IV. Statutory and Executive Order Reviews

Under Executive Order 12866, entitled “Regulatory Planning and Review” (58 FR 51735, October 4, 1993), this action was submitted to the Office of Management and Budget (OMB) for review. Any changes made to this document in response to OMB comments received by EPA during that review have been documented in the docket as required by the Executive Order.

Since this document does not impose recordkeeping requirements, we are not required to address any applicable requirements.

In particular, any comments or information that would help the Agency to consider human health or safety effects on children pursuant to the Endangered Species Act of 1995 (NTTAA) (15 U.S.C. 272 note); to consider voluntary consensus standards pursuant to section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA) (15 U.S.C. 272 note); to consider environmental health or safety effects on children pursuant to Executive Order 13045, entitled “Protection of Children from Environmental Health Risks and Safety Risks” (62 FR 19885, April 23, 1997); or to consider human health or environmental effects on minority or low-income populations pursuant to Executive Order 12898, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629, February 16, 1994).

The Agency will consider such comments during the development of any subsequent proposed rule as it takes appropriate steps to address any applicable requirements.

List of Subjects in 40 CFR Part 799

Environmental protection. Bisphenol A, BPA, Chemicals, Hazardous substances, Reporting and recordkeeping requirements.
Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

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

Previous Federal Actions

On August 30, 2006, we received a petition dated August 16, 2006, from three private citizens and three other parties (the Palouse Prairie Foundation, the Palouse Audubon Society, and Friends of the Clearwater) requesting that the giant Palouse earthworm (Driloleirus americanus) (GPE) be listed as an endangered or threatened species under the Act, and critical habitat be designated. The petition included supporting information regarding the species’ taxonomy and ecology, distribution, present status, and causes of decline. On October 9, 2007, we published a 90-day finding stating that the August 30, 2006, petition did not provide substantial scientific or commercial information to indicate that listing the GPE may be warranted (72 FR 57273). On January 24, 2008, the petitioners filed a lawsuit in the U.S. District Court, Eastern District of Washington against the U.S. Department of the Interior and the Service challenging the “not substantial” decision (Palouse Prairie Foundation et al. v. Dirk Kempthorne, et al., No. 2:08–cv–00032–FVS). On February 12, 2009, the Distric Court denied the Appellants’ motion for summary judgment and granted summary judgment in favor of the Service, upholding the October 9, 2007, determination. The U.S. Court of Appeals for the Ninth Circuit affirmed the District Court ruling on June 14, 2010 (D.C. no. 2:08–cv–00032–FVS).

History of the Current Petition

On July 1, 2009, we received a new petition dated June 30, 2009, from Friends of the Clearwater, Center for Biological Diversity, Palouse Audubon, Palouse Prairie Foundation, and Palouse Group of the Sierra Club (petitioners) requesting that the GPE be listed as an endangered or threatened species either in the entirety of its range, or in the Palouse bioregion as a significant portion of its range, and that critical habitat be designated under the Act. The petition clearly identified itself as such and included the requisite identification information for the petitioners, as required by 50 CFR 424.14(a). The petition included a finding that the petitioners, as additional information about the GPE and potential threats to the species. In an August 5, 2009, letter to the petitioners, we acknowledged receipt of the petition and determined that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act was not warranted. We also stated that, due to funding constraints in fiscal year 2009, we would not be able to further address the petition at that time but that we would further evaluate the petition when funding became available in fiscal year 2010.

On July 20, 2010, the Service announced a 90-day finding on the 2009 petition to list the GPE as endangered or threatened under the Act, and to designate critical habitat (75 FR 42059). Based on our review, we found the petition presented substantial scientific or commercial information indicating that listing the GPE as endangered or threatened may be warranted. We initiated a review of the status of the species to determine whether listing the GPE was warranted, and requested scientific and commercial data, and other information, regarding the species. This notice constitutes the 12-month finding on the July 1, 2009, petition to list the GPE as endangered or threatened, as petitioned.

Species Information

The GPE is one of about 100 native and at least 45 nonnative earthworms described in the United States (Hendrix and Bohlen 2002, p. 802). However, very little is known about the species. The GPE was first described by Smith in 1897, based on a collection near Pullman, Washington. At the time of this collection, Smith stated: “This species is very abundant in that region of the country and their burrows are sometimes seen extending to a depth of over 15 feet” (Smith 1897, pp. 202–203). His writing is based on second-hand information provided by R.W. Doane of Washington State Agricultural School (now Washington State University) in Pullman, Washington, which does not offer numerical or geographical context for his use of the terms “very abundant” or “that region of the country.” This burrow depth characterization has not been confirmed or contradicted by any subsequent field work.

Early descriptions indicate the GPE can be as long as 3 feet (ft) (0.9 meters (m); Smith 1897, p. 203). Reports in the popular literature of GPEs up to 3.3 ft (1 m) in length (Science Daily 2006, p. 1; Science Daily 2008, p. 1) have not been confirmed, and collections suggest that specimens are more moderate in size (approximately 6 to 8 inches (in) (15.2 to 20.3 centimeters (cm)) in length) (Smith 1937, p. 161; Science Daily 2006, p. 1; Science Daily 2008, p. 1).

Taxonomy and Species Description

The Service accepts the current taxonomic classification of the GPE (Subclass—Lumbricina; Superfamily—Megascolecoidea; Family—Megascolecidae; Genus—Driloleirus; Species—americanus) (Smith 1897, p. 203; Fender and McKey-Fender 1990, p. 372; Fender 1995, pp. 53–54). While the naming conventions of the GPE have changed over time (Megascolides americanus in 1897 (Smith 1897, p. 203) changed to Driloleirus americanus by 1990 (Fender and McKey-Fender 1990, p. 372), there is no information provided in the petition or in our files that would indicate scientific disagreement about its taxonomic classification as a species. Adult specimens in the Driloleirus genus are generally distinctive, but identifying to the species level requires expert morphological analysis, including dissection or DNA evidence. Both methods take time, and there are few species experts. It is difficult to identify juvenile earthworm species, because they have no clitellum (a glandular section in the body wall, similar in shape to a saddle). The clitellum is a
key morphological difference for determining many species, and juvenile earthworm coloration can also vary, depending on soil type. Newly hatched earthworms are even more difficult to identify, and until DNA analysis becomes a more available tool, earthworm identification requires the examination of sexually mature individuals. Depending on site conditions and growth, an earthworm would need to be 3 to 6 months of age before being recognizable as being in the genus *Driloleirus* (Johnson-Maynard 2011, pers. com.).

**Distribution**

Distribution of native earthworm species in the Pacific Northwest is limited by several factors. Pleistocene glaciation covered nearly the whole of Canada and the northern edge of the United States, eliminating earthworms from the area covered with ice (Fender 1995, p. 54). Since the retreat of the glaciers, earthworms in the Lumbricidae family have been able to colonize the ice-free areas in a few centuries, although earthworm distribution in the Megascolecidae family (to which the GPE belongs) stops near the terminal moraines (ridges of rock, gravel and soil across valleys at the end glaciers or ice fields) of the ice sheet. This may be because the megascolecids prefer fine-textured soils, which are largely absent at the edge of Pleistocene glaciation (Fender 1995, p. 55). Other barriers, including mountain ranges and arid areas (Bailey et al. 2002, p. 26), have slowed recolonization of the Columbia Basin.

At the time of the original description, in 1897, this taxon was known only from the area around Pullman, Washington (Smith 1937, p. 157). The GPE was originally considered to be an endemic species (a species native to a particular region), that uses grassland sites with deep soil and native vegetation of the Palouse bioregion (Wells 1983, p. 213; James 1995, p. 1; Niwa et al. 2001, p. 34). The Palouse bioregion is an area of rolling hills and deep soil in southeastern Washington and adjacent northwestern Idaho. More recently, this species has also been found in Douglas-fir forests in the Palouse region (Johnson-Maynard, September 21, 2010, in litt. p. 1; November 30, 2010, in litt. p. 1), and on the eastern slope of the North Cascades Mountains (Cascades) west of Ellensburg, Washington (Fender and McKey-Fender 1990, p. 358). In 2010, the GPE was also documented in dry pine forest habitat near Leavenworth, Washington (Johnson-Maynard 2010, p. 3, in litt.). This broader distribution, which is now known to include Latah County (Idaho), Whitman County (Washington), Kittitas County (Washington), and Chelan County (Washington), provides evidence that the species may not be endemic to Palouse grasslands.

Confirmed GPE locations, and other potential GPE locations (DNA is currently being analyzed for these specimens), are identified in Table 1. Two of the potential GPE collections are of particular interest: one in shrub/grassland habitat near Chelan, Washington, and one in second-growth forest habitat east of Moscow, Idaho (Johnson-Maynard 2010, pp. 1–2; November 30, 2010, in litt. p. 2). The DNA or morphology results for these specimens are not yet available to enable identification to the species level, but if these specimens are confirmed to be GPE, the currently known distribution and habitat types documented for the species will be expanded. One commenter provided a list of possible GPE locations in the Palouse region (Hall 2010, in litt. pp. 2–3), but acknowledged that the sites were not confirmed. Although these anecdotal locality reports may be helpful in identifying areas for future GPE surveys, they are not relevant to this finding.

