 ft) thick. We are not aware of any information or studies that have accessed the impacts on spring flows associated with the drawdown from the desired future condition. However, the drawdown levels could be substantial compared to the available groundwater, which receives little natural recharge beyond regional flow. So although it is impossible to determine precisely, we anticipate the planned level of groundwater drawdown will likely result in continued future declines in spring flow rates in the San Solomon Spring system. Therefore, we expect that continued drawdown of the aquifers as identified in the desired future conditions will contribute to ongoing and future spring flow declines. Based on these desired future conditions from the groundwater conservation districts, we conclude that the regulatory mechanisms available to the groundwater districts directing future groundwater withdrawal rates from the aquifers that support spring flows in the San Solomon Spring system are inadequate to protect against ongoing and future modification of habitat for the Phantom springsnail, Phantom tryonia, and diminutive amphipod.

Summary of Factor D

Some regulatory mechanisms are in place, such as the existence of groundwater conservation districts, which address the primary threat to the Phantom springsnail, Phantom tryonia, or diminutive amphipod of habitat loss due to spring flow decline. However, we find that these mechanisms are not serving to alleviate or limit the threats to the species because it is uncertain whether the planned groundwater declines will allow for the maintenance of the spring flows that provide habitat for the species. We assume that, absent more detailed studies, the large levels of anticipated declines are likely to result in continuing declines of spring flows in the San Solomon Spring system. We, therefore, conclude that these existing regulatory mechanisms are inadequate to sufficiently reduce the identified threats associated with groundwater decline and spring flow losses that provide habitat for the Phantom springsnail, Phantom tryonia, and diminutive amphipod now and in the future.

E. Other Natural or Manmade Factors Affecting Their Continued Existence (San Solomon Spring Species)

We considered three other factors that may be affecting the continued existence of the San Solomon Spring species: Nonnative snails, other nonnative species, and the small, reduced ranges of the three San Solomon Spring species.

Nonnative Snails

Another factor that may be impacting the San Solomon Spring species is the presence of two nonnative snails that occur in a portion of their range. The red-rim melania and quilted melania both occur at San Solomon Spring, and the red-rim melania also occurs at Phantom Lake and Giffin Springs (Allan 2011, p. 1; Bradstreet 2011, pp. 4–5; Lang 2011, pp. 4–5, 11). Both species are native to Africa and Asia and have been imported into the United States as aquarium species. They are now established in various locations across the southern and western portions of the United States (Bradstreet 2011, pp. 4–5; U.S. Geological Survey 2009, p. 2; Benson 2012, p. 2).

The red-rim melania was first reported from Phantom Lake Spring during the 1990s (Fullington 1993, p. 2; McDermott 2000, pp. 14–15) and was first reported from Giffin Spring in 2001 (Lang 2011, pp. 4–5). The species has been at San Solomon Spring for some time longer (Texas Parks and Wildlife Department 1999, p. 14), but it is not found in East Sandia Spring (Lang 2011, p. 10; Allan 2011, p. 1). Bradstreet reported the red-rim melania in all of the habitats throughout San Solomon Spring at moderate densities compared to other snails, with a total population estimate of about 390,000 snails (±350,000) (Bradstreet 2011, pp. 45–55). Lang (2011, pp. 4–5) also found moderate densities of red-rim melania at Giffin Spring in both the headspring area and downstream spring run area.

The quilted melania was first reported as being at San Solomon Spring in 1999 (Texas Parks and Wildlife Department 1999, p. 14) from observations in 1995 (Bowles 2012, pers. comm.). It was later collected in 2001 (Lang 2011, p. 4), but not identified until Bradstreet (2011, p. 4) confirmed its presence there. The species is not found in any other springs in the San Solomon Spring system, but occurs in all habitats throughout San Solomon Spring at moderate densities compared to other snails, with a total population estimate of about 840,000 snails (±1,070,000) (Bradstreet 2011, pp. 45–55).

The mechanism and extent of potential effects of the two nonnative snails on the native invertebrates have not been studied directly. However, because both nonnative snails occur in relatively high abundances, to presume that they are likely competing for space and food resources in the limited habitats in which they occur is reasonable. Rader *et al.* (2003, pp. 651–655) reviewed the biology and possible impacts of red-rim melania and suggested that the species had already displaced some native springsnails in spring systems of the Bonneville Basin of Utah. Appleton *et al.* (2009, entire) reviewed the biology and possible impacts of the quilted melania and found potentially significant impacts likely to occur to the native benthic invertebrate community in aquatic systems in South Africa. Currently, East Sandia Spring has remained free of nonnative snails, but their invasion there is a continuing concern (Bradstreet 2011, p. 95). We conclude that these two snails may be having some negative effects on the Phantom springsnail, Phantom tryonia, and diminutive amphipod based on a potential for competition for spaces and food resources.

Other Nonnative Species

A potential future threat to these species comes from the possible introduction of additional nonnative species into their habitat. In general, introduced species are a serious threat to native aquatic species (Williams *et al.* 1989, p. 18; Lodge *et al.* 2000, p. 7). The threat is particularly elevated at San Solomon Spring where the public access to the habitat is prolific by the thousands of visitors to the Balmorhea State Park who swim in the spring outflow pool. Unfortunately, people will sometimes release nonnative species into natural waters, intentionally or unintentionally, without understanding the potential impacts to native species. In spite of regulations that do not permit it, visitors to the Park may release nonnative species into the outflow waters of San Solomon Spring. This is presumably how the two nonnative snails became established there. Nonnative fishes are sometimes seen and removed from the water by Park personnel (Texas Parks and Wildlife Department 1999, pp. 46–47). The Park makes some effort to minimize the risk of nonnative species introductions by prohibiting fishing (so no live bait is released) and by taking measures to educate visitors about the prohibition of releasing species into the water (Texas Parks and Wildlife Department 1999, p. 48). In spite of these efforts, the risk, which cannot be fully determined, remains that novel and destructive nonnative species could be introduced in the future. This risk is much lower at the other three springs in the San Solomon Spring system because of the lack of public access to these sites.

We conclude that the future introduction of any nonnative species represents an ongoing concern to the aquatic invertebrates, however, the immediacy of this happening is relatively low because it is only a future possibility. In addition, the severity of the impact is also relatively low because it is most likely to occur only at San Solomon Spring and the actual effects of any nonnative species on the Phantom springsnail, Phantom tryonia, and diminutive amphipod are unknown at this time.

Small, Reduced Range

One important factor that contributes to the high risk of extinction for these species is their naturally small range that has been reduced from past destruction of their habitat. While the overall extent of the geographic range of the species has not changed, the number and distribution of local populations within their range has likely been reduced when other small springs within the San Solomon Spring system (such as Saragosa, Toyah, and West Sandia Springs) ceased to flow (Brune 1981, p. 386; Karges 2003, p. 145). These species are now currently limited to four small spring outflow areas, with the populations at Phantom Lake Spring in imminent threat of loss.

The geographically small range with only four populations of these invertebrate species increases the risk of extinction from any effects associated with other threats or stochastic events. When species are limited to small, isolated habitats, they are more likely to become extinct due to a local event that negatively affects the populations (Shepard 1993, pp. 354–357; McKinney 1997, p. 497; Minckley and Unmack 2000, pp. 52–53). In addition, the species are restricted to aquatic habitats in small spring systems and have minimal mobility and no other habitats available for colonization, so it is unlikely their range will ever expand beyond the current extent. This situation makes the magnitude of impact of any possible threat very high. In other words, the resulting effects of any of the threat factors under consideration here, even if they are relatively small on a temporal or geographic scale, could result in complete extinction of the species. While the small, reduced range does not represent an independent threat to these species, it does substantially increase the risk of extinction from the effects of other threats, including those addressed in this analysis and those that could occur in the future from unknown sources.

