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## Department of the Interior

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50 CFR Part 17

Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Big Sandy Crayfish and Endangered Species Status for the Guyandotte River Crayfish; Final Rule

**DEPARTMENT OF THE INTERIOR**

**Fish and Wildlife Service**

**50 CFR Part 17**

**[Docket No. FWS–R5–ES–2015–0015; 4500030113]**

**RIN 1018–BA85**

## Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Big Sandy Crayfish and Endangered Species Status for the Guyandotte River Crayfish

**AGENCY:** Fish and Wildlife Service, Interior.

**ACTION:** Final rule.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the Big Sandy crayfish (*Cambarus callainus*), a freshwater crustacean from Kentucky, Virginia, and West Virginia, and endangered status for the Guyandotte River crayfish (*C. veteranus*), a freshwater crustacean from West Virginia. This rule adds these species to the Federal List of Endangered and Threatened Wildlife.

**DATES:** This rule is effective May 9, 2016.

**ADDRESSES:** This final rule is available on the Internet at *http://www.regulations.gov* under Docket No. FWS–R5–ES–2015–0015 and at our Web site at: *http://www.fws.gov/northeast/crayfish/*. Comments and materials we received, as well as supporting documentation we used in preparing this rule, are available for public inspection at *http://www.regulations.gov.* Comments, materials, and documentation that we considered in this rulemaking will be available by appointment, during normal business hours, at: U.S. Fish and Wildlife Service, Northeast Regional Office, 300 Westgate Center Drive, Hadley, MA 01035; telephone 413–253–8615; facsimile 413–253–8482.

**FOR FURTHER INFORMATION CONTACT:** Martin Miller, Chief, Endangered Species, U.S. Fish and Wildlife Service, Northeast Regional Office, 300 Westgate Center Drive, Hadley, MA 01035; telephone 413–253–8615; facsimile 413–253–8482. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

**SUPPLEMENTARY INFORMATION:**

### Executive Summary

*Why we need to publish a rule.* Under the Endangered Species Act, a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species can only be completed by issuing a rule.

*This rule* makes final the listing of the Big Sandy crayfish (*Cambarus callainus*) as a threatened species and the Guyandotte River crayfish (*C. veteranus*) as an endangered species.

*The basis for our action.* Under the Endangered Species Act, we may determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We have determined that the Guyandotte River crayfish is in danger of extinction (*i.e.,* is endangered) and that the Big Sandy crayfish is likely to become in endangered within the foreseeable future (*i.e.,* is threatened) due primarily to the threats of land-disturbing activities that increase erosion and sedimentation, which degrade the stream habitat required by both species (Factor A), and of the effects of small population size (Factor E).

*Peer review and public comment.* We sought comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We invited these peer reviewers and the public to comment on our listing proposal during two comment periods, for a total of 90 days. We considered all comments and information we received during the comment periods.

### Previous Federal Actions

Please refer to the proposed listing rule for the Big Sandy crayfish and the Guyandotte River crayfish (80 FR 18710; April 7, 2015) for a detailed description of previous Federal actions concerning these species.

### Summary of Comments and Recommendations

In the proposed rule published on April 7, 2015 (80 FR 18710), we requested that all interested parties submit written comments on the proposal by June 8, 2015. We also contacted appropriate Federal and State agencies, scientific experts and organizations, and other interested parties and invited them to comment on the proposal. A newspaper notice inviting general public comment was published in the Lexington Herald on April 9, 2015, and in the Coalfield Progress and Charleston Gazette on April 10, 2015. We did not receive any requests for a public hearing. On December 15, 2015 (80 FR 77598), we reopened the public comment period for an additional 30 days to make the results of two 2015 summer surveys of the species available for public review and comment.

During the initial 60-day public comment period (April 7, 2015, to June 8, 2015) and the reopened 30-day comment period (December 15, 2015, to January 14, 2016), we received public comments from 42,026 individuals or organizations. Of these, 41,974 were form letters submitted by individuals associated with several nongovernmental organizations (NGOs) that expressed support for the listing of the two species but did not provide any new or substantive information. One NGO also submitted a separate comment letter on behalf of itself and 26 other NGOs. This comment letter was supportive of listing the Big Sandy and Guyandotte River crayfishes and generally reiterated information from the proposed rule. We also received five comments from government agencies. Two were generally supportive of the proposed listing, one was opposed, and two did not offer an opinion.