**Table 1—Locations and Characteristics of Collections of the GPE or Driloleirus Genus**

<table>
<thead>
<tr>
<th>Site name/year</th>
<th>County/State</th>
<th>Positive ID as GPE</th>
<th>Vegetation and other site characteristics, if known</th>
<th>Collector (sources) comments</th>
<th>Survey methods, if known</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pullman, 1897</td>
<td>Latah, ID .....</td>
<td>Yes ................</td>
<td>_____________________________________________</td>
<td>Collected by Doane. (Smith 1897, Gates 1967).</td>
<td></td>
</tr>
<tr>
<td>Pullman, 1931</td>
<td>Whitman, WA</td>
<td>Yes ................</td>
<td>_____________________________________________</td>
<td>Collected by Svilha. (Smith 1937).</td>
<td></td>
</tr>
<tr>
<td>Site name/year</td>
<td>County/State</td>
<td>Positive ID as GPE</td>
<td>Vegetation and other site characteristics, if known</td>
<td>Collector (sources) comments</td>
<td>Survey methods, if known</td>
</tr>
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</tr>
<tr>
<td>Smoot Hill, 2005.</td>
<td>Whitman, WA</td>
<td>Yes ................</td>
<td>Native Palouse prairie remnant, some shrubs; 25% slope, Northwest aspect, 2,723 feet elevation; Soil: silt loam, gravelly sandy.</td>
<td>Collected by Sánchez-de León. (Sánchez-de León and Johnson-Maynard 2009, p.1398; Johnson-Maynard November 30, 2010 in litt. p. 2–3 ). Found during 2-year survey that included remnant prairie and Conservation Reserve Program (CRP) grasslands in Palouse.</td>
<td>2010 GPE specimens were collected with electroshocker.* Handsorting conducted at the same time did not result in the collection of GPE (Johnson-Maynard December 21, 2010 in litt. p. 2). *Use of electrodes and a generator to direct electric current into the soil.</td>
</tr>
<tr>
<td>Paradise Ridge, 2010.</td>
<td>Latah, ID</td>
<td>Yes. Identified by James.</td>
<td>Palouse prairie, same as above.</td>
<td>Collected by Xu and Umiker. (Johnson-Maynard, November 30, 2010, in litt. p. 2). Adult GPE found at a privately owned prairie remnant near Moscow, Idaho, 2008 and 2010 Paradise Ridge sites less than 50 feet from each other. Nearby location surveyed in 2005 with no GPE found.</td>
<td>2010 GPE specimens were collected with electroshocker.* Handsorting conducted at the same time did not result in the collection of GPE (Johnson-Maynard December 21, 2010 in litt. p. 2). *Use of electrodes and a generator to direct electric current into the soil.</td>
</tr>
<tr>
<td>East of Moscow, ID, 2010.</td>
<td>Latah, ID</td>
<td>Pending ...........</td>
<td>Secondary growth forest (Douglas fir).</td>
<td>Collected by: ? (Johnson-Maynard, November 30, 2010, in litt. p. 2). Sample too degraded for morphological description; currently analyzing DNA.</td>
<td>2010 GPE specimens were collected with electroshocker.* Handsorting conducted at the same time did not result in the collection of GPE (Johnson-Maynard December 21, 2010 in litt. p. 2). *Use of electrodes and a generator to direct electric current into the soil.</td>
</tr>
</tbody>
</table>
Table 1 identifies confirmed GPE and potential GPE locations (at this time just identified to Driloleirus genus; DNA analysis is pending), and information on survey methods for each collection where available. While negative survey data are important to understand the distribution of any species, the Service found little information on surveys with negative results in the Palouse, and no information on negative surveys outside of the Palouse. The available information on negative survey results is presented in Table 1.

Earthworms are not randomly distributed in the soil (Guild 1952, as referenced in Edwards and Lofty 1977, p. 127), and some are difficult to detect. Factors that influence this non-random distribution could include: (1) Physical and chemical characteristics of the soil; (2) food availability; (3) the reproductive potential and dispersal capabilities of the species; or (4) interactions between these factors (Murchie 1958, as referenced in Edwards and Lofty 1977, p. 127). Earthworms also occur in patchy distributions, which make it difficult to determine population demographics (Whalen 2004, pp. 143, 148, Umicker 2009, p. 187). Edwards and Bohlen (1996, p. 90) stated that assessments of size, distribution, and structure of earthworm populations are difficult because numbers change with season, demography, and vertical distribution in the substrate.

In his letter submitted with the petition, James (2009 in litt. p. 2) states that a reasonable and sufficient effort has been made to find the GPE in a variety of habitats within its presumed range, and that these efforts have failed except in very rare instances in natural or little-disturbed vegetation. James also stated that the Washington State University team surveyed many locations (most importantly in agricultural lands), looking for large burrows that may indicate the presence of large earthworms, but only found Lumbricus terrestris (the common night crawler), an invasive species (James 2009, in litt. pp. 2–3). However, recently collected and confirmed specimens that have been documented in forested habitats and on the eastern slope of the Cascade Mountains in Washington (Table 1) indicate that survey efforts for the GPE to date have not been adequate to establish its distribution or the diversity of habitat types in which it occurs. Therefore, we believe the petitioners’ assumptions regarding the presumed distribution of the GPE are likely erroneous.

Fauci and Bezdicek’s study (2002, pp. 258–259) compared nonnative lumbricid earthworm distribution in the Palouse region of eastern Washington and northern Idaho. In the spring of 1999, they surveyed 46 sites in the Palouse, including sites in agricultural fields with a history of conservation tillage, areas next to waterways, and perennial vegetation areas along road rights-of-way or on old homesteads. Survey methods included digging six spades of soil in a 10-square-meter area, then hand-sorting and examining the soil. Additional samples were taken if immature worms were found to ensure adults for identification. Although the results for the GPE were negative, the Fauci and Bezdicek survey was not designed to specifically find this species. In addition, survey protocols have not yet been developed for the GPE; therefore, it is uncertain the protocol used in this study would have found GPE, if present. If reports that the GPE lives in burrows more than 15 feet deep are correct, the spade sampling method used by Fauci and Bezdicek would appear to be inadequate to confirm the species’ absence.

Table 1—Locations and Characteristics of Collections of the GPE or Driloleirus Genus—Continued

<table>
<thead>
<tr>
<th>Site name/year</th>
<th>County/State</th>
<th>Positive ID as GPE</th>
<th>Vegetation and other site characteristics, if known</th>
<th>Collector (sources) comments</th>
<th>Survey methods, if known</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leavenworth, 2010</td>
<td>Chelan, WA ...</td>
<td>Yes. Adult examined by Fender.</td>
<td>Ponderosa pine, Arrowleaf balsamroot/mule’s ear, annual grasses; South aspect, 27% slope; 1,846 feet elevation; Soil: sandy loam.</td>
<td>Collected by Xu and Umiker. (Johnson-Maynard 2010 p. 2–4). Multiple hatching specimens—will analyze one injured hatching for DNA.</td>
<td>Follow-up surveys specific to determining Driloleirus species and soil and site characteristics. Survey conducted in November, 2010. Soil was excavated from one large pit (approximately 60 cm by 60 cm) at each site. Soil was hand-sorted and all earthworms removed and counted. One sample was collected from each site for DNA analysis.</td>
</tr>
<tr>
<td>Chelan, WA ...</td>
<td>Pending ..........</td>
<td></td>
<td></td>
<td>Follow-up surveys specific to determining Driloleirus species and soil and site characteristics. Survey conducted in November, 2010. Soil was excavated from one large pit (approximately 60 cm by 60 cm) at each site. Soil was hand-sorted and all earthworms removed and counted. One sample was collected from each site for DNA analysis.</td>
<td></td>
</tr>
</tbody>
</table>
Other negative earthworm surveys in the Palouse area were also not specifically designed to find the GPE. Umiker et al. (2009, pp. 184–185, 187) compared soil characteristics, cropping practices, and earthworm densities in 24 agricultural fields in the Palouse, but did not identify the earthworms to species level in that study (p. 187). However, adult Driloleirus earthworms are distinctive enough that they likely would have been documented, had they been collected. Juvenile Driloleirus earthworms, on the other hand, are not distinctive (Johnson-Maynard 2011, pers. com.), and hence could have been missed in this survey. Johnson-Maynard et al. (2007, p. 338) compared earthworm dynamics and soil properties in conventionally tilled and no-till agricultural fields on one research farm in the Palouse, and found only the nonnative southern worm (Aporrectodea trapezoides) (p. 340).

Smetak et al. (2007, p. 161) investigated earthworm population density in urban settings in Moscow, Idaho; no native earthworm species were collected (p. 166). Nevertheless, while the negative survey data are interesting, in that the GPE has not been detected in agricultural fields or urban areas to date, coupled with information in Table 1, these data demonstrate how geographically limited the known survey efforts have been.

It is apparent that additional GPE surveys are needed to determine the range, habitat preference, and life history of this species, particularly in light of the recent confirmation of the species near Leavenworth, Washington, in forested habitat. James (2000, p. 5) acknowledges there have been a limited number of earthworms collected in the Columbia basin, which includes the eastern slope of the Cascade Mountains and the Palouse area, and only a small portion of potential habitat has been surveyed. In addition to limited survey efforts, this species is difficult to detect. Fender (September 14, 2010, in litt. p. 1) noted that Driloleirus species can at times be found near the surface during suitable survey conditions, but if conditions are dry they may be undetectable. Johnson-Maynard (September 21, 2010, in litt. p. 2) noted that one Palouse site had negative survey results for native earthworms in 2005, but later sampling in 2010 detected one adult GPE at the same site. The Xerces Society stated that due to the difficulty in detecting the Oregon giant earthworm (Driloleirus macellarii) (a similar species in the same genus), abundance estimates have not been made, and the species’ status and threats cannot be determined until an effective survey protocol is developed and tested (Xerces Society 2009, p. 3).

Due to the difficulty in surveying for the GPE, the Idaho Department of Fish and Game, the Service, and others have contributed resources to the University of Idaho to develop appropriate survey protocols to address the scientific challenges associated with GPE surveys (Green 2010, in litt. p. 2; Johnson-Maynard 2010, in litt. p. 2; Science Daily 2008, p. 2). Staff at the University of Idaho, including Johnson-Maynard and others, are currently working to develop and refine sampling methods and strategies, including a soil electroshocking technique that appears to be promising.

In summary, the level of survey effort for the GPE has been low, the species is difficult to detect, and effective survey methods are still being developed. There is a lack of survey data, and large geographic and taxonomic gaps in our knowledge (Fleckenstein 2011, in litt. p. 1). Researchers have only recently begun to look more broadly for the species including localities along the eastern slope of the Cascades. However, the GPE has now been documented in dry forest habitats, which provides further evidence that the complete range and distribution of the species is presently unknown, but are likely broader than the area identified by the petitioners.