Summary of Factor E

The potential impacts of these nonnative snails and any future introductions of other nonnative species on the Phantom springsnail, Phantom tryonia, and diminutive amphipod are largely unknown with the currently available information. But the nonnative snails are presumed to have some negative consequences to the native snails through competition for space and resources. The effects on the diminutive amphipod are even less clear, but competition could still be occurring. These nonnative snails have likely been co-occurring for at least 20 years at three of the four known locations for these species, and currently nothing will prevent the invasion of the species into East Sandia Spring. Considering the best available information, we conclude that the presence of these two nonnative snails and the potential future introductions of nonnative species currently represent a low-intensity threat to the Phantom springsnail, Phantom tryonia, and diminutive amphipod. In addition, the small, reduced ranges of these species limit the number of available populations and increase the risk of extinction from other threats. In combination with the past and future threats from habitat modification and loss, these factors contribute to the increased risk of extinction to the three native species.

Determination—San Solomon Spring Species

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the Phantom springsnail, Phantom tryonia, and diminutive amphipod. We find the species are in danger of extinction due to the current and ongoing modification and destruction of their habitat and range (Factor A) from the ongoing and future decline in spring flows, and historic modification of spring channels. The most significant factor threatening these species is a result of historic and future declines in regional groundwater levels that have caused some springs to cease flowing and threaten the remaining springs with the same fate. We did not find any threats with significant effects to the species under Factors B or C. We found that existing regulatory mechanisms are inadequate to provide protection to the species habitat from existing and future threats through groundwater management by groundwater conservation districts (Factor D). Finally, two nonnative snails occur in portions of the species' range that could be another factor negatively affecting the species (Factor E). The severity of the impact from these nonnative snails or other future introductions of nonnative species is not known, but such introductions may contribute to the risk of extinction from the threats to habitat through reducing the abundance of the three aquatic invertebrates through competition for space and resources. The small, reduced ranges (Factor E) of these species, when coupled with the presence of additional threats, also put them at a heightened risk of extinction.

The elevated risk of extinction of the Phantom springsnail, Phantom tryonia, and diminutive amphipod is a result of the cumulative nature of the stressors on the species and their habitats. For example, the past reduction in available habitat through modification of spring channels resulted in a lower number of individuals contributing to the sizes of the populations. In addition, the loss of other small springs that may have been inhabited by the species reduced the number of populations that would contribute to the species' overall viability. In this diminished state, the species are also facing future risks from the impacts of continuing declining spring flows, exacerbated by potential extended future droughts resulting from global climate change, and potential effects from nonnative species. All of these factors contribute together to heighten the risk of extinction and lead to our finding that the Phantom springsnail, Phantom tryonia, and diminutive amphipod are in danger of extinction throughout all of their ranges and warrant listing as endangered species.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the species, and have determined that the Phantom springsnail, Phantom tryonia, and diminutive amphipod all meet the definition of endangered species under the Act. They do not meet the definition of threatened species, because significant threats are occurring now and in the foreseeable future, at a high magnitude, and across the species' entire range. This makes them in danger of extinction now, so we have determined that they meet the definition of endangered species rather than threatened species. Therefore, on the basis of the best available scientific and commercial information, we are listing the Phantom springsnail, Phantom tryonia, and diminutive amphipod as endangered species in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is threatened or endangered throughout all or a significant portion of its range. The species being listed in these rules are highly restricted within their range, and the threats occur throughout their range. Therefore, we assessed the status of the species throughout their entire range. The threats to the survival of the species occur throughout the species' range and are not restricted to any particular significant portion of that range. Accordingly, our assessment and determination applies to the species throughout their entire range.

Diamond Y Spring Species—Diamond tryonia, Gonzales tryonia, and Pecos amphipod

The following five-factor analysis applies to the three species that occur in the Diamond Y Spring system in Pecos County, Texas: Diamond tryonia, Gonzales tryonia, and Pecos amphipod.

A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range (Diamond Y Spring Species)

Spring Flow Decline

The primary threat to the continued existence of the Diamond Y Spring species is the degradation and potential future loss of aquatic habitat (flowing water from the spring outlets) due to the decline of groundwater levels in the aquifers that support spring surface flows. Habitat for these species is exclusively aquatic and completely dependent upon spring outflows. Spring flows in the Diamond Y Spring system appear to have declined in flow rate over time, and as spring flows decline, available aquatic habitat is reduced and altered. When a spring ceases to flow continually, all habitats for these species are lost, and the populations will be extirpated. When all of the springs lose consistent surface flows, all natural habitats for these aquatic invertebrates will be gone, and the species will become extinct. We know springs in this area can fail due to groundwater pumping, because larger nearby springs, such as Comanche and Leon Springs have already ceased flowing and likely resulted in the extirpation of local populations of these species (assuming they were present historically). While these springs likely originate from a different aquifer source than Diamond Y Spring, the situation demonstrates the potential for spring losses in this area.

The springs do not have to cease flowing completely to have an adverse effect on invertebrate populations. The small size of the spring outflows in the Diamond Y Spring system makes them particularly susceptible to changes in water chemistry, increased water temperatures, and freezing. Because these springs are small, any reductions in the flow rates from the springs can reduce the available habitat for the species, decreasing the number of individuals and increasing the risk of extinction. Water temperatures and chemical factors such as dissolved oxygen in springs do not typically fluctuate (Hubbs 2001, p. 324); invertebrates are narrowly adapted to spring conditions and are sensitive to changes in water quality (Hershler 1998, p. 11). Spring flow declines can lead to the degradation and loss of aquatic invertebrate habitat and present a substantial threat to the species.

No one has made regular recordings of spring flow discharge at Diamond Y Spring to quantify any trends in spring flow. The total flow rates are very low, as Veni (1991, p. 86) estimated total discharge from the upper watercourse at 0.05 to .08 cms (2 to 3 cfs) and from the lower watercourse at 0.04 to 0.05 cms (1 to 2 cfs). The nature of the system with many diffuse and unconfined small springs and seeps makes the estimates of water quantity discharging from the spring system difficult to attain. Recent measurements of outflows from the Diamond Y Spring headspring between 2010 and 2013 have showed a discharge range from 0.0009 to 0.003 cms (0.03 to 0.09 cfs) (U.S. Geological Survey 2013, p. 1). Many authors (Veni 1991, p. 86; Echelle *et al.* 2001, p. 28; Karges 2003, pp. 144–145) have described the reductions in available surface waters observed compared to older descriptions of the area (Kennedy 1977, p. 93; Hubbs *et al.* 1978, p. 489; Taylor 1985, pp. 4, 15, 21). The amount of aquatic habitat may vary to some degree based on annual and seasonal conditions, but the overall declining trend in the reduction in the amount of surface water over the last several decades is apparent.

A clear example of the loss in aquatic habitat comes from Kennedy's (1977, p. 93) description of one of his study sites in 1974. Station 2 was called a ''very large pool'' near Leon Creek of about 1,500 to 2,500 sq m (16,000 to 27,000 sq ft) with shallow depths of 0.5 to 0.6 m (1.6 to 2.0 ft), with a small 2-m (6.6-ft) deep depression in the center. Today very little open water is found in this area, only marshy soils with occasional trickles of surface flow. This slow loss of aquatic habitat has occurred throughout the system over time and represents a substantial threat to the continued existence of the Diamond tryonia, Gonzales tryonia, and the Pecos amphipod.

The precise reason for the declining spring flows remains uncertain but is presumed to be related to a combination of groundwater pumping, mainly for agricultural irrigation, and a lack of natural recharge to the supporting aquifers. In addition, future changes in the regional climate are expected to exacerbate declining flows. Local conditions related to vegetation growth and limited local precipitation may also be contributing factors.