We received 46 comments from individuals, including peer reviewers and various industry groups or companies. Of these 46, 18 were supportive of listing the two species, 14 were opposed, and 7 did not offer an opinion. The remaining seven public commenters submitted comments on topics related to other issues not specific to the listing proposal, such as general criticism of the Act (16 U.S.C. 1531 *et seq.*) or of coal mining. Because these seven comments are not substantive regarding the proposed listing rule, we do not address them further. Comments regarding recommendations for research or conservation actions are outside the scope of this final listing rule, but such recommended actions will be considered during the recovery planning process. All substantive information provided during the comment periods is summarized below and has either been incorporated directly into this final determination or is addressed in the response to comments below.

#### *Comments From Peer Reviewers*

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinion from seven knowledgeable individuals with expertise in the field of astacology (the study of crayfishes) and stream ecology. We received individual responses from six of these peer reviewers.

In general, the peer reviewers all commented that we had thoroughly and accurately summarized the best available scientific data. We incorporated revisions into the final rule as a result of the peer reviewer comments. Any substantive comments are discussed below.

(1) *Comment:* We received conflicting comments from five of the six peer reviewers about the sufficiency of the data from which we determined the population status and trends for the Big Sandy or Guyandotte River crayfishes. Two of the reviewers indicated that additional quantitative evidence was needed to support our conclusions regarding declines in range, population, or abundance for the Big Sandy crayfish, including the historical presence of the species in the lower Levisa Fork and Tug Fork basins. In contrast to the concern regarding a lack of data, a third reviewer commented that the proposed rule was based on more quantitative data than are available for most crayfish species, which supports a fourth reviewer's conclusion that the recent survey data were sufficient to suggest declining ranges and possibly abundances for both species. Finally, a fifth reviewer observed that, while data to inform precise population trends for these (and most other) crayfish species are lacking, the decline in population and range for both the Big Sandy and Guyandotte River crayfishes was undebatable.

*Our Response:* The Act requires that the Service make listing determinations based solely on the best scientific and commercial data available. When we published the proposed rule on April 7, 2015 (80 FR 18710), we relied on the best quantitative and qualitative data available at that time to determine the status of each species, including previous crayfish surveys and habitat assessments, range maps, genetic evidence, analysis of museum specimens, and expert scientific opinion. As we discussed in the proposed rule, the available scientific data indicated that the range of each species has been reduced and that most existing subpopulations of these species had low abundance.

Since publishing the proposed rule, the Service funded additional crayfish surveys in the Upper Guyandotte and Big Sandy River basins to better inform our final analysis. The results of these new crayfish surveys (see Loughman 2015a, entire; Loughman 2015b, entire) generally confirmed our previous analysis of each species' status and range, and are discussed in more detail under Summary of Biological Status and Threats, below. The surveys found two new stream occurrences (four sites) for the Big Sandy crayfish in the lower Tug Fork basin (Loughman 2015a, pp. 10–17). These data, along with the 2009 confirmation of the species in the lower Levisa Fork, support our conclusion that the Big Sandy crayfish historically occupied suitable habitat in the lower portions of these river basins. As discussed in the proposed rule, other lines of evidence that the species once occupied a much greater range in the lower reaches of the Levisa and Tug Fork basins than it currently does include: (1) Genetic evidence that the range of the species within the Big Sandy basin was once much larger than it is presently; (2) the opinion of crayfish experts who have surveyed for the species; and (3) the analogous range reduction of the closely related Guyandotte River crayfish, which is subject to similar environmental stressors and threats as the Big Sandy crayfish.

Additionally, the new occurrence locations in the lower Tug Fork, specifically the three Pigeon Creek sites, indicate an increase in the Big Sandy crayfish's redundancy above what was known when we published the proposed rule. This increase in redundancy also contributes to the species' overall resiliency and is discussed under Summary of Biological Status and Threats, below.

(2) *Comment:* One peer reviewer commented that the existing scientific data may have been insufficient to provide for an accurate assessment of the habitat preferences of the Big Sandy crayfish. This reviewer noted that our cited sources consisted of status and distribution surveys that were not designed to determine specific microhabitats used by the species among the suite of all habitats present. However, this reviewer further stated that the available information does likely support that the Big Sandy crayfish is associated with unembedded slab boulders.