**Habitat**

Habitat requirements for the GPE are not well understood. The original descriptions by Smith (1897, 1937) do not present any descriptive information about the habitat where the specimens were initially collected. The GPE was originally thought to be a Palouse-region grassland species, and several specimens have been found in Palouse grassland remnants (Table 1; Sánchez-de León and Johnson-Maynard 2009, p. 193; Science Daily 2008, p. 1; Johnson-Maynard September 21, 2010, in litt. pp. 1–2; Johnson-Maynard, November 30, 2010, in litt. p. 2–3; Jensen 2010, in litt. p. 6). Wells et al. (1983, p. 213) noted that Fender collected specimens under hawthorn thickets; Johnson-Maynard (September 21, 2010, in litt. p. 1) described the vegetation type at Johnson and Johnson’s Moscow Mountain site as Douglas-fir forest. There is limited specific information on the habitat type associated with the GPE collected near Ellensburg, Washington. Fender and McKey-Fender (1990) described the site as “in the hills west of Ellensburg,” and they described the GPE range at this locality as extending into “treeless areas” (pp. 358, 366). The GPE was not collected in recent surveys conducted in agricultural and urban locations in Latah County, Idaho (Johnson-Maynard et al. 2007, p. 340, Smetak et al. 2007, p. 166; Umiker et al. 2009, p. 187), and Whitman County, Washington (Fauci and Bezdicek 2002 p. 257). Vegetation and soil characteristics of confirmed and potential GPE sites are described above in Table 1, where that information was available. Sánchez-de León and Johnson-Maynard (2009, p. 1394, Petition, p. 5) observed that remaining prairie remnants in the Palouse are often steep or rocky, or contain shallow soil, and, therefore, may be less suitable for earthworms (Sánchez-de León and Johnson-Maynard 2009, pp. 1394, 1398; Petition, p. 5). However, Johnson-Maynard (2010, pp. 2–3) noted that soils at the Paradise Ridge site near Latah, Idaho, had a high gravel content, suggesting that the GPE may be able to exist in soil types that would not be expected to be preferred habitat for most earthworms. She further noted that past *Driloleirus* samples provided by a landowner near Leavenworth, Washington, were obtained from a compacted area covered with gravel.

Johnson-Maynard (2010, pp. 3–4) described the confirmed GPE collection site near Leavenworth, Washington, as Ponderosa pine forest with an understory of *Balsamorhiza sagittata* (arrowleaf balsamroot) and annual grasses. Although the GPE has also been documented in forests on the eastern slope of the Cascades and in Douglas-fir forests in the Palouse, significant uncertainties exist as to whether the species occurs in specific types or ages of forests, occurs in previously logged forests, or may be habitat-limited because of elevation or other site characteristics.

**Biological**

Earthworms are generally divided into three life-history strategies based on their habitat use: epigeic, endogeic, or anecic (Bouche 1977, as referenced in James 2000, p. 2; Edwards and Bohlen 1996, pp. 113–115). Epigeic worms live near the ground’s surface and consume organic litter on and near the surface. Endogeic worms (which the petitioners currently believe the GPE to be (James 2009, in litt. p. 3)): (1) Live in the upper layers of mineral soil, (2) consume organic material in the mineral soil or at the soil-litter interface, and (3) are often pale in appearance (Edwards and Bohlen 1996, p. 114). Anecic worms, which the petitioners generally believed the GPE to be (James 2009, in litt. p. 3), and we believe the GPE to be based on
In our 2010 90-day finding (75 FR 42059), we solicited scientific information on the GPE’s endogeic or anecic life-history strategy to inform our status review. Johnson-Maynard (in litt. 2010, p. 2) stated that the GPE is likely anecic, based on her surveys at locations near Leavenworth, WA. In those studies, the GPE was associated with pores leading down into unconsolidated parent material, and surface castings were observed, which are indicative of a deep-burrowing species. Johnson-Maynard has conducted or been involved with common earthworm surveys where GPE specimens were collected (see Table 1 above). Therefore, based on the best available scientific information, field observations, and the existing literature, we believe the prevailing evidence indicates the GPE is an anecic earthworm species, although we acknowledge that there are still significant uncertainties regarding its biological requirements.

In summary, the current understanding regarding the life cycles of earthworms is inadequate and requires more study (Edwards and Lofty 1977, p. 68), and there are many species about which little is known (Edwards and Bohlen 1996, p. 46). Accordingly, there are significant scientific uncertainties regarding the biology, distribution, habitat, and population trends of the GPE. The GPE’s distribution has been documented to include areas within the Palouse bioregion, and areas within the eastern slope of the Cascade Mountains in Washington. We do not know whether there are other occupied sites between or outside of these locations, as few surveys have been conducted, the species is difficult to survey for, and survey methods are still being developed.

Documented habitat types used by the GPE in the Palouse bioregion include native grasslands and Douglas-fir forest. In addition, the GPE location near Leavenworth, Washington, is described as dry Ponderosa pine forest. There is very little specific information on habitat type at the Leavenworth, WA location. The Driloleius earthworm species recently collected near Clelan, Washington, and east of Moscow, Idaho, are being identified (see Table 1 above). If these specimens are confirmed to be the GPE through DNA or other analysis, the species’ range and diversity of habitat types used would be expanded.

**Summary of Information Pertaining to the Five Factors**

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

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

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

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

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

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

Given the paucity of information on GPE, surrogates may be useful. The petitioners claim that it is appropriate to use other earthworms as surrogates to determine effects to the GPE, provided they are biologically and ecologically similar (Sappington et al. 2001, p. 2869; Caro et al. 2005, p. 1821; Petition, p. 19). In some instances, the use of surrogate species (such as other earthworms) may be helpful in evaluating potential effects to the GPE, provided the appropriate scientific controls and precautions are taken. Caro et al. (2005, p. 1821) states “for substitute species to be appropriate, they should share the same key ecological or behavioral traits that make the target species sensitive to environmental disturbance and the relationship between populations’ vital rates and disturbance levels should match that of the target; these conditions are unlikely to be met in the majority of cases and the use of substitute species to predict endangered populations’ responses to disturbance is questionable.” The Oregon giant earthworm (*Driloleirus macelfreshi*) is in the same genus, and is believed to construct permanent, deep, subsurface burrows (a characteristic that indicates an anecic life-history strategy), and could potentially be an appropriate surrogate. However, the status and threats of this species cannot be determined until an effective survey protocol is developed and tested (Foltz 2009, pp. 2–3). Therefore, using it as a surrogate would provide little to no additional insight into potential threats to GPE. No other relevant surrogate
species have been suggested or investigated.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Habitat Loss and Fragmentation

Historical information regarding potential habitat loss is presented in the following discussion, for context. However, the focus for purposes of our analysis and response to the petition is on current and future habitat conditions, and whether the activities responsible for those conditions present a threat to the GPE such that listing under the Act is warranted.

As described in the 2010 90-day finding (75 FR 42061), the petitioners claim that the GPE is threatened by habitat conversion, loss, and fragmentation from agriculture and urban sprawl in the Palouse region (Petition, pp. 1, 7). The petitioners cite Sánchez-de León and Johnson-Maynard (2009, pp. 1393–1394, 1398), who state that combined effects of land-use change, habitat fragmentation, and competitive interactions have caused native earthworm declines. James (2009, p. 1) stated that indigenous earthworms are sensitive to habitat disturbance, and that to find indigenous earthworms one must work in undisturbed or mildly disturbed vegetation. Undisturbed vegetation is rare in the Palouse bioregion, as the native grassland habitat has been reduced to less than 1 percent of its pre-agricultural extent (Petition, p. 8; James 2009, p. 1; Noss et al. 1995, p. 74).

Estimates of native habitat conversion in the Palouse bioregion vary, but several studies indicate the conversion has been high: 99.9 percent of Palouse prairie habitats have been converted to agriculture (Noss 1995, p. 74); 94 percent of the grasslands and 97 percent of the wetlands in the Palouse bioregion have been converted to crop, hay, or pasture (Black et al. 1998, pp. 9–10); 21 percent of previously forested lands have been converted to agriculture or urban uses (Gilmore 2004, p. 3); and less than 1 percent of the original bunchgrass prairie habitat remains (Donovan et al. 2009, p. 1). However, comments on the 90-day finding noted that habitat loss in the Palouse due to agriculture happened historically and is not currently occurring. Much of the prairie was converted to farms by 1910, and much of the urban growth around the Pullman area occurred on farmland, not remaining prairie fragments (McGregor 2010, in litt., p. 2; McGregor 1982, p. 109). However, habitat conversion in the Palouse may still occur, as neither Latah County, Idaho, nor Whitman County, Washington, have ordinances to prevent native habitat conversion (Latah County Board of Commissioners 2010, pp. 1–27; Whitman County 2010, pp. 1–76).

The petition identified several locations in the Palouse area that contain prairie remnants (Petition, p. 5). A study of four prairie remnants and adjacent Conservation Reserve Program (CRP) fields was carried out by Sánchez-de León and Johnson-Maynard (2009, pp. 1393, 1395, Petition, p. 4). In that study, the researchers collected one GPE, and commented that many remaining prairie remnants are not suitable for tillage because they are often steep or rocky, or contain shallow soil (2009, p. 6; Petition, p. 5). They also hypothesized that prairie remnants may not be the preferred habitat for the GPE due to shallow rocky soil. They described the GPE collection site at Paradise Ridge near Latah, Idaho, as having a high gravel content (Johnson-Maynard 2010, pp. 2–3). They acknowledged that sampling challenges could bias survey information on the GPE, and cautioned that hand-sampling methods may underestimate abundance of anecic species (Sánchez-de León and Johnson-Maynard 2009, p. 1399). There is no baseline (i.e., pre-agriculture) density and distribution information on the GPE, and there are significant challenges associated with surveying for this species. These challenges, coupled with the fact that earthworms have patchy distributions (Guild 1952, as referenced in Edwards and Lofty 1977, p. 127; Murchie 1958, as referenced in Edwards and Lofty 1977, p. 127; Whalen 2004, pp. 143, 148; Umicker 2009, p. 187), preclude our ability to correlate land use impacts with GPE abundance, based on the best available information. The GPE has been documented in both the Palouse bioregion and on the eastern slope of the Cascade Mountains, near Ellensburg and Leavenworth, in central Washington (see Table 1 above). There is little description about the habitat associated with the GPE that was collected near Ellensburg; it’s not clear whether the location is grassland or a different habitat type, and the specific location is uncertain. James (2009 in litt., p. 2) speculated the Ellensburg site collection is a relict of a distribution that must have been more or less continuous at one time, but due to climate change and increased aridity has now become fragmented. Fender and McKey-Fender (1990) described the locality as “just west of Ellensburg,” and noted that the range of the GPE extends into “treeless areas” (pp. 358, 366). A report by Adolfson Associates (2005, p. 1) was presented as evidence of urban sprawl being a threat to GPE habitat. However, this report was limited to areas within the City of Ellensburg, Washington boundary, and is not particularly instructive in terms of correlating future urban development with loss of GPE habitat because pre-development density or distribution or both in that area are unknown. The petitioners also claim the grasslands around Ellensburg have been extensively modified by agriculture, similar to the Palouse bioregion (Adolfson Associates 2005, p. 2; Petition, p. 8; James 2009, in litt., p. 2). However, the best available information is insufficient to determine or infer how or whether the GPE has been impacted by habitat loss and fragmentation in this area, because we have no baseline information with which to correlate land use modification with GPE abundance.