Substantial scientific uncertainty exists regarding the aquifer sources that provide the source water to the Diamond Y Springs. Initial studies of the Diamond Y Spring system suggested that the Edwards-Trinity Aquifer was the primary source of flows (Veni 1991, p. 86). However, later studies supported that the Rustler Aquifer is instead more likely the chief source of water (Boghici 1997, p. 107). However, more recent studies by the U.S. Geological Survey suggest that the Rustler Aquifer only contributes some regional flow mixing with the larger Edwards-Trinity (Plateau) Aquifer in this area through geologic faulting and artesian pressure, as the Rustler Aquifer is deeper than the Edwards-Trinity Aquifer (Bumgarner 2012, p. 46; Ozuna 2013, p. 1). In contrast, the Texas Water Development Board indicates that the strata underlying the Edwards-Trinity (Plateau) Aquifer provide most of the spring flow at Diamond Y Spring and that the artesian pressure causing the groundwater to issue at Diamond Y Spring is likely from below the Rustler Aquifer (French 2013, pp. 2–3). The Middle Pecos Groundwater Conservation District suggested that Diamond Y Spring is a mixture of discharge from the Edwards-Trinity (Plateau) Aquifer and leakage from the other Permian-age formations, including the Rustler and possibly other formations below the Edwards-Trinity (Plateau) Aquifer (Gershon 2013, p. 6). Obviously, we have substantial uncertainty as to the exact nature of the groundwater sources for Diamond Y Spring, but based on the best available information, we presume the springflows originate from some combination of the Rustler and Edwards-Trinity (Plateau) Aquifers.

The Rustler Aquifer is one of the less-studied aquifers in Texas and encompasses most of Reeves County and parts of Culberson, Pecos, Loving, and Ward Counties in the Delaware Basin of west Texas (Boghici and Van Broekhoven 2001, pp. 209–210). The Rustler strata are thought to be between 75 to 200 m (250 to 670 ft) thick (Boghici and Van Broekhoven 2001, p. 207). Very little recharge to the aquifer likely comes from precipitation in the Rustler Hills in Culberson County, but most of it may be contributed by cross-formational flows from old water from deeper aquifer formations (Boghici and Van Broekhoven 2001, pp. 218–219). Groundwater planning for the Rustler aquifer anticipates no annual recharge (Middle Pecos Groundwater Conservation District 2010b, p. 18).

Historic pumping from the Rustler aquifer in Pecos County may have contributed to declining spring flows, as withdrawals of up to 9 million cm (7,500 af) in 1958 were recorded, with estimates from 1970 to 1997 suggesting groundwater use averaged between 430,000 cm (350 af) to 2 million cm (1,550 af) per year (Boghici and Van Broekhoven 2001, p. 218). As a result, declines in water levels in Pecos County wells in the Rustler aquifer from the mid-1960s through the late 1970s of up to 30 m (100 ft) have been recorded (Boghici and Van Broekhoven 2001, p. 213). We assume that groundwater pumping has had some impacts on spring flows of the Diamond Y Spring system in the past; however, they have not yet been substantial enough to cause the main springs to cease flowing.

The Edwards-Trinity (Plateau) Aquifer underlies about 109,000 square km (42,000 square miles) of west-central Texas, extending from Travis to Brewster Counties (Baker and Ardis 1996, pp. B2–B3). The aquifer underlies much of the region around Diamond Y Spring in Pecos County and about 50 percent of the aquifer ranges from 71 to 110 m (234 to 362 ft) thick (Bumgarner *et al.* 2012, p. 47). The 2009 estimate of the annual amount of groundwater used in Pecos County for irrigation was 143 million cm (115,650 af), and the majority of the water comes from the Edwards-Trinity (Plateau) Aquifer (Middle Pecos Groundwater Conservation District 2010b, pp. 18, Appendix D).

Future groundwater withdrawals may further impact spring flow rates if they occur in areas of the Rustler or Edwards-Trinity (Plateau) Aquifers that affect the spring source areas. Groundwater pumping withdrawals in Pecos County are expected to continue in the future mainly to support irrigated agriculture (Region F Water Planning Group 2011, pp. 2–16—2–19) and will result in continued lowering of the groundwater levels in the aquifers. The latest plans from Groundwater Management Area 3 (the planning group covering the relevant portion of the Rustler Aquifer) allows for a groundwater withdrawal in the Rustler Aquifer not to exceed 90 m (300 ft) in the year 2060 (Middle Pecos Groundwater Conservation District 2010b, pp. 15–16). This level of drawdown will accommodate 12.9 million cm (10,508 af) of annual withdrawals by pumping (Middle Pecos Groundwater Conservation District 2010b, p. 15). This level of pumping would be 30 times more than the long-term average and could result in an extensive reduction in the available groundwater in the aquifer based on the total thickness of the Rustler strata. The latest plans from Groundwater Management Area 7 (the planning group covering the relevant portion of the Edwards-Trinity (Plateau) Aquifer) allows for a groundwater withdrawal in the Edwards-Trinity (Plateau) Aquifer not to exceed 3.6 m (12 ft) in the year 2060 (Middle Pecos Groundwater Conservation District 2010b, p. 10). This level of drawdown will accommodate 294 million cm (238,000 af) of annual withdrawals by pumping, including withdrawals from both the Edwards-Trinity (Plateau) and Pecos Valley Aquifers (Middle Pecos Groundwater Conservation District 2010b, p. 11). This level of pumping would be about twice more than the long-term average withdrawals. Therefore, based on these expected increasing levels of groundwater drawdown, we anticipate continued declines in spring flow rates in the Diamond Y Spring system.

In addition to pumping within the groundwater district, surrounding counties that do not have a groundwater district conduct groundwater withdrawals from the Edwards-Trinity (Plateau) Aquifer). This unregulated pumping could also contribute to aquifer level declines and impact spring flow rates.

The exact relationship between aquifer levels and spring flow rates has not been quantified and represents an area of substantial uncertainty. However, we think that the anticipated increase in groundwater withdrawals, if occurring in an area contributing water to the Diamond Y Spring system, would have a negative impact on habitat availability for these species and significantly increase their risk of extinction.

Another factor possibly contributing to declining spring flows is climatic changes that may increase the frequency and duration of local and regional drought. The term ‘‘climate’’ refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ‘‘climate change’’ thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Although the bulk of spring flows probably originates from water sources with limited recent recharge, any decreases in regional precipitation patterns due to prolonged drought will further stress groundwater availability and increase the risk of diminishment or drying of the springs. Drought affects both surface and groundwater resources and can lead to diminished water quality (Woodhouse and Overpeck 1998, p. 2693; MacRae *et al.* 2001, pp. 4, 10) in addition to reducing groundwater quantities. Lack of rainfall may also indirectly affect aquifer levels by resulting in an increase in groundwater pumping to offset water shortages from low precipitation (Mace and Wade 2008, p. 665).

Recent drought conditions may be indicative of more common future conditions. The current, multiyear drought in the western United States, including the Southwest, is the most severe drought recorded since 1900 (Overpeck and Udall 2010, p. 1642). In 2011, Texas experienced the worst annual drought since recordkeeping began in 1895 (NOAA 2012, p. 4), and only 1 other year since 1550 (the year 1789) was as dry as 2011 based on tree-ring climate reconstruction (NOAA 2011, pp. 20–22). In addition, numerous climate change models predict an overall decrease in annual precipitation in the southwestern United States and northern Mexico.

Future global climate change may result in increased severity of droughts and further contribute to impacts on the aquatic habitat from reduction of spring flows. Many semiarid areas like the western United States are likely to suffer a decrease in water resources due to ongoing climate change (IPCC 2007b, p. 7; Karl *et al.* 2009, pp. 129–131), as a result of less annual mean precipitation. Milly *et al.* (2005, p. 347) also project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Even under lower greenhouse gas emission scenarios, recent projections forecast a 10 percent decline in precipitation in western Texas by 2080 to 2099 (Karl *et al.* 2009, pp. 129–130). Assessments of climate change in west Texas suggest that the area is likely to become warmer and at least slightly drier (Texas Water Development Board 2008, pp. 22–25).