*Our Response:* As we described in the proposed rule, there is consensus among crayfish experts that have surveyed for the Big Sandy and Guyandotte River crayfishes that these species are naturally associated with the faster-flowing sections of streams and rivers because these sections maintain an abundance of unembedded slab boulders that provide shelter for the species. Following publication of the proposed rule, the Service funded additional crayfish surveys (224 individual survey sites) throughout the ranges of both species (see Loughman 2015a, entire; Loughman 2015b, entire). All Big Sandy and Guyandotte River crayfish collected during these surveys were associated with faster-flowing waters in streams with unembedded substrates and slab boulders. At sites where these habitat conditions were degraded or absent, more generalist crayfish species (*e.g.,* the spiny stream crayfish (*Orconectes cristavarius*)) were dominant and were found utilizing other instream habitats including woody debris snags and leaf packs. Neither the Big Sandy crayfish nor Guyandotte River crayfish was found associated with woody debris or leaf packs.

*(3) Comment:* One peer reviewer questioned our conclusion that the Flannagan Reservoir posed a barrier that prevented Big Sandy crayfish movement between the Pound River and the Cranes Nest River subpopulations. The reviewer correctly noted that the Flannagan Reservoir was not sampled for the Big Sandy crayfish. The reviewer referenced a scientific study on a different species of stream crayfish native to Arkansas and Missouri that had been found to inhabit a reservoir in Missouri as evidence that the Flannagan Reservoir might not be a barrier to the Big Sandy crayfish.

*Our Response:* We are not aware of any surveys for the Big Sandy crayfish in the Flannagan Reservoir, but because reservoirs generally lack flowing water and accumulate bottom sediments at an accelerated rate (Baxter 1997, p. 259; Appalachian Power Company 2008, pp. 28–33), it is reasonable to conclude that the bottom substrate in the Flannagan Reservoir (and the lower reaches of the Pound and Cranes Nest Rivers, which form arms of the reservoir) lacks unembedded slab boulders and is therefore likely not suitable habitat for the Big Sandy crayfish. However, because no physical barrier separates the subpopulations of Big Sandy crayfish in the Pound River and Cranes Nest Rivers, we do not rule out that these subpopulations may interact with each other, perhaps seasonally when reservoir levels are lowered and the lower portions of these rivers temporarily assume more riverine characteristics. However, the best available data support our ongoing conclusions that the Flannagan Dam poses a barrier between the Pound River and Cranes Nest River subpopulations and the wider Russell Fork and Levisa Fork populations because it physically separates areas of suitable habitat, and that habitat fragmentation is a threat to the species.

(4) *Comment:* Several peer reviewers commented on other potential threats to the Big Sandy and Guyandotte River crayfishes and suggested that we discuss the effects of climate change and dams on the two species.

*Our Response:* We agree that the potential effects of dams and climate change on the two species warrant further analyses; we have incorporated these below, under Factors A and E, respectively, in this final rule.

(5) *Comment:* One peer reviewer examined the genetic data in GenBank® (a database of genetic sequence data maintained by the National Center for Biotechnology Information; see *http://www.ncbi.nlm.nih.gov/genbank/*) and commented that the available molecular evidence suggests that the Big Sandy and Guyandotte River crayfishes are distinct taxonomic entities that are only distantly related to each other. The reviewer also commented that additional genetic analysis of coexisting *Cambarus* crayfish species in the region is needed to better understand their relationships.

*Our Response:* We appreciate this additional independent analysis that supports our conclusion that the Big Sandy and Guyandotte River crayfishes are separate taxonomic entities. And while we also agree that additional genetic research on the native crayfish of this region would help inform future conservation efforts, we must base our listing decision on the best available scientific data.

(6) *Comment:* One peer reviewer suggested several potential new lines of inquiry or alternative methods of analyzing or presenting existing data that would provide additional support for our proposed decision to list the Big Sandy and Guyandotte River crayfishes. For example, the commenter suggested we use probabilistic analyses of State water quality data to better infer the degree of impairment across the species' ranges.

*Our Response:* We appreciate the reviewer's suggestions and recognize that alternative analyses could be used to assess the primary and contributing threats affecting the Big Sandy and Guyandotte River crayfishes. However, the Act requires that the Service make listing determinations based solely on the best scientific and commercial data available, and the analyses suggested by the reviewer would require data that are not available. When we published the proposed rule on April 7, 2015 (80 FR 18710), we relied on the best quantitative and qualitative data available at that time to determine the status of each species. And while there may be other methods for analyzing the existing data, we concluded, and the six scientific peer reviewers (including this reviewer) generally concurred, that our analysis was sufficient to make a listing determination for these two species. We welcome any new data the reviewer can provide and may consider his suggestions during the recovery planning process to help inform potential conservation measures.