The best available scientific information is also inconclusive as to whether the GPE occurs in a certain forest type or age, or whether the species occurs in a broad variety of habitats. The GPE site near Moscow, Idaho, is in Douglas-fir forest habitat, and the Leavenworth, Washington, site is in dry ponderosa pine forest. Quigley et al. (1996, p. 54) stated that in the Columbia Basin, the total area in forest has remained relatively constant during the last two centuries, and broad indicators of sustainability indicate that Basin forest acreage and inventory volumes are relatively constant. If the GPE is a forested habitat generalist, it could be stable in forested locations; however, if it requires a forest of a specific type or age it may or may not be impacted by habitat loss, depending on the type of development activity involved. In either case, the available scientific evidence does not address that uncertainty.

In summary, the GPE’s current and historical population size, distribution, and range of habitat types used are unknown based on current definitions. The GPE’s range outside of the Palouse region has been expanded and now includes portions of the eastern slope of the Cascade Mountains. The GPE has also been documented in both grassland and forested habitats in the Palouse. However, survey efforts have been limited, and sampling protocols are still being developed to improve researchers’ ability to detect the species during field investigations. While habitat conversion may occur and there may be local impacts, the GPE range is much wider than previously known and includes more diverse habitats than previously.
known. Because we cannot identify the full extent of the GPE’s range or the
varieties of habitat types it may use, we are unable to correlate habitat
conversion with GPE abundance.

Therefore, for the reasons stated above, the best available scientific information
does not indicate current or future habitat loss or fragmentation represents
a threat to the species.

General Impacts to Soil Characteristics

The petitioners present several claims in their petition, each of which has been
evaluated and addressed below. They claim that earthworms or their grassland
habitats are influenced by soil disturbance, tillage, traffic, food sources, chemical and pesticide residues, and soil microclimate (Jennings et al. 1990, p. 75; Edwards and Bohlen 1996, pp. 283–289; Edwards et al. 1995, pp. 200–
201; USDA–NRCS 2001, p. 2; Petition, p. 10). Moisture, temperature, and food
availability influence earthworm populations in general, and earthworms need
the organic matter found in the topsoil that agriculture removes (James 2000, pp. 1–2; Petition, p. 11). Bare soil can increase the effects of flooding, drought, or other weather conditions
due to the lack of vegetation that buffers soil from extreme moisture, dryness, and temperature fluctuations. These conditions can temporarily or
permanently make soils unusable by earthworms (James 2000, pp. 1–2; Petition, p. 11). James (2009, in litt., p. 1) stated that earthworms are highly
sensitive to habitat disturbance, such as forest clear cutting or conversion of any
habitat to agriculture, and the native earthworms are generally destroyed by
any type of drastic and sudden habitat modification. One commentator stated
there may have been long periods of bare soil historically in the Palouse
region, but seedling and fertilizing technology improvements now enable
farmers to prepare seedbeds with minimal disturbance (McGregor 2010, in
litt., p. 2). James also stated, “when seeking the indigenous earthworms, it is
almost always a complete waste of time to work in anything but undisturbed or
mildly disturbed stands of vegetation)” (James 2009, in litt., p. 1). GPE have
been found in forested locations, but it is unknown whether these are
previously disturbed habitats.

We acknowledge that soil disturbance has occurred and may still be occurring in GPE habitat. However, we currently have no information linking soil
disturbance with GPE presence or absence. Survey efforts for GPE have been
limited, and sampling protocols remain to be developed. Until we have a better understanding of the species’

distribution and habitat information, we are unable to determine with reasonable
confidence whether the GPE uses disturbed or undisturbed habitats, or both. Therefore, the best available scientific information does not indicate soil disturbance is a threat to the GPE.

Soil Compaction

The petitioners claim that soil compaction from farm machinery or
other activities can affect earthworms by making burrowing and feeding more
difficult (James 2000, p. 9), by decreasing soil pore size and thereby
decreasing nutrient retention and changing the soil food web (Niwa et al. 2001, pp. 7, 13), or by favoring nonnative earthworms that prefer course soils rather than the fine soils
apparently preferred by the GPE (Fender and McKey-Fender 1990, p. 364;
Petition, p. 11). Johnson-Maynard (September 21, 2010, in litt., pp. 2–3) noted that the effects of soil compaction on earthworm density can vary based on
the species’ ecological strategy (i.e., anecic versus endogeic); larger species,
such as anecic earthworms, have been found to be less sensitive to soil compaction than smaller species (Cluzeau et al. 1992, p. 1661) and may be
more abundant in compacted areas compared to non-compacted areas
(Cuendet 1992, p. 1467). Fender (1995, p. 57) has often found other
Argilophilini worms (a tribe of native Pacific Northwest earthworms that
includes the GPE) in compacted trails; Capowiez et al. (2009, p. 214) notes that our current knowledge of the sensitivity of earthworms to compaction is limited. In addition, the assumption that compaction would favor exotic species over
native species due to their preference for finer-textures soils is invalid; while compaction does impact total porosity and pore size distribution, it does not alter soil texture (Johnson-Maynard, September 21, 2010, in litt., p. 3). Johnson-Maynard states that
generalizations such as those presented by the authors of the 2009 petition,
suggesting that compaction favors nonnative species, should be interpreted with caution (Johnson-Maynard, September 21, 2010, in litt., p. 3). In
addition, survey efforts for the GPE have been limited, and sampling protocols remain to be developed. Until we have a better understanding of the species’

distribution and habitat information, we are unable to determine with reasonable
confidence whether soil compaction is occurring in GPE habitat, and if it is,
whether there is a negative response in the species. Therefore, the best available scientific information does not indicate soil compaction is a threat to the species.

Soil Chemistry

The pH scale describes how acidic or basic a substance is, and ranges from 0
to 14, with 7 being neutral, below 7 being acidic, and greater than 7 being
basic. The petitioners cite soil chemistry effects, notably a reduction in soil pH
from nitrogenous fertilizer application, as having deleterious effects on
earthworms (Ma et al. 2000, p. 76), and state that generally earthworms do not
thrive in soils with a pH below 5 (Petition, p. 11; Edwards and Lofty 1977, p. 234). However, the best available scientific information related to the
responses of earthworms to pH appears to both support and contradict the
petitioners’ claim with regard to the GPE. Soil pH is a factor that often greatly affects earthworm populations, both in numbers of individuals and
numbers of species. According to the Natural Resources Conservation Service
(USDA–NRCS 2001, p. 5), earthworms do not thrive in soils with a pH below
5 (USDA–NRCS 2001, p. 2; Edwards and Lofty 1977, p. 234; Edwards and Bohlen 1996, p. 276). However, one Australian study of tillage effects to one
native anecic earthworm species (Spenceiella hamiltoni) described the surface soil in
the study area as highly acidic (pH = 4.1), with the pH increasing (or acidity
decreasing) with depth (pH = 5.0 at 0.8 meters) (Chan 2004, p. 90). Some
earthworm species are intolerant of acid soil conditions, some are tolerant, and
others can tolerate wide ranges of soil pH (Edwards and Bohlen 1996, p. 142).
Because soil pH is related to other soil factors, such as clay content, or cation
exchange capacity (the ability to hold plant nutrients), it is often difficult to
establish a direct cause-and-effect relationship between soil pH and the
size of earthworm populations (Edwards and Bohlen 1996, p. 144).

Fender (1995, p. 56) stated that
Argilophilini worms appear to have higher tolerance than lumbricids
(nonnative earthworms, such as the night crawler) for low pH (below 5,
acidic) soils; high clay; and resinous,
low-nitrogen, plant litter. Sánchez-de
1397, 1399) found a significant negative
interaction between soil pH and mean
earthworm density and mean
earthworm fresh weight. The nonnative
southern earthworm (Aporrectodea
trapezoides) was more abundant in CRP
sites with lower pH values (pH 5.9 to
6.2) than prairie soils (pH 6.3 to 6.6) in
a limiting of factors favoring prairie
remnant sites. Their data did not
support their hypothesis that native
earthworms would be dominant in
prairie remnants and exotic earthworms
dominant in CRP set-aside lands
(Sánchez-de León and Johnson-Maynard
2009, pp. 1398). In that study, one GPE
was collected during sampling at the
Smoot Hill prairie remnant study site. In
the study, the prairie remnants’ mean
soil pH at depth was pH 6.3 (20–30 cm),
PH 6.5 (10–20 cm), and pH 6.6 (0–10
cm), while in the CRP study sites the
mean soil pH at depth was pH 6.2 (20–
30 cm), pH 6.0 (10–20 cm), and pH 5.9
(0–10 cm) (Sánchez-de León and
Johnson-Maynard 2009, p. 1397). The
researchers stated they were unsure
whether lower pH (more acid) in CRP
sites correlated with some other non-
measured soil parameter, such as
previous fertilizer applications and
resultant increased organic matter. They
hypothesized the negative relationship
between earthworm density and soil pH
could be a reflection of a past land use
rather than a direct effect of soil pH on
earthworms (Sánchez-de León and
Johnson-Maynard 2009, p. 1399). Other
studies in the Palouse region
demonstrated the mean soil pH in
direct-seeded agricultural fields was pH
5.35, and in conventional tillage fields
One commenter (McGregor 2010,
in litt., p. 4) stated less than 0.5 to 1 percent
of the soils sampled in the Palouse have
pH levels below 5.

In summary, studies investigating
relationships between earthworms and
soil pH indicate that earthworm
response can vary with species,
location, life-history strategy, or other
attributes. The best available scientific
information on this relationship for the
GPE is limited (e.g., to our knowledge,
only the Smoot Hill study has
investigated the potential soil pH
relationship). There is significant
uncertainty regarding the correlation
between soil pH and GPE occurrence or
persistence, and insufficient data to
identify pH cause-and-effect
relationships that might be limiting for
the persistence of this species. However,
in the Palouse region, soil pH levels do
not appear to be so acidic (below pH 5)
that they negatively affect earthworms
generally. Also, the GPE may be more
tolerant to acidity than some species of
earthworms. In addition, the range of the
GPE is wider than previously
known, and includes pine forests on the
eastern slope of the Cascades, although
the full extent and type of forested
habitats occupied by the GPE are not yet
known. Detailed soil characteristics are
not known for the GPE location near
Leavenworth, Washington. Accordingly,
the best available information does not
indicate that changes in soil chemistry
represent a threat to the GPE.