The potential effects of future climate change could reduce overall water availability in this region of western Texas and compound the stressors associated with declining flows from the Diamond Y Spring system. As a result of the effects of increased drought, spring flows could decline indirectly as a result of increased pumping of groundwater to accommodate human needs for additional water supplies (Mace and Wade 2008, p. 664; Texas

Water Development Board 2012c, p. 231).

In conclusion, the Diamond tryonia, Gonzales tryonia, and Pecos amphipod are vulnerable to the effects of habitat loss because of the past and expected future declining spring flows. Some nearby springs have already gone dry. While the sources of the stress of declining spring flows are not known for certain, the best available scientific information would indicate that it is the result of a combination of factors including past and current groundwater pumping and climatic changes (decreased precipitation and recharge). The threat of habitat loss from declining spring flows affects the entire range of the three species, as all are at risk of future loss due to declining spring flows. All indications are that the source of this threat will persist into the future and will result in continued degradation of the species' habitats, placing the species at a high risk of extinction.

Water Quality Changes and Contamination

Another potential factor that could impact habitat of the Diamond Y Spring species is the potential degradation of water quality from point pollutant sources. This pollution can occur either directly into surface water or indirectly through contamination of groundwater that discharges into spring run habitats used by the species. The primary threat for contamination in these springs comes from activities related to oil and gas exploration, extraction, transportation, and processing.

Oil and gas activities are a source of significant threat to the Diamond Y Spring species because of the potential groundwater or surface water contamination from pollutants (Veni 1991, p. 83; Fullington 1991, p. 6). The Diamond Y Spring system is within an active oil and gas extraction field that has been operational for many decades. In 1990, within the Diamond Y Preserve were 45 active and plugged wells, and an estimated 800 to 1,000 wells perforated the aquifers within the springs' drainage basins (Veni 1991, p. 83). At this time many active wells are still located within about 100 m (about 300 ft) of surface waters. In addition, a natural gas processing plant, known as the Gomez Plant, is located within 0.8 km (0.5 mi) upslope of Diamond Y Spring. Oil and gas pipelines cross the habitat, and many oil extraction wells are located near the occupied habitat. Oil and gas drilling also occurs throughout the area of supporting groundwater providing another potential source of contamination through the groundwater supply. The Gomez Plant, which collects and processes natural gas, is located about 350 m (1,100 feet) up gradient from the head pool of Diamond Y Spring (Hoover 2013, p. 1). Taylor (1985, p. 15) suggested that an unidentified groundwater pollutant may have been responsible for reductions in abundance of Diamond tryonia in the headspring and outflow of Diamond Y Spring, although no follow-up studies were ever done to investigate the presumption. The potential for an event catastrophic to the Diamond Y Spring species from a contaminant spill or leak is possible at any time (Veni 1991, p. 83).

As an example of the possibility for spills, in 1992 approximately 10,600 barrels of crude oil were released from a 15-cm (6-in) pipeline that traverses Leon Creek above its confluence with Diamond Y Draw. The oil was from a pipeline, which ruptured at a point several hundred feet away from the Leon Creek channel. The spill site itself is about 1.6 km (1 mi) overland from Diamond Y Spring. The pipeline was operated at the time of the spill by the Texas-New Mexico Pipeline Company, but ownership has since been transferred to several other companies. The Texas Railroad Commission has been responsible for overseeing cleanup of the spill site. Remediation of the site initially involved aboveground land farming of contaminated soil and rock strata to allow microbial degradation. In later years, remediation efforts focused on vacuuming oil residues from the surface of groundwater exposed by trenches dug at the spill site. No impacts on the rare fauna of Diamond Y Springs have been observed, but no specific monitoring of the effects of the spill was undertaken (Industrial Economics, Inc. 2005, pp. 4–12).

If a contaminant were to leak into the habitat of the species from any of the various sources, the effects of the contamination could result in death to exposed individuals, reductions in food availability, or other ecological impacts (such as long-term alteration to water or soil chemistry and the microorganisms that serve as the base of food web in the aquatic ecosystem). The effects of a surface spill or leak might be contained to a local area and only affect a portion of the populations; however, an event that contaminated the groundwater could impact both the upper and lower watercourses and eliminate the entire range of all three species. No regular monitoring of the water quality for these species or their habitats currently occurs, so it is unlikely that the effects would be detected quickly to allow for a timely response.

These invertebrates are sensitive to water contamination. Springsnails as a group are considered sensitive to water quality changes, and each species is usually found within relatively narrow habitat parameters (Sada 2008, p. 59). Taylor (1985, p. 15) suggested that an unidentified groundwater pollutant may have been responsible for reductions in abundance of Diamond tryonia in the headspring and outflow of Diamond Y Spring, although no follow-up studies were ever conducted to investigate the presumption. Additionally, amphipods generally do not tolerate habitat desiccation (drying), standing water, sedimentation, or other adverse environmental conditions; they are considered very sensitive to habitat degradation (Covich and Thorpe 1991, pp. 676–677).

Several conservation measures have been implemented in the past to reduce the potential for a contamination event. In the 1970s the U.S. Department of Agriculture, Natural Resources Conservation Service (then the Soil Conservation Service) built a small berm encompassing the south side of Diamond Y Spring to prevent a surface spill from the Gomez Plant from reaching the spring head. After The Nature Conservancy purchased the Diamond Y Springs Preserve in 1990, oil and gas companies undertook a number of conservation measures to minimize the potential for contamination of the aquatic habitats. These measures included decommissioning buried corrodible metal pipelines and replacing them with synthetic surface lines, installing emergency shut-off valves, building berms around oil pad sites, and removing abandoned oil pad sites and their access roads that had been impeding surface water flow (Karges 2003, p. 144).

Presently, we have no evidence of habitat destruction or modification due to groundwater or surface water contamination from leaks or spills, and no major spills affecting the habitat have been reported in the past (Veni 1991, p. 83). However, the potential for future adverse effects from a catastrophic event is an ongoing threat of high severity of potential impact but not immediate.

Modification of Spring Channels

The spring outflow channels in the Diamond Y Spring system have remained mostly intact. The main subtle changes in the past were a result of some cattle grazing before The Nature Conservancy discontinued livestock use in 2000, and roads and well pads that were constructed in the spring outflow areas. Most of these structures were removed by the oil and gas industry following The Nature Conservancy assuming ownership in 1990. Several caliche (hard calcium carbonate material) roads still cross the spring outflows with small culverts used to pass the restricted flows.

A recent concern has been raised regarding the encroachment of bulrush into the spring channels. Bulrush is an emergent plant that grows in dense stands along the margins of spring channels. (An emergent plant is one rooted in shallow water and having most of its vegetative growth above the water.) When flow levels decline, reducing water depths and velocities, bulrush can become very dense and dominate the wetted channel. In 1998, bulrush made up 39 percent (± 33 percent) of the plant species in the wetted marsh areas of the Diamond Y Draw (Van Auken *et al.* 2007, p. 54). Observations by Itzkowitz (2008, p. 5; 2010, pp. 13–14) found that bulrush were increasing in density at several locations within the upper and lower watercourses in Diamond Y Draw resulting in the loss of open water habitats. Itzkowitz (2010, pp. 13–14) also noted a positive response by bulrush following a controlled fire for grassland management.

In addition to water level declines, the bulrush encroachment may have been aided by a small flume that was installed in 2000 about 100 m (300 ft) downstream of the springhead pool at Diamond Y Spring (Service 1999, p. 2). The purpose of the flume was to facilitate spring flow monitoring, but the instrumentation was not maintained. The flume remains in place and is now being used for flow measurements by the U.S. Geological Survey. The installation of the flume may have slightly impounded the water upstream creating shallow, slow overflow areas along the bank promoting bulrush growth. This potential effect of the action was not foreseen (Service 1999, p. 3). Whether or not the flume was the cause, the area upstream of it is now overgrown with bulrush, and the two snails have not been found in this section for some time.