*Comments From Federal Agencies*

*(7) Comment:* One Federal agency stated that it works with landowners on a voluntary basis to implement conservation measures, some of which may provide direct and indirect benefits to the Big Sandy and Guyandotte River crayfishes or their habitats. In order to continue their successful conservation partnerships with private landowners, the Federal agency expressed a willingness to work with the Service to develop mutually acceptable avoidance measures and practices that will benefit these species.

*Our Response:* The Service appreciates the work of the Federal agency and looks forward to working with them as conservation partners regarding the Big Sandy and Guyandotte River crayfishes.

*Comments From States*

*(8) Comment:* The Kentucky Department of Fish and Wildlife Resources (KDFWR) commented that it is difficult to determine Big Sandy crayfish population changes based on the supporting documents and survey information. The agency also commented that the species' present distribution appears to differ from its historical distribution, but that it is difficult to determine the magnitude and implication of these changes. The KDFWR also concurred that the available information indicates that physical habitat quality is correlated with the presence or absence of the Big Sandy crayfish.

*Our Response:* We appreciate the KDFWR's review and comments on the proposed rule and acknowledge the challenges in analyzing the best available data to determine the status of the Big Sandy crayfish (please see our response to Comment 1, above). We look forward to working with the KDFWR as a conservation partner as we develop a recovery strategy for the species.

*(9) Comment:* The Virginia Department of Game and Inland Fisheries (VDGIF) commented that its data on the Big Sandy crayfish support our determination to list the species as endangered. The agency confirmed that in Virginia, the species is extant in at least 10 sites in the Russell Fork watershed and 1 site in the Levisa Fork watershed. The VDGIF also provided information on an occurrence location within the Russell Fork watershed that we were unaware of and noted two locations in the upper Levisa Fork watershed from which the species appears to have been extirpated. However, the agency does not believe the addition of the new occurrence location affects the listing proposal.

*Our Response:* We appreciate the VDGIF's additional data on Big Sandy crayfish occurrence locations in Virginia, and we have incorporated this information into this final rule. We look forward to continuing our conservation partnership with the VDGIF as we develop a recovery strategy for the species.

*(10) Comment:* The VDGIF commented that while recent survey data describe Big Sandy crayfish distribution in the Commonwealth, data on population sizes and trends do not exist. They noted that while Big Sandy crayfish surveys conducted in 2009 (see Thoma 2009b) were not necessarily designed to determine the species' population numbers, the agency interpreted the results as evidence that the Big Sandy crayfish subpopulations in the Russell Fork, Indian Creek, and Dismal Creek appeared to be stable and reproducing, and the subpopulations in the Pound River and Cranes Nest River appeared smaller and did not appear to be stable.

*Our Response:* As we indicated in the proposed rule, we agree that quantitative data on which to base population estimates for this species are sparse, and we concur that, based on the best available data, the species' health appears to vary at different occurrence locations throughout its range. Following publication of the proposed rule, the Service funded additional crayfish surveys in the Big Sandy River basin to better inform our final analysis (Loughman 2015a, entire). These new data confirmed that the Big Sandy crayfish is generally present throughout the Russell Fork basin, with eight of the nine surveyed stream systems supporting the species. However, in the upper Levisa Fork basin, six streams were surveyed, and the species was confirmed to be present in only one. The 2015 data also indicated that the species is notably absent from many other streams within its range, especially in the lower Levisa Fork and Tug Fork basins.

Additionally, in January 2016, the VDGIF provided the Service with 12 Big Sandy crayfish survey and relocation reports for work conducted in the Russell Fork and upper Levisa Fork watersheds in Virginia between 2009 and 2014. These crayfish survey and relocation efforts were associated with infrastructure projects (*i.e.,* pipeline stream crossings, bridge replacements, culvert replacement) and generally confirmed the species' presence in streams for which we already had occurrence records. Because most of these efforts were intended to remove all Big Sandy crayfish from pending construction areas, the raw numbers of individual crayfish captured provides some indication of the species' population densities and supports our conclusion (80 FR 18710, pp. 18719–18720) that where suitable habitat conditions exist, about 20 to 25 individual Big Sandy (or Guyandotte River) crayfish should be present at a survey location. The numbers of individual crayfish captured at the Russell Fork sites surveyed (n=22) ranged from 0 to 99, with a mean of 21.7 Big Sandy crayfish per site.