Tillage and Agriculture
The petition states that tillage
removes the original topsoil, which may
reduce earthworm burrow densities, soil
aeration, soil infiltration rates, and the
amount of organic matter available to
the GPE for forage (Petition, pp. 10–11).
Literature cited by the petitioners stated
the original topsoil has been lost from
10 percent of cropland, and 60 percent
of cropland has lost 25 to 75 percent
of its topsoil (Veseth 1986b, p. 2). The
petition did not present detailed
information on agriculture activities in
the Ellensburg area, although the
14–22) presented with the petition
includes maps and photographs
depicting areas converted to agriculture
within the Ellensburg, Washington, city
boundaries.

The potential threats to the GPE from
tillage and cultivation are reduced food
sources and burrow compaction, but
would likely vary depending on its life-
history strategy. Annual crops put a
small fraction of their production into
root mass (James 2009, in litt., pp. 3–4),
whereas perennial prairie grasses put
approximately 50 percent of their
annual production into roots, which
provide resources for soil invertebrates
(including endogeic earthworms).
Endogeic earthworms, which the
petitioners assert the GPE to be (James
2009, in litt., pp. 3–4), would probably
be more susceptible to agricultural
activities that reduce soil organic
matter, based on their need for organic
matter as a food source. However,
anecic earthworms use surface litter as
a food source, and the best available
scientific information supports the GPE
being an anecic earthworm species. In
either case, surveys to date in the
Palouse have not documented the GPE
in either agricultural fields or CRP lands
(Fauci and Bezdicek, 2002, p. 254;
Sánchez-de León and Johnson-Maynard
2009, p. 1393; Johnson-Maynard et al.
2007, p. 340). Therefore, we have no
information indicating that the GPE
would be exposed to reduced soil
organic matter or reduced surface litter
caused by ongoing cultivation in the
Palouse region.

One Australian study demonstrated
that 3 years of tillage reduced
earthworm burrow density by nearly 90
percent (Chan 2004, p. 89; Petition, p.
10), which reduced the maximum
infiltration rate of the soil and
significantly increased the likelihood of
runoff (Chan’s study (2004, p. 90) compared tillage effects to soil
infiltration by monitoring burrow
density for the North Auckland worm
(Spenceriella hamiltoni), an anecic
member of the Megascolecidae (in the
same family as the GPE), under three
conditions: no-till (crops drilled directly
into ground with a special slit drill),
conventional one-pass, and
conventional two-pass tilled agriculture
(Chan 2004, p. 94). The effect of tillage
on earthworm abundance is usually
negative because tilling causes physical
damage and burial of residues, although
tillage could also increase the
abundance of some earthworm species
due to increases in food supply by
incorporation of residues into the soil
(Chan 2004, p. 90). In this study, tillage
was found to decrease burrow density
and water infiltration into the soil (Chan
2004, pp. 89, 94). The author concluded
that under cropping, preservation of
earthworm burrows can be achieved by
adopting conservation tillage techniques
(Chan 2004, p. 96). Conservation tillage
techniques generally involve
establishing crops in a previous crop’s
residues, which conserves water and
minimizes soil disturbance and erosion.

Johnson-Maynard (September 24,
2010, in litt., p. 2) discusses studies in
which tillage effects on earthworm
density were found to be dependent on
the ecological grouping of earthworms
in an area (i.e., anecic or endogeic).
Chan (2001, pp. 179, 185–187) found in
a 3-year study that tillage had a strong
negative impact on anecic species due
to a combination of direct damage,
burial of residue (food source), and
destruction of earthworm burrows,
while endogeic species were positively
affected in the short term due to their
smaller size (less physical damage) and
increased availability of organic matter.
In the Palouse bioregion, tillage removes
the original topsoil, which may reduce
earthworm burrow densities, soil
aeration, soil infiltration rates, and the
amount of organic matter available to
the giant Palouse earthworm for forage
(Veseth 1986b, p. 2; Petition, pp. 10–11).
Edwards and Bohlen (1996, p. 213)
noted that earthworm populations were
larger in soil that was manipulated using no-till methods.
No-till agriculture accounted for 14,563
acres (5,893 hectares), or roughly 5
percent of the total surveyed acreage in
the Palouse in 1989, up from the
previous 5-year average (1984–1988) of
3 percent (Hall 1999, p. 15).

The GPE has been documented in
the Palouse in remnant native grassland
and in Douglas-fir forests, and in ponderosa
pine forest at the Leavenworth site near
Chelan, Washington. The GPE
distribution is widely unknown, but its
total distribution remains uncertain
because the species is very
difficult to detect, survey protocols are still being developed, and the level of survey efforts within and outside of the Palouse area has been very low. While there may have been historical impacts to the GPE from agriculture in the Palouse, the magnitude of threats from those activities is difficult to determine because we have no baseline population or distribution information with which to make a comparison, other than the anecdotal statement in Smith (1897, pp. 202–203). In addition, to date the GPE has not been found in agriculture fields in the Palouse, and we have no information that indicates the GPE is or will be exposed to tillage and agriculture. Accordingly, the best available information does not indicate that tillling and agriculture represent a threat to the GPE.

Grazing

James stated that grazing degrades earthworm habitats, potentially to the point of causing extirpation, and that soil compaction from livestock grazing can affect earthworms by making burrowing and feeding more difficult (James 2000, pp. 9–10). The petition also claims that livestock grazing changes the quality and accessibility of detrital material, decreasing organic matter available to earthworms through conversion of herbage to partly digested clumps of organic matter (James 2000, p. 9; Petition, p. 14).

Individuals also commented that grazing degrades earthworm habitats, potentially to the point of causing extirpation, and that soil compaction from livestock grazing can affect earthworms by making burrowing and feeding more difficult (James 2000, pp. 9–10). The petition also claims that livestock grazing changes the quality and accessibility of detrital material, decreasing organic matter available to earthworms through conversion of herbage to partly digested clumps of organic matter (James 2000, p. 9; Petition, p. 14).

The petitioners describe livestock grazing as a pervasive land use in the range of the GPE. James (2000, p. 9) stated: (1) Livestock grazing can cause soil compaction, thereby making burrowing and feeding more difficult for earthworms; (2) effects are variable by earthworm species or habitat type (or both); (3) large earthworm species are less heavily impacted by grazing; and (4) “without further knowledge about native earthworms and the presence or absence of earthworms in lands subject to grazing in the Columbia River basin assessment area, it is of little use to speculate further.” Cluzeau et al. (1992, pp. 1661, 1663) demonstrated intensive trampling by cattle can reduce earthworm densities, particularly for smaller species and those living near the surface. No specific information was provided by the petitioners regarding the extent of livestock grazing impacts in the Palouse or Ellensburg areas. However, several individuals (Field 2010, in litt., p. 2; Jensen 2010, in litt., p. 6) commented that grazing can benefit some earthworms through increasing organic matter and plant species. Taylor and Neary (2008, p. 2) claimed that grazing can benefit some earthworm species through increasing organic matter and plant species. Taylor and Neary (2008, p. 2) could be required for those impacts to rise to a level of being a threat to the species. Exposure could also vary, depending on the GPE’s strategy. Anecic species (which we believe the GPE to be based on the best available scientific information) may have less exposure than other forms. For example, the black-headed worm (Aporrectodea longa), an anecic species, was determined to be less susceptible to pesticides because of its ability to burrow deep into the soil. This species also undergoes an obligatory diapause in the summer months, which may limit pesticide exposure (Wheatley and Hardman 1996, p. 126). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms. Contaminant exposure and toxicity depend on a wide range of chemical, physical, and biological factors, and the rate of application. Specific knowledge of the fate and transport of the chemical within the environment, physicochemical attributes of the exposure media, and biological characteristics of the organism are required to determine if a species may be impacted by environmental contaminants. Although pesticide application is widespread within the Palouse, information on GPE distribution, biology, and life history is limited. There is significant uncertainty with regard to determining the potential impact pesticides might present to this species, and what application rate(s) would be required for those impacts to rise to a level of being a threat to the species. Exposure could also vary, depending on the GPE’s strategy. Anecic species (which we believe the GPE to be based on the best available scientific information) may have less exposure than other forms. For example, the black-headed worm (Aporrectodea longa), an anecic species, was determined to be less susceptible to pesticides because of its ability to burrow deep into the soil. This species also undergoes an obligatory diapause in the summer months, which may limit pesticide exposure (Wheatley and Hardman 1996, p. 126). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms.

Chemical Applications

Earthworms have been shown to be sensitive to some pesticides (Edwards and Bohlen 1996, pp. 283–285), and the toxicity varies depending on the type of pesticide used. Generally, carbamates (organic compounds derived from carbamic acid and frequently used in insecticides) are the most toxic (Edwards and Bohlen 1996, pp. 283–285). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms. Contaminant exposure and toxicity depend on a wide range of chemical, physical, and biological factors, and the rate of application. Specific knowledge of the fate and transport of the chemical within the environment, physicochemical attributes of the exposure media, and biological characteristics of the organism are required to determine if a species may be impacted by environmental contaminants. Although pesticide application is widespread within the Palouse, information on GPE distribution, biology, and life history is limited. There is significant uncertainty with regard to determining the potential impact pesticides might present to this species, and what application rate(s) would be required for those impacts to rise to a level of being a threat to the species. Exposure could also vary, depending on the GPE’s strategy. Anecic species (which we believe the GPE to be based on the best available scientific information) may have less exposure than other forms. For example, the black-headed worm (Aporrectodea longa), an anecic species, was determined to be less susceptible to pesticides because of its ability to burrow deep into the soil. This species also undergoes an obligatory diapause in the summer months, which may limit pesticide exposure (Wheatley and Hardman 1996, p. 126). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms.