Dense bulrush stands may alter habitat for the invertebrates in several ways. Bulrush grows to a height of about 0.7 m (2 ft) tall in very dense stands. Dense bulrush thickets will result in increased shading of the water surface, which is likely to reduce the algae and other food sources for the invertebrates. In addition, the stems will slow the water velocity, and the root masses will collect sediments and alter the substrates in the stream. These small changes in habitat conditions may result in proportionally large areas of the spring outflow channels being unsuitable for use by the invertebrates, particularly the springsnails. Supporting this idea is the reported distributions of the snails found in highest abundance in areas with more open flowing water not dominated by bulrush (Allan 2011, p. 2). The impacts of dense bulrush stands as a result of declining spring flow rates may be negatively affecting the distribution and abundance of the invertebrates within the Diamond Y Spring system.

Another recent impact to spring channels comes from disturbance by feral hogs *(Sus scrofa).* These species have been released or escaped from domestic livestock and have become free-ranging over time (Mapston 2005, p. 6). They have been in Texas for about 300 years and occur throughout the State. The area around Diamond Y Spring has not previously been reported as within their distribution (Mapston 2005, p. 5), but they have now been confirmed there (Allan 2011, p. 2). The feral hogs prefer wet and marshy areas and damage spring channels by creating wallows, muddy depressions they use to keep cool and coat themselves with mud (Mapston 2005, p. 15). In 2011, wallows were observed in spring channels formerly inhabited by the invertebrates in both the upper and lower watercourses at the Diamond Y Preserve (Allan 2011, p. 2). The alterations in the spring channels caused by the wallows make the affected area uninhabitable by the invertebrates. The effects of feral hog wallows are limited to small areas but act as another stressor on the very limited habitat of these three Diamond Y Spring species.

Some protection for the spring channel habitats for the Diamond Y Spring species is provided with the ownership and management of the Diamond Y Spring Preserve by The Nature Conservancy (Karges 2003, pp. 143–144). Their land stewardship efforts ensure that intentional or direct impacts to the spring channel habitats will not occur. However, land ownership by The Nature Conservancy provides limited ability to prevent changes such as increases in bulrush or to control feral hogs. Moreover, the Nature Conservancy can provide little protection from the main threats to this species—the loss of necessary groundwater levels to ensure adequate spring flows or contamination of groundwater from oil and gas activities (Taylor 1985, p. 21; Karges 2003, pp. 144–145).

In summary, the modifications to the natural spring channels at the Diamond Y Spring system represent activities that are occurring now and will likely continue in the future through the continued encroachment of bulrush as spring flows continue to decline and through the effects of feral hog wallows. Conservation actions over the past two decades have removed and minimized some past impacts to spring channels by removing livestock and rehabilitating former oil pads and access roads. While additional direct modifications are not likely to occur in the future because of land ownership by The Nature Conservancy, future modifications from bulrush encroachment and feral hog wallows contribute to the suite of threats to the species' habitat by reducing the overall quantity of available habitat and, therefore, reducing the number of individuals of each species that can inhabit the springs. The lower the overall number of individuals of each species and the less available habitat, the greater the risk of extinction. Therefore, the modification of spring channels contributes to increased risk of extinction in the future as a consequence of ongoing and future impacts.

Other Conservation Efforts

The Diamond Y Spring system is inhabited by two fishes federally listed as endangered—Leon Springs pupfish (Service 1985, pp. 3) and Pecos gambusia (Service 1983, p. 4). In addition, the area is also inhabited by the federally threatened Pecos sunflower (Service 2005, p. 4) and the federally endangered Pecos assiminea snail (Service 2010, p. 5). Critical habitat has not been designated for Pecos gambusia. The outflow areas from Diamond Y Spring have been designated as critical habitat for Leon Springs pupfish, Pecos sunflower, and Pecos assiminea snail (45 FR 54678, August 15, 1980; 73 FR 17762, April 1, 2008; 76 FR 33036, June 7, 2011, respectively).

The three Diamond Y Spring species have been afforded some protection indirectly in the past due to the presence of these other listed species in the same locations. Management and protection of the spring habitats by the Texas Parks and Wildlife Department, The Nature Conservancy, and the Service has benefited the aquatic invertebrates (Karges 2007, pp. 19–20). However, the primary threat from the loss of habitat due to declining spring flows related to groundwater changes have not been abated by the Federal listing of the fish or other species. Therefore, the conservation efforts provided by the concomitant occurrence of species already listed under the Act have not prevented past and current habitat loss, nor are they expected to do so in the future.

Summary of Factor A

Based on our evaluation of the best available information, we conclude that habitat loss and modification for the Diamond tryonia, Gonzales tryonia, and Pecos amphipod is a threat that has significant effects on individuals and populations of these species. These impacts in the past have come from the loss of natural spring flows at several springs likely within the historic range, and the future threat of the loss of additional springs as groundwater levels are likely to decline in the future. As springs decline throughout the small range of these species, the number of individuals and populations will decline and continue to increase the risk of extinction of these species. The sources of this threat are not confirmed but are presumed to include a combination of factors associated with groundwater pumping and climatic changes. The potential for a spill of contaminants from oil and gas operations presents a constant future threat to the quality of the aquatic habitat. Finally, the risk of extinction is heightened by the ongoing and future modification of spring channels, which reduces the number of individuals in each population, from the encroachment of bulrush and the presence of feral hogs.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (Diamond Y Spring Species)

Very few people are interested in or study springsnails and amphipods, and those who do are sensitive to their rarity and endemism. Consequently, collection for scientific or educational purposes is very limited. We know of no commercial or recreational uses of these invertebrates. For these reasons we conclude that overutilization for commercial, recreational, scientific, or educational purposes are not a threat to the Diamond tryonia, Gonzales tryonia, and Pecos amphipod, and we have no indication that these factors will affect these species in the future.

C. Disease or Predation (Diamond Y Spring Species)

The Diamond Y Spring species are not known to be affected by any disease. These invertebrates are likely natural prey species for fishes that occur in their habitats. We know of no nonnative predatory fishes within their spring habitats, but there are crayfish, which are known predators of snails (Hershler 1998, p. 14; Dillon 2000, pp. 293–294). Ladd and Rogowski (2012, p. 289) suggested that the nonnative red-rim melania may prey upon different species of native snail eggs. However, the evidence of such predation is very limited, and the extent to which the predation might affect native snails is unknown. For more discussion about red-rim melania, see ‘‘Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence (Diamond Y Spring Species).’’ We are not aware of any other information indicating that the Diamond Y Spring species are affected by disease or predation. For these reasons we conclude that neither disease nor predation are threats to the Diamond tryonia, Gonzales tryonia, and Pecos amphipod, and we have no indication that these factors will affect these species in the future.

D. The Inadequacy of Existing Regulatory Mechanisms (Diamond Y Spring Species)

Under this factor, we examine whether existing regulatory mechanisms are inadequate to address the threats to the species discussed under the other four factors. Section 4(b)(1)(A) of the Endangered Species Act requires the Service to take into account ‘‘those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species . . . .’’ We interpret this language to require the Service to consider relevant Federal, State, and Tribal laws and regulations that may minimize any of the threats we describe in threat analyses under the other four factors, or otherwise enhance conservation of the species. An example would be the terms and conditions attached to a grazing permit that describe how a permittee will manage livestock on a BLM allotment. They are nondiscretionary and enforceable, and are considered a regulatory mechanism under this analysis. Other examples include State governmental actions enforced under a State statute or constitution, or Federal action under statute.