*(11) Comment:* The VDGIF commented that the available evidence indicates that the Russell Fork and Levisa Fork subpopulations of Big Sandy crayfish are genetically distinct and may warrant conservation as separate management units.

*Our Response:* We agree that the best available scientific data indicate there are genetic distinctions between the various subpopulations of the Big Sandy crayfish. The potential species management implications of these genetic differences will be discussed during the recovery planning process.

*(12) Comment:* The VDGIF commented that a female crayfish with instars was found during the month of May, which could indicate either that late-breeding females from the previous mating season overwinter instars longer than previously reported or that the species can spawn earlier in the year than previously reported.

*Our Response:* We appreciate this new information. While this observation does not alter our listing determination, it may be useful in developing the species' recovery plan and other conservation measures.

*(13) Comment:* The VDGIF provided comments related to critical habitat and future recovery options for the Big Sandy crayfish.

*Our Response:* We appreciate the VDGIF's interest in contributing to the conservation of the Big Sandy crayfish. However, these comments related to critical habitat and recovery planning are outside the scope of this final listing rule. We will consider these comments when developing a proposed critical habitat designation, and we look forward to working with the agency as we develop a recovery plan for the species.

*(14) Comment:* The West Virginia Department of Environmental Protection, Division of Mining and Reclamation (WVDEP/DMR) concurred with our conclusion that both species have reduced ranges and generally low abundances at existing occurrence locations, but the agency recommended the two species not be listed at this time. The WVDEP/DMR requested that additional time be afforded to research existing museum, academic, and government crayfish collections to verify the distribution and abundance of the two species within their described ranges.

*Our Response:* We appreciate the WVDEP/DMR's comments on the proposed listing rule and their request that additional time be afforded to conduct more research. However, section 4(b)(6)(A) of the Act provides a statutory timeline for making listing determinations: within 1 year from the date a proposed regulation is published, the Secretary will either publish a final regulation, provide notice that the proposed regulation is being withdrawn, or provide notice that the 1-year period is being extended for up to 6 months because of substantial disagreement regarding the sufficiency or accuracy of the available data relevant to the determination. In addition to the statutory time limitations described above, the Act requires that the Secretary make listing determinations based solely on the best scientific and commercial data available.

When we published the April 7, 2015, proposed rule, we relied on the best scientific and commercial data available at that time to determine the distribution and abundance of the Big Sandy and the Guyandotte River crayfishes. As described in the proposed rule, these data included a Service-funded biological status review of the two species, which included an examination of records and vouchered specimens in all known crayfish collections from the region. These collections are held by the United States National Museum, Illinois Natural History Survey, Eastern Kentucky University, Ohio State University, West Liberty University, and the Virginia Department of Game and Inland Fisheries. The only relevant new data we received during the public comment period were three new stream occurrence records, two for the Big Sandy crayfish (Pigeon Creek and lower Tug Fork mainstem) and one for the Guyandotte River crayfish (Clear Fork). We used this information in developing this final rule. We received no other substantive information regarding the sufficiency or accuracy of the available data and note that the six scientific peer reviewers indicated that we conducted a thorough review and analysis of the best available data. There is no substantial disagreement regarding the sufficiency or accuracy of the available data to indicate the need for a 6-month extension.

*(15) Comment:* The WVDEP/DMR expressed concern that only three Big Sandy crayfish survey sites were identified in the West Virginia portion of the species' range and that this indicated insufficient information regarding the species' status in West Virginia.

*Our Response:* As we indicated in Table 2b in the proposed rule (80 FR 18710, p. 18721), between 2006 and 2014, 25 individual sites in West Virginia were surveyed for the Big Sandy crayfish. Of these, the species was confirmed at four of these sites. During the summer of 2015, the Service funded additional survey work that included 32 sites in West Virginia. The Big Sandy crayfish was confirmed at 11 of these sites. These new data provided the first occurrence records for the species in the lower Tug Fork and confirmed the species' presence in 7 of 17 stream systems in the Tug Fork basin (this includes streams in both Kentucky and West Virginia). This information has been incorporated into this final rule.