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Earthworms have been shown to be sensitive to some pesticides (Edwards and Bohlen 1996, pp. 283–285), and the toxicity varies depending on the type of pesticide used. Generally, carbamates (organic compounds derived from carbamic acid and frequently used in insecticides) are the most toxic (Edwards and Bohlen 1996, pp. 283–285). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms. Contaminant exposure and toxicity depend on a wide range of chemical, physical, and biological factors, and the rate of application. Specific knowledge of the fate and transport of the chemical within the environment, physicochemical attributes of the exposure media, and biological characteristics of the organism are required to determine if a species may be impacted by environmental contaminants. Although pesticide application is widespread within the Palouse, information on GPE distribution, biology, and life history is limited. There is significant uncertainty with regard to determining the potential impact pesticides might present to this species, and what application rate(s) would be required for those impacts to rise to a level of being a threat to the species. Exposure could also vary, depending on the GPE’s strategy. Anecic species (which we believe the GPE to be based on the best available scientific information) may have less exposure than other forms. For example, the black-headed worm (Aporrectodea longa), an anecic species, was determined to be less susceptible to pesticides because of its ability to burrow deep into the soil. This species also undergoes an obligatory diapause in the summer months, which may limit pesticide exposure (Wheatley and Hardman 1996, p. 126). In addition, although chemicals may not result in direct toxicity, they may have indirect effects such as reduction in organic matter, which is a food source for earthworms.
The impact of forest management actions on soils varies, and uneven-aged management (i.e., clearcut harvest) can result in machinery-induced soil compaction over a larger area than even-aged management (i.e., clearcut harvest) (Harvey et al. 1994, p. 44). However, while selective timber harvest practices may result in soil disturbance or compaction from heavy equipment, there will be less loss of surface or soil organic matter than when clearcut timber harvest methods are used (James 2000, p. 10). Forest management operations can alter the cycling of above-ground organic materials and their incorporation into soil (Harvey et al. 1994, p. 11), which may result in not only impacts to soil nutrients, but also changes to soil characteristics such as water-holding capacity, aeration, drainage, and cation exchange.

The GPE has been documented in Douglas-fir forest at Moscow Mountain in the Palouse, and recently confirmed in dry ponderosa pine forest near Leavenworth, Washington (see Table 1 above), although information regarding details on the forest stand at the GPE locations, and the extent of habitats the GPE occupies in forested environments, is incomplete. Forest types have changed in the Columbia Basin since historical times, although the numbers of forested acres are not substantially different (Quigley et al. 1996, p. 54). The potential impacts to the GPE from forest management activities would likely depend on whether the species requires certain forest types or ages, and if so, the specific nature of the management prescription being applied in those areas. There are uncertainties with regard to whether the GPE is restricted to certain types of forests, certain ages of forest, or certain elevations or other site characteristics, or whether surface vegetation is relevant to the species. If the GPE occurs in multiple types and ages of forest, the availability of a particular forested habitat type may not be a limiting factor, and forest management may have little impact.

James stated in 1995, that he can “confidently state that nothing is known of the impact of any management practice on any Columbia River Basin native earthworm species” (James 1995, p. 12). However, in 2000, James stated that logging: (1) Degraded earthworm habitat, potentially to the point of causing extirpation and changes in plant communities, and (2) may degrade habitat through changing soil type, soil temperature, moisture regime, or food resources (James 2000, p. 10). In his 2000 study, James also related the primary effect of tree removal on endogeic earthworms to soil climate and the availability of surface and soil organic matter sufficient to support earthworms until second-growth plants become established. James also stated
that epigeic species would be expected to suffer most from the loss of tree cover because the preferred microhabitat would be less hospitable and ultimately less abundant, with the loss of annual leaf input, and indicated that disturbance caused from heavy equipment use may be the most deleterious to earthworms (Shafer and others 1990, in James 2000, p. 10). However, James did not discuss how these types of activities would affect an earthworm species with a deep-burrowing, anecic, life-history strategy (James 2000, p. 10), such as the GPE. The Service recognizes that forest management activities can affect soils, temperatures, and vegetation, and the impacts would vary with types of forest management, types of forest, and habitat needs of the GPE. However, we were unable to determine how much forested habitat the GPE occupies or where it occurs in forested habitat (other than the above confirmed localities). Additional surveys will be needed to determine the extent of forested habitat occupied by the species. In addition, we have no information to indicate how GPE would respond to different types of forest management activities. Therefore, the best available information does not indicate that forest management activities represent a threat to the GPE.

Summary of Factor A

The GPE is known to occur in both grassland habitats and forested habitats in the Palouse. Native grassland habitats in the Palouse have declined to very low levels; information on changes to forested habitats in the Palouse is less well understood. The species’ range outside of the Palouse region is substantially greater than was previously known, and includes portions of the eastern slope of the Cascade Mountains. Survey efforts have been limited, it is difficult to survey for the species, and effective survey methods remain to be developed. In addition, there are significant scientific uncertainties regarding the GPE’s distribution, habitat diversity, biology, and population trends, which need to be resolved to be able to conduct a credible scientific assessment of potential threats to the species. The best available information is inconclusive with regard to whether soil pH is a limiting factor, or whether there are certain types of management activities that affect soil pH in a manner that presents a threat to the GPE. The literature suggests that compacting soils may result in impacts to earthworms, depending on their life-history stage. However, there is no information with which to determine with reasonable confidence whether soil compaction is occurring in GPE habitat, and if so, whether it would result in a negative response in the species.

While there may have been historical impacts to the GPE from agricultural conversion in the Palouse, most agriculture conversion activities were completed by 1910 (McGregor, 1982, p. 109). The extent to which agricultural activities currently present a threat to the GPE is undeterminable, given the limited information available on the species’ life history, its range, and the diversity of habitat types where it occurs. However, the species has not been collected in agricultural areas to date. The extent of the GPE’s range and habitat types used beyond the Palouse is also unknown. While there may potentially be impacts from grazing activities, we have an incomplete understanding of the species’ occupied habitat, whether grazing occurs therein, the magnitude and intensity of grazing activities in those areas, and the GPE’s exposure to grazing impacts. We have some information on pesticides used in the Palouse area, and we have generalized information on pesticide toxicity to earthworms. However, we are unable to correlate that information to soils or habitats used by the GPE in the Palouse or elsewhere, and whether the GPE is exposed to those chemicals. The limited information on pesticide applications in the Ellensburg, Washington, vicinity is not instructive with regard to whether or not those activities might threaten the GPE, and there is no information related to pesticide application in the Leavenworth, Washington, GPE locality. Because of our limited knowledge of the species’ range and occupied habitat, we cannot credibly evaluate the threat of urban or rural development to the species. We recognize that forest management activities can affect soils, temperatures, and vegetation, but there is no information correlating these activities to a possible negative response by the GPE. In summary, there is very little information available, and the best available scientific information does not indicate that threats from deforestation, modification, or curtailment of the GPE’s habitat or range from any of the above activities constitutes a threat to the species such that listing under the Act is warranted.

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

The petition did not identify overutilization for commercial, recreational, scientific, or educational purposes as a potential threat to the GPE. Unlike butterflies, for example, earthworms are not likely targets for collection by hobbyists. Recent records of the GPE are based on the few individuals that were killed during or after their collection (fewer than 10). While we anticipate some additional GPE mortality due to scientific collection as we learn more about the species, we have no reason to believe the loss of a few individuals for scientific purposes would present a threat to the continued existence of the species. Therefore, we conclude that overutilization for commercial, recreational, scientific, or educational purposes is not a threat to the species such that listing under the Act is warranted.

Factor C. Disease or Predation

The petition did not identify any threats to the GPE related to disease or predation. Hendrix and Bohlen (2002, p. 802) stated that imported nonnative earthworms may be vectors for plant or animal pathogens or viruses, but the authors do not correlate this potential threat to the GPE. Although James (1995, p. 11) stated that predation on earthworms can be accentuated by tilling the soil and exposing earthworms to bird predators, the correlation to the GPE is uncertain as the GPE is believed to be an anecic species and therefore may be less likely to be exposed by tilling. Also, surveys to date have not found the GPE in agricultural fields, although we acknowledge the extent of those surveys has been limited. However, the species would not be exposed to increased predation caused by ongoing tillage if it does not occupy agricultural areas. In summary, we do not have any evidence indicating that disease or predation is a threat to the GPE such that listing under the Act is warranted.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

In our 2010 90-day finding (75 FR 42064; July 20, 2010), we determined the existing regulatory mechanisms may be inadequate to address potential threats to the GPE. The petitioners claim Federal, State, or local regulations do not specifically protect the GPE or its habitat. The Washington Department of Fish and Wildlife identifies the GPE as a species of concern (WDFW 2009, p. 1), although this status does not provide regulatory protection for the species. The petition states the Palouse Subbasin Management Plan (Gilmore 2004) includes objectives to protect and restore native grassland habitat within the Palouse subbasin, and increase wildlife habitat value on agricultural land, but is voluntary in nature and
does not provide regulatory mechanisms that protect the GPE or its habitat.

Habitat conversion in the Palouse may still occur, as neither Latah County, Idaho, nor Whitman County, Washington, have ordinances or regulations to prevent native habitat conversion (Latah County Board of Commissioners 2010, pp. 1–27; Whitman County 2010, pp. 1–76). However, we do not have evidence that habitat loss is a threat (see Factor A discussion). The petition also acknowledges the existence of the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, Environmental Protection Agency, and National Oceanic and Atmospheric Administration (NOAA) Fisheries Memorandum of Understanding (MOU, USDA Forest Service et al. 2003), in which the agencies agreed to voluntarily utilize the scientific findings of the Interior Columbia Basin Strategy (CBS) to guide project implementation and to revise resource management plans. The petitioners state the MOU and CBS do not address the GPE or provide regulatory mechanisms for its protection (Petition, p. 15), and claim existing regulations are ineffective in reducing the importation of nonnative earthworm species, which present a threat to the GPE. However, the best available information does not indicate that exotic earthworms represent a threat to the GPE (see Factor E discussion).

The U.S. Environmental Protection Agency (EPA) Office of Pesticide Programs evaluates which ingredients and which pesticide products can be used (registered) in the United States. The EPA evaluates the potential effects of pesticides on human health and the environment, conducts risk assessments, and works with companies to develop label instructions that ensure safety (see the National Pesticide Information Center at http://www.npic.orst.edu/reg.htm). One study found the use of pesticides at recommended rates had no detectable negative effects on earthworms or anecic or endogeic species (Simonsen et al., 2010, cited in Johnson-Maynard, 2010, in litt., p. 2). Therefore, the best available information indicates that the species is not threatened by the inadequacy of pesticide management.