Having evaluated the significance of the threat as mitigated by any such conservation efforts, we analyze under Factor D the extent to which existing regulatory mechanisms are inadequate to address the specific threats to the species. Regulatory mechanisms, if they exist, may reduce or eliminate the impacts from one or more identified threats. In this section, we review existing State and Federal regulatory mechanisms to determine whether they effectively reduce or remove threats to the three San Solomon Spring species.

Texas laws provide no specific protection for these invertebrate species, as they are not listed as threatened or endangered by the Texas Parks and Wildlife Department. However, even if they were listed by the State, those regulations (Title 31 Part 2 of Texas Administrative Code) would only prohibit the taking, possession, transportation, or sale of any animal species without the issuance of a permit. The State makes no provision for the protection of the habitat of listed species, which is the main threat to these aquatic invertebrates.

Some protection for the habitat of this species is provided with the land ownership of the springs by The Nature Conservancy. However, this land ownership provides some protection to the spring outflow channels only and provides no protection for maintaining groundwater levels to ensure continuous spring flows.

In the following discussion we evaluate the local regulations related to groundwater management within areas that might provide indirect benefits to the species' habitats through management of groundwater withdrawals, and Texas regulations for oil and gas activities.

Local Groundwater Regulations

One regulatory mechanism that could provide some protection to the spring flows for these species comes from local groundwater conservation districts. Groundwater in Texas is generally governed by the rule of capture unless a groundwater district is in place. The rule of capture allows a landowner to produce as much groundwater as he or she chooses, as long as the water is not wasted (Mace 2001, p. 11). However, local groundwater conservation districts have been established throughout much of Texas and are now the preferred method for groundwater management in the State (Texas Water Development Board 2012, pp. 23–258). Groundwater districts ‘‘may regulate the location and production of wells, with certain voluntary and mandatory exemptions’’ (Texas Water Development Board 2012, p. 27).

Currently one local groundwater district in the area could likely manage groundwater to protect spring flows in the Diamond Y Spring system (Texas Water Development Board 2011, p. 1). The Middle Pecos Groundwater Conservation District covers all of Pecos County and was confirmed as a district in 2002. The Middle Pecos County Groundwater Conservation District seeks to implement water management strategies to ‘‘help maintain a sustainable, adequate, reliable, cost effective and high quality source of groundwater to promote the vitality, economy and environment of the District'' (Middle Pecos Groundwater Conservation District 2010b, p. 1). However, the management plan does not provide specific objectives to maintain spring flow at Diamond Y Spring. This lack of acknowledgement of the relationship between the groundwater resources under the Districts' management to the conservation of the spring flow habitat at the Diamond Y Spring system limits any direct benefits of the management plan for the three aquatic invertebrates.

In 2010 the Groundwater Management Area 3 established ''desired future conditions'' for the aquifers occurring within a six-county area of west Texas (Texas Water Development Board 2012b, entire). These projected conditions are important because they guide the plans for water use of groundwater within groundwater conservation districts in order to attain the desired future condition of each aquifer they manage (Texas Water Development Board 2012c, p. 23). The latest plans from Groundwater Management Area 3—the planning group covering the relevant portion of the Edwards-Trinity (Plateau) and Rustler Aquifers that may be related to the source aquifers of Diamond Y Spring—identify the desired future condition of aquifer drawdown compared to 2010 levels in the next 50 years (2060) for each aquifer and county. The desired future condition for the Rustler Aquifer was not to exceed a 90-m (300-ft) drawdown (Middle Pecos Groundwater Conservation District 2010a, p. 24). The Rustler strata are thought to be between only about 75 and 200 m (250 and 670 ft) thick. This level of drawdown will accommodate 12.9 million cm (10,508 af) of annual withdrawals by pumping (Middle Pecos Groundwater Conservation District 2010b, p. 15; Williams 2010, pp. 3–5). For the Edwards-Trinity (Plateau) Aquifer, the desired future condition is for an average drawdown in 50 years of about 9 m (28 ft) (Middle Pecos Groundwater Conservation District 2010a, p. 20). We expect that the groundwater district will use their district rules to regulate water withdrawals in such a way as to implement these desired future conditions.

Researchers have large uncertainty related to determining source aquifers of Diamond Y Spring; therefore, determining what effects management of these aquifers will have on spring flows is difficult. Without better understanding of the interrelationships of the aquifers and the spring flows, we cannot confidently predict whether or not the existing groundwater management for the desired future conditions will provide the necessary flows to maintain the species' habitat. In addition, the Edwards-Trinity (Plateau) Aquifer is larger in geographic extent than the Rustler Aquifer and extends beyond the boundaries of the Middle Pecos Groundwater Conservation District into counties without a groundwater district. Unmanaged groundwater withdrawals in those areas, outside of the management of a groundwater conservation district, could also affect spring flows at Diamond Y Spring. For these reasons, we find that the regulatory mechanisms directing future groundwater withdrawal rates from the nearby aquifers that may support spring flows in the Diamond Y Spring system are inadequate to protect against ongoing and future modification of habitat for the Diamond tryonia, Gonzales tryonia, and Pecos amphipod.

Texas Regulations for Oil and Gas Activities

The Railroad Commission of Texas has regulations that oversee many activities by the oil and gas industries to minimize the opportunity for the release of contaminants into the surface water or groundwater in Texas (Texas Administrative Code, Title 16. Economic Regulation, Part 1). While the regulations in place may be effective at reducing the risk of contaminant releases, they cannot remove the threat of a catastrophic event that could lead to the extinction of the aquatic invertebrates. With only one known location of these species, any possible negative impact heightens their risk of extinction. Therefore, because of the inherent risk associated with oil and gas activities in proximity to the habitats of the three Diamond Y Spring species, and the severe consequences to the species of any contamination, Texas regulations for oil and gas activities cannot remove or alleviate the threats associated with water contamination from an oil or gas spill.

Summary of Factor D

Some regulatory mechanisms are in place, such as the existence of groundwater conservation districts that address the primary threat to the Diamond tryonia, Gonzales tryonia, or Pecos amphipod of habitat loss due to spring flow decline. However, we find that these mechanisms are not serving to alleviate or limit the threats to the species for three reasons. First, the lack of conclusive science on the groundwater systems and sources of spring flow for Diamond Y means that we cannot be sure which aquifers are the most important to protect. Until we can reliably determine the sources of spring flows, we cannot know if existing regulations are adequate to ensure long-term spring flows. Second, and similarly, due to the lack of understanding about the relationships between aquifer levels and spring flows, we cannot know if the current or future desired future conditions adopted by the groundwater management areas are sufficient to provide for the species' habitats. To our knowledge, none of the desired future conditions, which include large reductions in aquifer levels in 50 years, have been used to predict future spring flows at Diamond Y Spring. Finally, other sources of groundwater declines outside of the control of the current groundwater conservation districts could lead to further loss of spring flows. These sources include groundwater pumping not regulated by a local groundwater conservation district or climatic changes that alter recharge or underground flow paths between aquifers. Therefore, although important regulatory mechanisms are in place, such as the existence of groundwater conservation districts striving to meet desired future conditions for aquifers, we find that the mechanisms may not be able to sufficiently reduce the identified threats related to future habitat loss.

Although regulatory mechanisms overseeing oil and gas operations are in place, even a small risk of a contaminant spill presents a high risk of resulting extinction of these species because of their extremely limited range. We, therefore, conclude that these existing regulatory mechanisms are inadequate to sufficiently reduce the identified threats to the Phantom springsnail, Phantom tryonia, and diminutive amphipod now and in the future.

E. Other Natural or Manmade Factors Affecting Their Continued Existence (Diamond Y Spring Species)

We considered four other factors that may be affecting the continued existence of the Diamond Y Spring species: nonnative fish management, a nonnative snail, other nonnative species, and the small, reduced ranges of the three Diamond Y Spring species.