*(16) Comment:* The WVDEP/DMR disagreed with our inclusion of water quality degradation, specifically high conductivity levels, as one of the greatest threats to the two crayfish species. The agency contends that the evidence provided in the proposed rule indicates that bottom sedimentation is the primary threat to the species and that because of the marine ancestry of the taxonomic order Decapoda (which includes crayfish), the Big Sandy and Guyandotte River crayfishes are not likely sensitive to elevated conductivity levels.

*Our Response:* As we indicated in the proposed rule, the best available scientific data indicate that degradation of stream habitat from sedimentation and substrate embeddedness is the primary threat to the Big Sandy and Guyandotte River crayfishes. However, the best available data also suggest that water quality degradation is likely a contributing threat to these species.

The Service funded new crayfish surveys during the summer of 2015 that compared crayfish presence and abundance (as catch per unit effort

(CPUE)) with various habitat parameters, including conductivity levels (Loughman 2015a, entire; Loughman 2015b, entire). The results of both of these studies clearly demonstrated that high instream habitat quality, as measured by the Qualitative Habitat Evaluation Index (QHEI), is positively correlated with the presence of both species. While Loughman found a statistical relationship between high conductivity levels and the absence of Guyandotte River crayfish, the data for the Big Sandy crayfish did not indicate such a relationship (Loughman 2015a, entire; Loughman 2015b, entire). However, studies of a different crayfish species did indicate that high conductivity levels were harmful, especially during certain crayfish life stages (see ''Water Quality Degradation,'' under the *Factor A* discussion in Summary of Factors Affecting the Species).

*(17) Comment:* The West Virginia Division of Natural Resources (WVDNR), which funded some of the survey work referenced in the proposed rule, indicated that they have no additional data regarding the status of the two species and generally concurred with our analysis and conclusions that the existing data indicate that the ranges of both the Big Sandy and Guyandotte River crayfishes have decreased from their historical distributions, that existing populations are small and vulnerable, and that habitat degradation continues to affect both species. Based on the available data, the WVDNR concurred that listing of the two species is warranted.

*Our Response:* We appreciate the WVDNR's contribution toward assessing the status of the two species within West Virginia and their comments on the proposed rule. We look forward to continuing our conservation partnership with the WVDNR as we develop a recovery strategy for these species.

*Comments From the Public*

*(18) Comment:* Several commenters requested that the 60-day public comment period be extended by 60 to 180 days to provide additional time to: (1) Review the available data; (2) seek new data; (3) examine the data in light of the taxonomic split of *Cambarus callainus* from *C. veteranus* or; (4) prepare comments.

*Our Response:* The 60-day comment period for the April 7, 2015, proposed rule closed on June 8, 2015. At that time, we declined to extend the comment period because we intended to reopen the comment period after the results of new surveys became available. During the summer of 2015, the Service funded those surveys, as discussed above. On December 15, 2015, the results of these survey efforts were made available to the public and the public comment period was reopened for 30 days (80 FR 77598) to afford the public an opportunity to comment on these survey results and to submit any new data or analysis that became available since the close of the initial comment period. This reopened comment period closed on January 14, 2016. We received six new comments during the reopened comment period, including substantive information that has been incorporated into this final rule.

Because the two public comment periods totaled 90 days and because we received few comments during the reopened comment period, we believe that there has been sufficient time for the public to review and provide comments on the proposed rule and supporting information. While we welcome new information about these species at any time, as previously stated, the Service must make listing determinations based solely on the best available data and within certain statutory timeframes (see our response to Comment 14).

*(19) Comment:* Several commenters expressed concern that we published the proposed listing rule prior to submitting it for peer review or that we did not seek input from the State wildlife agencies.

*Our Response:* In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited the expert opinion of seven independent specialists regarding the pertinent scientific or commercial data and assumptions related to the proposed listing of the Big Sandy and Guyandotte River crayfishes. Our policy provides that this process take place during the public comment period on the proposed rule.

Prior to drafting the proposed rule, we did seek input from the State wildlife or environmental resource agencies in Kentucky, Virginia, and West Virginia. We also submitted notice of the proposed rule to the affected States in accordance with the Act. In response, we received substantive data and/or comments from the Kentucky Division of Water (KDOW), the VDGIF, the WVDEP/DMR, and the WVDNR. We addressed the agency comments (see *Comments from States,* above) and incorporated them into this rule where appropriate. As we discussed above, these comments generally supported our analysis in the proposed rule. We note also that much of the recent survey work for the Big Sandy and Guyandotte River crayfishes (see Thoma 2009b; Thoma 2010; Loughman and Welsh 2010) was funded by several of these same State agencies.