Surveys for the GPE have been limited, and there are significant uncertainties regarding the species’ distribution and life history, as well as the diversity of habitat types where it may be found. This type of information is essential to credibly assess whether or not existing regulatory mechanisms are adequate to address potential threats to the species. While we acknowledge the regulations and plans described above do not provide specific protections for the GPE, we have no information to indicate this lack of specific protections is resulting in threats to the species. Therefore, we find that the available information does not support a conclusion that the inadequacy of existing regulatory mechanisms is a threat to the GPE.

**Factor E. Other Natural or Manmade Factors Affecting the Species’ Continued Existence**

The petitioners claim that the GPE is threatened by invasive, nonnative earthworms (Petition, p. 1). In a 3-year study of earthworms in the Palouse region of eastern Washington and Idaho, Sánchez-de León and Johnson-Maynard (2009, p. 1393) found a dominance of invasive, nonnative earthworms in both native and nonnative grasslands. Nonnative earthworms can invade new habitats, change the ecological soil functions, and displace native species (Hendrix and Bohlen 2002, p. 805; Petition, p. 16). Earthworm populations are dominated by nonnative earthworms in agricultural sites and native prairie remnants in the Palouse region (Fauci and Bezdicek 2002, p. 257; Sánchez-de León and Johnson-Maynard 2009, pp. 1396, 1399–1400; Petition, p. 16).

Habitat conversion favors invasion of nonnative earthworm species that are better adapted to a disturbed or degraded environment (Petition, p. 16; James 1995, p. 5). James (1995, p. 5) stated that many exotic species occur in the Columbia Basin, possibly altering previously worm-free soils and nutrient cycling pathways, competing with native species, and generally modifying any processes linked to soil physical or chemical properties. He also stated that invasive earthworm species present a potential threat to the GPE, and described the loss of a deep-dwelling Illinois earthworm species as an example of this threat, although the particular study was not cited (James 2000, in litt., p. 2). Based on the limited information that was provided, we were unable to locate the study. James stated that although invasive earthworms do not always reduce or eliminate populations of indigenous worms, the invasion cannot help, and some species may be highly competitive with, a deeper-dwelling species like the GPE, while others may not (James 2009, in litt., p. 2). There are substantial weaknesses in extrapolating data from an Illinois earthworm species to the GPE, because information that would indicate the responses would be similar. While the Service concludes that the GPE is anecic based on the best available information, there is some expert disagreement on the GPE’s life-history strategy. However, it is unclear whether this matters in relation to invasion by nonnative earthworms, and James (2009 in litt., p. 2) did not present a scientific basis for using an Illinois species as a surrogate for the GPE.

We agree that a correlation of decline and extirpation of some native earthworm species with the arrival of introduced earthworm species is well documented (Hendrix and Bohlen 2002, pp. 805–806; Sánchez-de León and Johnson-Maynard 2009, pp. 1393–1394), although the cause may not always be direct. The causes of the declines of native species of earthworms are not documented, but theories center on ecosystem disturbance (Hendrix and Bohlen 2002, pp. 805–806) and competitive exclusion (James 2000, p. 8; Hendrix and Bohlen 2002, pp. 805–806).

In addition, James (2009, in litt., p. 2) noted that invasive earthworms do not always reduce or eliminate populations of indigenous earthworms. Depending on ecological requirements, some species may be highly competitive with a deeper-dwelling species like the GPE, and some not competitive, or there may be a combination of effects coupled with habitat modification. Co-occurrence of native and nonnative earthworm species is common both in disturbed and undisturbed ecosystems; however, it is not known if this is a transient or permanent state (Hendrix 2006, p. 1203). Ecosystem disturbance sufficient to degrade or destroy habitat for native species may be caused by the arrival of introduced worm species, or the arrival of introduced species may follow habitat degradation caused by other factors (Hendrix and Bohlen 2002, pp. 805–806). Nonnative earthworm invasions may depend on the degree of disturbance, competition with natives, and adaptability to site conditions (Hendrix and Bohlen 2002, p. 1203; Sánchez-de León and Johnson-Maynard 2009, p. 1394).

In a 2003–2005 research effort in the Palouse region of southeastern Washington and northern Idaho, Sánchez-de León and Johnson-Maynard (2009, pp. 1394–1395) compared four paired study sites representing native prairie remnants and CRP set-aside lands. The study objective was to characterize and compare native and nonnative earthworm populations in two important grassland ecosystems within the Palouse region. Their results found that one invasive earthworm species, the southern worm (Aporrectodea trapezoides) comprised...
90 percent of the total earthworm density in their study areas (Sánchez-de León and Johnson-Maynard 2009, p. 1396). One GPE was collected at one of the four prairie remnant study sites. The authors suggested that because native earthworms are found in fragmented native habitats along with exotic earthworms, the GPE may be able to coexist with exotic species in Palouse prairie remnants. They indicated that further study would be required to determine whether the GPE is a resilient species based on its deep-burrowing behavior, or whether the results of their study demonstrate a species replacement process (Sánchez-de León and Johnson-Maynard 2009, pp. 1398).

The rarity of native earthworms in their native prairie remnant study areas lends support to the researchers’ theory that native earthworms are being replaced by nonnative earthworms, even in visibly intact remnants of fragmented habitats (Sánchez-de León and Johnson-Maynard 2009, pp. 1398–1399). The researchers suggested *Aporrectodea trapezoides* may compete with the GPE for food in upper layers of soil (Sánchez-de León and Johnson-Maynard 2009, pp. 1398–1399), but could not exclude the possibility that the GPE did not historically occur in high densities within these prairie remnants because of their steep slope or high rock content, the very factors that prevented these areas from being plowed and preserved them as remnant prairie (Sánchez-de León and Johnson-Maynard 2009, p. 1398). They acknowledged that these findings are inconsistent with other studies showing that native earthworms predominate in undisturbed or minimally disturbed grasslands (James 1991, pp. 2101–2109; Callahan et al. 2003, pp. 1079–1093; Winsome et al. 2006, pp. 38–53; in Sánchez-de León and Johnson-Maynard 2009, pp. 1397–1398).

The researchers suggested that a combination of extensive habitat fragmentation in the Palouse region, low habitat quality of remaining prairie remnants, and possible competitive interactions with nonnative earthworms could have decimated GPE populations at their study sites (Sánchez-de León and Johnson-Maynard 2009, p. 1398). They acknowledged that no information is available on GPE pre-agricultural density or distribution, but the description of the species as being abundant by Smith (1897) contrasts with the rarity of finding the earthworm today. They stated that this suggests a significant reduction in population size (Sánchez-de León and Johnson-Maynard 2009, pp. 1394, 1399), but acknowledge their sampling methodology could have influenced the results. The hand-sorting sampling method is regarded as the best method to estimate abundance of most earthworm species, but is also known to underestimate the abundance of deep-burrowing species. The researchers recommend the use of a combination of methods for future studies, including non-destructive alternatives such as electrical methods or extraction methods with chemicals of low toxicity that are more suited for deep-burrowing earthworm species (Sánchez-de León and Johnson-Maynard 2009, p. 1399). The GPE’s range is more extensive than previously known, survey efforts for this species have been limited, and effective survey protocols remain to be developed. We acknowledge conflicting opinions by earthworm researchers regarding the GPE’s life-history strategy, which could influence how it interacts with exotic earthworms. However, we believe the prevailing evidence points to the GPE being a deep-burrowing anecic species, based on observations in the field by scientists who appear to be most familiar with this particular species, and the report by Smith (1897, pp. 202–203) describing burrows extending to a depth of over 15 feet in new road cuts. Endogeic worms (which the petitioners believe the GPE to be) live in the upper layers of mineral soil, whereas anecic earthworms live in deep, semi-permanent burrows. The researchers Sánchez-de León and Johnson-Maynard also acknowledge that the hand-sorting sampling method (which has apparently been applied in most earthworm surveys) most likely underestimates the abundance of deep-burrowing species. In addition, the limited evidence available does not lead to a reasoned scientific conclusion regarding competitive interactions between exotic earthworms and the GPE. In summary, we do not have evidence to support a conclusion that competition with exotic earthworms is a threat to the GPE.

Nonnative Plants

The petitioners describe the existence of introduced annual grasses and noxious weeds in the Palouse region, including *Poa pratensis* (Kentucky bluegrass), crops, *Bromus tectorum* (cheatgrass), and *Centaurea solstitialis* (yellowstar-thistle) (Gilmore 2004, pp. 1–87), and state that it is likely these species do not provide the same quality and quantity of earthworm forage as native vegetation (Petition, p. 17). However, they did not provide any evidence to support this statement. There may be differences in nutritive value between weeds and native plants, and there may be differences in phenology (e.g., nonnative plants emerging at a different time than native plants), but it is unknown if this is important to the GPE. Invasive weed control in the Palouse is difficult (Jensen, 2010, in litt., p. 3; Nyamai 2009, pp. 6–7, 21–22). Native plant communities in the Palouse are susceptible to invasion by nonnative plants (Gilmore 2004, pp. 1–26; James 2000, p. 8); domination of deep-soil sites by Kentucky bluegrass is common, and in shallow soils cheatgrass and yellowstar-thistle weeds compete with native grasslands. McGregor (1982, pp. 124–125) commented that nonnative weeds, including cheatgrass, have been present in the Palouse region since the 1890s. The Draft Palouse Subbasin Management Plan (Gilmore 2004, pp. 1–86) states that exotic weed invasions are possibly the greatest threat facing the grasslands and shrublands of the arid and semiarid West today, and species-rich ecosystems are being converted to monotonous weedlands as aggressive weeds replace native plants and degrade habitat for wildlife.

There are significant scientific uncertainties regarding the distribution and life history of the GPE, and the range of habitat types it occupies is unknown. Although there have been some studies relevant to nonnative plant invasion and conversion of native habitats and ecosystems, we are unaware of any scientific studies or other data that would allow an extrapolation of these observations to the GPE. Accordingly, we have no information to indicate that the introduction of nonnative plants represents a threat to the species.