Nonnative Fish Management

Another source of potential impacts to these species comes from the indirect effect of management to control nonnative fishes in Diamond Y Spring. One of the major threats to the endangered Leon Springs pupfish, which is also endemic to the Diamond

Y Spring system, is hybridization with the introduced, nonnative sheepshead minnow *(Cyprinodon variegatus).* On two separate occasions efforts to eradicate the sheepshead minnow have incorporated the use of fish toxicants in the upper watercourse to kill and remove all the fish and restock with pure Leon Springs pupfish. The first time was in the 1970s when the chemical rotenone was used (Hubbs *et al.* 1978, pp. 489–490) with no documented conservation efforts or monitoring for the invertebrate community.

A second restoration effort was made in 1998 when the fish toxicant Antimycin A was used (Echelle *et al.* 2001, pp. 9–10) in the upper watercourse. In that effort, actions were taken to preserve some invertebrates (holding them in tanks) during the treatment, and an intense monitoring effort was conducted to measure the distribution and abundance of the invertebrates immediately before and for 1 year after the chemical treatment (Echelle *et al.* 2001, p. 14). The results suggested that the Antimycin A had an immediate and dramatic negative effect on Pecos amphipods; however, their abundance returned to pretreatment levels within 7 months (Echelle *et al.* 2001, p. 23). Gonzales tryonia also showed a decline in abundance that persisted during the 1 year of monitoring following the treatment at both treated and untreated sites (Echelle *et al.* 2001, pp. 23, 51).

No information is available on the impacts of the initial rotenone treatment, but we suspect that, like the later Antimycin A treatment, at least short-term effects resulted on the individuals of the Diamond Y Spring species. Both of these chemicals kill fish and other gill-breathing animals (like the three invertebrates) by inhibiting their use of oxygen at the cellular level (U.S. Army Corps of Engineers 2009, p. 2). Both chemicals are active for only a short time, degrade quickly in the environment, and are not toxic beyond the initial application. The long-term effects of these impacts are uncertain, but the available information indicates that the Gonzales tryonia may have responded negatively over at least 1 year. This action was limited to the upper watercourse populations, and the effects were likely short term in nature.

The use of fish toxicants represents past stressors that are no longer directly affecting the species but may have some lasting consequences to the distribution and abundance of the snails. Currently the Gonzales tryonia occurs in this area of the upper watercourse in a very narrow stretch of the outflow channel from Diamond Y Spring, and the Diamond tryonia may no longer occur in this stretch. Whether or not the application of the fish toxicants influenced these changes in distribution and the current status of the Gonzales tryonia is unknown. However, these actions could have contributed to the current absence of the Diamond tryonia from this reach and the restricted distribution of the Gonzales tryonia that now occurs in this reach. These actions only occurred in the past, and we do not anticipate them occurring again in the future. If the sheepshead minnow were to invade this habitat again, we do not expect that chemical treatment would be used due to a heightened concern about conservation of the invertebrates. Therefore, we consider this threat relatively insignificant because it was not severe in its impact on the species, and it is not likely to occur again in the future.

Nonnative Snail

Another factor that may be impacting the Diamond Y Spring species is the presence of the nonnative red-rim melania, an invertebrate species native to Africa and Asia that has been imported as an aquarium species and is now established in various locations across the southern and western portions of the United States (Benson 2012, p. 2).

The red-rim melania became established in Diamond Y Spring in the mid-1990s (Echelle *et al.* 2001, p. 15; McDermott 2000, p. 15). The exotic snail is now the most abundant snail in the Diamond Y Spring system (Ladd 2010, p. 18). It occurs only in the first 270 m (890 ft) of the upper watercourse of the Diamond Y Spring system, and it has not been detected in the lower watercourse (Echelle *et al.* 2001, p. 26; Ladd 2010, p. 22).

The mechanism and extent of potential effects of this nonnative snail on the native invertebrates have not been studied directly. However, because the snail occurs in relatively high abundances, to presume that it is likely competing for space and food resources in the limited habitats within which they occur is reasonable. Rader *et al.* (2003, pp. 651–655) reviewed the biology and possible impacts of red-rim melania and suggested that the species had already displaced some native springsnails in spring systems of the Bonneville Basin of Utah. In the upper watercourse where the red-rim melania occurs, only the Gonzales tryonia occurs there now in very low abundance in the area of overlap, and the Diamond tryonia does not occur in this reach any longer (Ladd 2010, p. 19).

The potential impacts of the red-rim melania on the three aquatic invertebrate species in the Diamond Y Spring system are largely unknown with the currently available information, but the nonnative snail is presumed to have some negative consequences to the native snails through competition for space and resources. The effects on the Pecos amphipod is even less clear, but competition could still be occurring. The red-rim melania has been present in the upper watercourse since the mid-1990s, and nothing currently would prevent the invasion of the species into Euphrasia Spring in the lower watercourse by an incidental human introduction or downstream transport during a flood. Considering the best available information, we conclude that the presence of this nonnative snail represents a moderate threat to the Diamond tryonia, Gonzales tryonia, and Pecos amphipod.

Other Nonnative Species

A potential future threat to these species comes from the possible introduction of additional nonnative species into their habitat. In general, introduced species are a serious threat to native aquatic species (Williams *et al.* 1989, p. 18; Lodge *et al.* 2000, p. 7). The threat is moderated by the limited public access to the habitat on The Nature Conservancy's preserve. Unfortunately, the limited access did not prevent the introduction of the nonnative sheepshead minnow on two separate occasions (Echelle *et al.* 2001, p. 4). In addition, invertebrates could be inadvertently moved by biologists conducting studies in multiple spring sites (Echelle *et al.* 2001, p. 26).

While the introduction of any future nonnative species could represent a threat to the aquatic invertebrates, the likelihood of this happening is relatively low because it is only a future possibility. In addition the extent of the impacts of any future nonnative species on the Diamond tryonia, Gonzales tryonia, and Pecos amphipod are unknown at this time.

Small, Reduced Range

One important factor that contributes to the high risk of extinction for these species is their naturally small range that has likely been reduced from past destruction of their habitat. The overall geographic range of the species may have been reduced from the loss of Comanche Springs (where the snails once occurred and likely the Pecos amphipod did as well) and from Leon Springs (if they historically occurred there). And within the Diamond Y Spring system, their distribution has been reduced as flows from small springs and seeps have declined and reduced the amount of wetted areas in the spring outflow. These species are now currently limited to two small spring outflow areas.

The geographically small range and only two proximate populations of these invertebrate species increases the risk of extinction from any effects associated with other threats or stochastic events. When species are limited to small, isolated habitats, they are more likely to become extinct due to a local event that negatively affects the populations (Shepard 1993, pp. 354–357; McKinney 1997, p. 497; Minckley and Unmack 2000, pp. 52–53). In addition, the species are restricted to aquatic habitats in small spring systems and have minimal mobility and no other habitats available for colonization, so it is unlikely their range will ever expand beyond the current extent. This situation makes the severity of impact of any possible separate threat very high. In other words, the resulting effects of any of the threat factors under consideration here, even if they are relatively small on a temporal or geographic scale, could result in complete extinction of the species. While the small, reduced range does not represent an independent threat to these species, it does substantially increase the risk of extinction from the effects of other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Summary of Factor E

We considered four additional stressors as other natural or manmade factors that may be affecting these species. The effects from management actions to control nonnative fish species are considered low because they occurred in the past, with limited impact, and we do not expect them to occur in the future. The potential impacts of the nonnative snail red-rim melania and any future introductions of other nonnative species on the Phantom springsnail, Phantom tryonia, and diminutive amphipod are largely unknown with the current available information. But the nonnative snail is presumed to have some negative consequences to the native snails through competition for space and resources. The effects on the Pecos amphipod are even less clear, but competition could still be occurring. These nonnative snails have likely been co-occurring for up to 20 years at one of the two known locations for these species, and nothing is currently preventing the invasion of the species into Euphrasia Spring by an incidental human introduction or downstream transport during a flood. Considering the best available information, we conclude that the presence of the nonnative snail and the potential future introductions of nonnative species is a threat with a low-magnitude impact on the populations of the Diamond tryonia, Gonzales tryonia, and Pecos amphipod. In addition, the effects of the small, reduced ranges of these species limits the number of available populations and increases the risk of extinction from other threats. In combination with the past and future threats from habitat modification and loss, these factors contribute to the increased risk of extinction to the three native species.