*(20) Comment:* Several commenters stated that we should withdraw or postpone our listing decision or that we should make a ''warranted but precluded'' finding until more data are available upon which to base our listing decisions. Some commenters stated that the Service's timeline for developing the listing rule was governed by the settlement agreement with the Center for Biological Diversity rather than sufficient study or data development.

*Our Response:* The Act requires that we make listing determinations based solely on the best scientific and commercial data available. As we discussed in response to Comment 1, above, when we published the proposed rule on April 7, 2015 (80 FR 18710), we relied on the best quantitative and qualitative data available at that time. Furthermore, as we discussed previously, the Act requires us to, within 1 year after the date the proposed rule is published, either publish a final regulation, provide notice that the proposed regulation is being withdrawn, or provide notice that the 1-year period is being extended for up to 6 months because of substantial disagreement regarding the sufficiency or accuracy of the available data relevant to the determination. While some commenters disagreed with our interpretation of the best available data or our conclusions, we received no new substantive data that would indicate the listing proposal should be withdrawn or that substantial disagreement existed regarding the sufficiency or accuracy of the available data.

A ''warranted but precluded'' finding means the Service has enough information to list a species as endangered or threatened, but is precluded from undertaking the rulemaking process because of other actions for species with higher conservation priorities. Given the best available scientific data that indicated the Guyandotte River crayfish was known only from a single location and was subject to ongoing threats to the species' habitat and to individual crayfish, the Guyandotte River crayfish was the Service's highest priority at the time. In addition, the data for the Big Sandy crayfish indicated that it too was in decline and facing threats similar to those faced by the Guyandotte River crayfish. Therefore, we appropriately prioritized the proposed listing of both species. These determinations were within the Service's discretion.

*(21) Comment:* Several commenters expressed concern that if the Big Sandy

and Guyandotte River crayfishes are listed, various extractive industries in the region would be negatively affected or off-road vehicle (ORV) trail development would be restricted. The commenters believe listing of either or both species would cause economic harm to the industries or local communities.

*Our Response:* While we appreciate the concerns about the possible economic impact of potential management actions that may result from listing the Big Sandy and Guyandotte River crayfishes, the Act does not allow us to factor those concerns into our listing decision. Rather, listing decisions under the Act must be made solely on the basis of the best scientific and commercial data and in consideration of the five factors in section 4(a)(1) of the Act. That said, we are committed to working with industry organizations, State and Federal agencies, local communities, ORV groups, and other stakeholders to develop protections for the two crayfish species and their habitats while allowing continued use of the region's resources.

*(22) Comment:* One commenter expressed that all of the information the Service relied upon in making the proposed listing should be made readily available (*i.e.,* in electronic form) to the public.

*Our Response:* When we published the proposed rule and opened the public comment period, we included an electronic version of our reference list with citations for all of the data we relied upon in drafting the proposed rule. In the proposed rule, we also provided contact information and instructions to allow the public to inspect the supporting documentation at the U.S. Fish and Wildlife Service, Northeast Regional Office. We note that we received no requests to review the supporting documentation.

*(23) Comment:* Several commenters stated that we did not articulate the needed conservation and recovery measures for the two species or how listing either species would add to existing conservation efforts.

*Our Response:* We appreciate the commenters' concern for the conservation and recovery of these species. As we discussed under the heading *Available Conservation Measures* in the April 7, 2015, proposed rule (80 FR 18710, p. 18736), the general conservation benefits of listing include increased public awareness; conservation by Federal, State, Tribal, and local agencies and private organizations; and prohibitions of certain practices. The Act also encourages cooperation between stakeholders and calls for recovery actions for listed species. However, articulating these measures or describing how listing will aid conservation of the species is not a standard for listing a species under the Act, but will be developed through the recovery planning process for both species.

*(24) Comment:* Several commenters claimed that we did not adequately consider the positive effects existing Federal and State environmental laws (*e.g.,* Clean Water Act (CWA; 33 U.S.C. 1251 *et seq.*), Surface Mining Control and Reclamation Act of 1977 (SMCRA; 30 U.S.C. 1201 *et seq.*), and others), regulations, and best management practices (BMPs) have had on the two species and stated that because of the protections afforded by these regulatory mechanisms, listing under the Act is not necessary.