Climate Change

The petitioners noted that, because Fender and McKee-Fender (1990, p. 366) describe annual precipitation as a parameter of GPE habitat, it is likely that changing weather patterns caused by global warming will impact this species’ habitat and distribution (Petition, p. 17). This citation in fact defines the lower limit of precipitation tolerated by argilophilini worm species to be about 15 in (38 cm) annually, which the authors characterize as being “about the edge of moist forests in our area, although the range of *Driloleirus americanus* extends into treeless areas.” Although the petition expresses a concern about future climate change and its effects on the GPE, it did not present information or data in this regard.

The Service evaluated information available in our files and queried other available information related to this potential threat. Lawler and Mathias
investigated possible climate change impacts to vascular plants, stating that plants may mature earlier, creating potential mismatches between pollinators and plants, parasites and hosts, and herbivores and food sources; increased summer temperatures and decreased summer precipitation may lead to changes in distribution of some plant species; sagebrush steppe and grasslands may contract, while dry forests and woodlands expand; and plant distribution changes will depend in part on plant water-use efficiencies. According to the United Nations Framework Convention on Climate Change (2010, p. 1), plant growth may benefit from fewer freezes and chills, but some crops may be damaged by higher temperatures, particularly if combined with water shortages. Certain weeds may expand their range into higher-latitude habitats. Higher levels of carbon dioxide should stimulate photosynthesis in certain plants, in principle. This is particularly true for C3 plants (named for their carbon fixation pathway) because increased carbon dioxide tends to suppress their photo-respiration. C3 plants make up the majority of species globally, especially in cooler and wetter habitats, and include most crop species, such as wheat, rice, barley, cassava, and potato. It is difficult to predict how or if future changes in growth or distribution of vegetation resulting from climate change will affect local conditions for weeds, native vegetation, or both, or to predict how such changes would affect earthworms. Earthworm mortality can result from extreme temperatures, and the upper lethal temperature for different earthworm species is lower than for other invertebrates (Edwards and Bohlen 1996, p. 146) (e.g., 28 °C (82 °F) for Lumbricus terrestris; 37 to 37.75 °C (98.6 to 100 °F) for Pheretima californica (Schread 1952, as referenced in Edwards and Lofty 1977, pp. 156–157)). Earthworms tolerate higher temperatures by migrating, or burrowing deeper, but must still be able to feed on the surface or the top layers of the soil. The petition did not present any specific information, and we are unaware of any studies, that would facilitate an evaluation of the extent to which the GPE may be affected by: (1) Increased air temperatures or soil changes; (2) earlier seasonality of plant production; or (3) changes in plant distribution. Climate change models used in the Intergovernmental Panel on Climate Change Fourth Assessment Report project increased air annual temperatures in the Pacific Northwest of, on average, 1.1 °C (2.0 °F) by the 2020s, 1.8 °C (3.2 °F) by the 2040s, and 2.9 °C (5.3 °F) by the 2080s, compared to 1970 and 1999 (averaged across all climate models); however, increased air temperature does not necessarily correlate with increased surface or soil temperatures. Projected changes in annual precipitation averaged over all models are small (+1 to +2 percent), but some models project an enhanced seasonal precipitation cycle with changes toward wetter autumns and winters, and drier summers (Littell et al., 2009, p. 1). In the Pullman, Washington, area, baseline annual precipitation is estimated at 21.1 in (53.6 cm); models projecting to 2080 do not project annual precipitation below 15 in (38.1 cm) under any scenarios (Climate Impacts Group 2009, pp. 197–198). Fifteen inches (38.1 cm) of annual precipitation has been suggested as the lower limit of precipitation tolerated by argilophilini worm species, such as the GPE (Fender and McKey-Fender 1990, p. 366).

The impact of climate change on selected but economically significant crops in eastern Washington was predicted to be generally mild in the short term (i.e., the next two decades), but increasingly detrimental with time (potential yield losses reaching 25 percent for some crops by the end of the century). The projected elevated carbon dioxide (CO₂) was expected to provide significant mitigation of climate change and its effects, and in fact result in important yield gains for some crops (Littell et al. 2009, p. 212), and it is likely that some native or nonnative plants would be similarly increased, potentially increasing the forage base for GPE.

Existing climate change projections are inadequate to allow a prediction regarding whether or how future climate change will impact the GPE or its habitat. This is further complicated by the significant uncertainties that exist regarding the species’ distribution, biology, and habitat needs. However, given that the prevailing evidence indicates the species is anecic based on the results of survey efforts and the description of deep burrows associated with the species (Smith 1897, pp. 202–203), it is reasonable to conclude the species’ deep-burrowing behavior will limit its exposure and increase its adaptability to increased soil temperatures. It is unclear how or whether drier summers would impact the GPE, or whether vegetation changes would impact the GPE. Therefore, based on the best available information, we conclude that climate change does not constitute a threat to the species.

Summary of Factor E

Although the decline and extirpation of some native earthworm species with the arrival of introduced earthworm species has been well documented, survey efforts for this species have been limited and effective survey protocols remain to be developed. In addition, there are conflicting opinions by earthworm researchers regarding the GPE’s life history strategy, which could influence how it interacts with exotic earthworm species. Native plant communities in the Palouse bioregion are susceptible to invasion by nonnative plants, although we are unaware of any studies that correlate nonnative plant invasion and conversion of GPE habitat. The petition stated that future climate change could affect the GPE, although no supporting information or data was presented. Our examination of this concern has determined that existing climate change projections are inadequate to predict how future climate change may impact the GPE, which is further complicated because of the significant uncertainties regarding the species’ distribution, life history, and the range of habitat types it occupies. In summary, there is no scientific evidence to support a conclusion that the GPE is threatened by competitive interactions with exotic earthworms, the conversion of habitat by nonnative plants, or future climate change.

Summary of Factors

A summary of our conclusions for each of the five factors is found in Table 2. More specific information for each threat considered under the five factors is available in the Summary of Information Pertaining to the Five Factors section above.
TABLE 2—SECTION 4(A)(1) LISTING FACTORS SUMMARY OF POTENTIAL THREATS CONSIDERED—Continued

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor A</td>
<td>Climate change: The best available information is insufficient to determine the extent to which the GPE might be affected by climate change, including projected changes in temperature and precipitation.</td>
</tr>
<tr>
<td>Factor B</td>
<td>Mortality resulting from scientific collections: Earthworms are not targets for collection by hobbyists; some mortality is expected from scientific collection, but we have no basis to conclude that removal of a few individuals for this purpose would have population-level impacts.</td>
</tr>
<tr>
<td>Factor C</td>
<td>Predation resulting from exposure during tilling operations: GPEs have not been observed in agricultural areas; the GPE is believed to be an anecic species, which would be less likely to be exposed by tilling, even if it were to occupy agricultural areas.</td>
</tr>
<tr>
<td>Factor D</td>
<td>Non-regulatory programs and measures: Although the WDFW considers the GPE to be a species of concern and the USFS, FWS, NOAA, BLM, EPA developed a MOU agreeing to use scientific findings of the CBS to guide management plans, these are voluntary measures and have no regulatory effect; EPA pesticide regulations: The EPA regulates use of pesticide in the U.S.; one study found the use of pesticides at recommended rates had no detectable negative effects on anecic or endogeic earthworms; and having a better understanding of GPE distribution, life history, and diversity of habitat used is essential to credibly assess whether existing regulatory mechanisms are inadequate.</td>
</tr>
<tr>
<td>Factor E</td>
<td>Nonnative invasive earthworms: The co-occurrence of native and nonnative earthworms is common in both disturbed and undisturbed ecosystems, and the limited evidence available does not lead to a reasoned scientific conclusion regarding competitive interactions between the GPE and exotic earthworms; Nonnative plants: Significant scientific uncertainties exist regarding GPE distribution, life history, and range; the best available information does not allow an extrapolation of nonnative plant invasion to GPE threats.</td>
</tr>
</tbody>
</table>

Finding

As required by the Act, we considered the five factors in assessing whether the GPE is endangered or threatened throughout all or a significant portion of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the GPE. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with the most qualified GPE experts and queried universities, State agencies, conservation districts, and other entities. In considering what factors might constitute threats, we must look beyond the mere exposure of the species to the factor to determine whether the species responds to the factor in a way that causes actual impacts to the species. If there is exposure to a factor, but no response, or only a positive response, that factor is not a threat. If there is exposure and the species responds negatively, the factor may be a threat and we then attempt to determine how significant a threat it is. If the threat is significant, it may drive or contribute to the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined by the Act. This does not necessarily require empirical proof of a threat.
The Service’s Policy Regarding the Endangered or Threatened Wildlife and Plants; 5-Year Status Reviews of Seven Listed Species

DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service

50 CFR Part 17

Endangered and Threatened Wildlife and Plants; 5-Year Status Reviews of Seven Listed Species

AGENCY: Fish and Wildlife Service, Interior.
ACTION: Notice of initiation of reviews; request for information.

SUMMARY: We, the U.S. Fish and Wildlife Service, are initiating 5-year status reviews under the Endangered Species Act of 1973, as amended (Act), of seven animal and plant species. We conduct these reviews to ensure that our classification of each species on the Lists of Endangered and Threatened Wildlife and Plants as threatened or endangered is accurate. A 5-year review assesses the best scientific and commercial data available at the time of the review. We are requesting the public to send us any information that has become available since the most recent status reviews on each of these species. Based on review results, we will determine whether we should change the listing status of any of these species.

DATES: To ensure consideration, please send your written information by September 26, 2011. However, we will continue to accept new information about any listed species at any time.

ADDRESSES: For how and where to send comments or information, see “VIII. Contacts” under SUPPLEMENTARY INFORMATION.

FOR FURTHER INFORMATION CONTACT: To request information, see “VIII. Contacts” under SUPPLEMENTARY INFORMATION.

Individuals who are hearing impaired or speech impaired may call the Federal Relay Service at 800–877–8337 for TTY (telephone typewriter or teletypewriter) assistance.

SUPPLEMENTARY INFORMATION:
I. Why do we conduct a 5-year review?

Under the Act (16 U.S.C. 1531 et seq.), we maintain Lists of Endangered and Threatened Wildlife and Plants (which we collectively refer to as the List) in the Code of Federal Regulations (CFR) at 50 CFR 17.11 (for animals) and 17.12 (for plants). Section 4(c)(2)(A) of the Act requires us to review each listed species’ status at least once every 5 years. Then, under section 4(c)(2)(B), we determine whether to remove any species from the List (delist), to