Determination—Diamond Y Spring Species

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the Diamond tryonia, Gonzales tryonia, and Pecos amphipod. We find the species are in danger of extinction due to the current and ongoing modification and destruction of their habitat and range (Factor A) from the ongoing and future decline in spring flows, ongoing and future modification of spring channels, and threats of future water contamination from oil and gas activities. The most significant factor threatening these species is a result of historic and future declines in regional groundwater levels that have caused the spring system to have reduced surface aquatic habitat and threaten the remaining habitat with the same fate. We did not find any significant threats to the species under Factors B or C. We found that existing regulatory mechanisms that could provide protection to the species through groundwater management by groundwater conservation districts and Texas regulations of the oil and gas activities (Factor D) are inadequate to protect the species from existing and future threats. Finally, the past management actions for nonnative fishes, the persistence of the nonnative red-rim melania, and the future introductions of other nonnative species are other factors that have or could negatively affect the species (Factor E). The severity of the impact from the red-rim melania is not known, but it and future introductions may contribute to the risk of extinction from the threats to habitat by reducing the abundance of the three aquatic invertebrates through competition for space and resources. The small, reduced ranges (Factor E) of these species, when coupled with the presence of additional threats, also put them at a heightened risk of extinction.

The elevated risk of extinction of the Diamond tryonia, Gonzales tryonia, and Pecos amphipod is a result of the cumulative nature of the stressors on the species and their habitats. For example, the past reduction in available habitat from declining surface water in the Diamond Y Spring system results in lower numbers of individuals contributing to the sizes of the populations. In addition, the loss of other spring systems that may have been inhabited by these species reduced the number of populations that would contribute to the species' overall viability. In this diminished state, the species are also facing future risks from the impacts of continuing declining spring flows, exacerbated by potential extended future droughts resulting from global climate change, and potential effects from nonnative species. All of these factors contribute together to heighten the risk of extinction and lead to our finding that the Diamond tryonia, Gonzales tryonia, and Pecos amphipod are in danger of extinction throughout all of their ranges and warrant listing as endangered species.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the species, and have determined that the Diamond tryonia, Gonzales tryonia, and Pecos amphipod all meet the definition of endangered under the Act. They do not meet the definition of threatened species, because significant threats are occurring now and in the foreseeable future, at a high magnitude, and across the species' entire range. This situation makes them in danger of extinction now, so we have determined that they meet the definition of endangered species rather than threatened species. Therefore, on the basis of the best available scientific and commercial information, we are listing the Diamond tryonia, Gonzales tryonia, and Pecos amphipod as endangered species in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is threatened or endangered throughout all or a significant portion of its range. The species we are listing in this rule are highly restricted in their range, and the threats occur throughout their ranges. Therefore, we assessed the status of these species throughout their entire ranges. The threats to the survival of these species occur throughout the species' ranges and are not restricted to any particular significant portion of their ranges. Accordingly, our assessments and determinations apply to these species throughout their entire ranges.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed, preparation of a draft and final recovery plan, and revisions to the plan as significant new information becomes available. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The recovery plan identifies site-specific management actions that will achieve recovery of the species, measurable criteria that determine when a species may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (comprising species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our Web site (*http://www.fws.gov/endangered*), or from our Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribes, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (e.g., restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because the species' range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands.

If these species are listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the State of Texas would be eligible for Federal funds to implement management actions that promote the protection and recovery of these species. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants.*

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Federal agency actions within the species habitat that may require conference or consultation or both as described in the preceding paragraph include management and any other landscape altering activities on Federal lands administered by the U.S. Bureau of Reclamation; issuance of section 404 Clean Water Act permits by the Army Corps of Engineers; construction and management of gas pipeline and power line rights-of-way by the Federal Energy Regulatory Commission; and construction and maintenance of roads or highways by the Federal Highway Administration.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered wildlife. The prohibitions of section 9(a)(2) of the Act, codified at 50 CFR 17.21 for endangered wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. Under the Lacey Act (18 U.S.C. 42–43; 16 U.S.C. 3371–3378), it is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 for endangered species, and at 17.32 for threatened species. With regard to endangered wildlife, a permit must be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

Our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), is to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a listing on proposed and ongoing activities within the range of listed species. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

(1) Unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting of the species, including import or export across State lines and international boundaries, except for properly documented antique specimens of these taxa at least 100 years old, as defined by section 10(h)(1) of the Act;

(2) Introduction into the habitat of the six west Texas aquatic invertebrate species of nonnative species that compete with or prey upon any of the six west Texas aquatic invertebrate species;

(3) The unauthorized release of biological control agents that attack any life stage of these species;

(4) Unauthorized modification of the springs or spring outflows inhabited by the six west Texas aquatic invertebrates; and

(5) Unauthorized discharge of chemicals or fill material into any waters in which these species are known to occur.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Austin Ecological Services Office (see **FOR FURTHER INFORMATION CONTACT**).

Required Determinations

Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.)

This rule does not contain any new collections of information that require approval by OMB under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). This rule will not impose recordkeeping or reporting requirements on State or local governments, individuals, businesses, or organizations. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

National Environmental Policy Act (42 U.S.C. 4321 et seq.)

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*), need not be prepared in connection with listing a species as endangered or threatened under the Endangered Species Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of references cited in this rulemaking is available on the Internet at *http://www.regulations.gov* at Docket No. FWS–R2–ES–2012–0029 and upon request from the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this package are the staff members of the Southwest Region of the Service.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Regulation Promulgation

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

PART 17—[AMENDED]

■ 1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; and 4201–4245, unless otherwise noted.

■ 2. In § 17.11(h), add entries for ‘‘Springsnail, Phantom’’, ‘‘Tryonia, Diamond’’, ‘‘Tryonia, Gonzales’’, and ‘‘Tryonia, Phantom’’ under ‘‘Snails’’ and ‘‘Amphipod, diminutive’’ and ‘‘Amphipod, Pecos’’ under ‘‘Crustatceans’’ to the List of Endangered and Threatened Wildlife in alphabetical order to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*	*	*	*	*	*	*	
Snails							
*	*	*	*	*	*	*	
Springsnail, Phantom.	Pyrgulopsis texana ..	U.S.A. (TX)	NA	E	812	17.95(f)	NA
*	*	*	*	*	*	*	
Tryonia, Diamond.	Pseudotryonia adamantina.	U.S.A. (TX)	NA	E	812	17.95(f)	NA
Tryonia, Gonzales.	Tryonia circumstriata	U.S.A. (TX)	NA	E	812	17.95(f)	NA
Tryonia, Phantom.	Tryonia cheatumi	U.S.A. (TX)	NA	E	812	17.95(f)	NA
*	*	*	*	*	*	*	
Crustaceans							
Amphipod, diminutive.	Gammarus hyalleloides.	U.S.A. (TX)	NA	E	812	17.95(h)	NA
*	*	*	*	*	*	*	
Amphipod, Pecos.	Gammarus pecos	U.S.A. (TX)	NA	E	812	17.95(h)	NA
*	*	*	*	*	*	*	

* * * * *

Dated: June 25, 2013.

Daniel M. Ashe,

Director, U.S. Fish and Wildlife Service.

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