*Our Response:* We agree that the various Federal and State environmental regulations and BMPs, when fully complied with and enforced, have resulted in improvements in water and habitat quality when compared to conditions prior to enactment of these laws. However, as we described in the April 7, 2015, proposed rule (80 FR 18710, pp. 18724–18729, 18732) and this final rule, State water quality reports, published scientific articles, and expert opinion indicate that the aquatic habitat required by the Big Sandy and Guyandotte River crayfishes continues to be degraded despite these regulatory mechanisms. The best available scientific data demonstrate that the range of the Guyandotte River crayfish has declined since enactment of the CWA, the SMCRA, and the various other regulations and BMPs. And although we have less temporal data for the Big Sandy crayfish, the genetic data and expert opinion strongly suggest that this pattern of range reduction is similar for that species. We also emphasize that the threats to the Big Sandy and Guyandotte River crayfishes that we discuss under *Factor E,* below, are not addressed by any existing regulatory mechanism. Therefore, we conclude that the best available data indicate that existing regulations, by themselves, have not been sufficient to prevent the continued degradation of the habitat of these two species.

*(25) Comment:* One commenter stated that because the Big Sandy and Guyandotte River crayfishes survived through the severe environmental degradation that characterized the region's largely unregulated industrialization in the early to mid-1900s (see the *Historical context* discussion in the April 7, 2015, proposed rule; 80 FR 18710, pp. 18723–18724), modern-day regulated activities are much less harmful and do not pose a risk to the species.

*Our Response:* As we discussed in the proposed rule, the past industrialization of the region severely degraded the habitat required by the Big Sandy and Guyandotte River crayfishes and likely led to their extirpation from many streams within their ranges. The crayfish subpopulations that survived through this period of widespread environmental degradation are now largely isolated from one another because of dams or inhospitable intervening habitat (resulting from past and ongoing activities) in each river system and individual crayfish are found in low numbers at most of the remaining sites. These now isolated and generally low-abundance crayfish subpopulations do not maintain the same resiliency or redundancy of the original widespread and interconnected (at least initially) populations that were subjected to the rapid industrialization of the region in the 1900s and are at an increased risk of extirpation (see *Factor E* discussion, below). We, therefore, conclude that current regulated activities, while not causing widespread degradation on the scale seen in the 1900s, continue to pose a risk to the two species as they now exist.

*(26) Comment:* Several commenters expressed that the proposed rule incorrectly identified or focused on coal mining and timber operations as specific threats to the Big Sandy and Guyandotte River crayfishes and that we ignored other threats, including human development, roads, dams, and natural flood events.

*Our Response:* As we described in the *Factor A* discussion under the Summary of Factors Affecting the Species in the April 7, 2015, proposed rule (80 FR 18710), the primary threat to the Big Sandy and Guyandotte River crayfishes is habitat degradation caused by erosion and sedimentation from land-disturbing activities, including coal mining, commercial timber operations, road construction, ORV use, oil and gas development, and unpaved road surfaces (80 FR 18710, pp. 18722–18731). We also identified several contributing factors related to human population growth in the area, including wastewater discharges and unpermitted stream channel dredging. The best available scientific data, including published articles and State water quality reports, support our conclusion that these activities degrade the aquatic habitat required by these species.

In the proposed rule, we did not identify natural flood events as a threat to either the Big Sandy or the Guyandotte River crayfishes. Because these species evolved to live in the fast-flowing streams and rivers in the Appalachian Plateaus physiographic province, where episodic flood events are natural and recurring phenomena, we did not consider floods as a threat to either species' existence. However, as we discussed in the proposed rule, and below in this final rule (see ''Residential/Commercial Development and Associated Stream Modifications'' under the *Factor A* discussion in Summary of Factors Affecting the Species), human attempts to modify the streams and rivers to control flooding or mitigate flood damage may degrade the habitat that these species require. In the proposed rule, we discussed the effects of stream dredging or bulldozing on the habitat of these species, and while we did not list dams as specific threats, we did identify habitat fragmentation, caused at least in part by dams, as a threat. Based on input from some peer reviewers and public commenters, we have reconsidered the effects of dams on the two species and have added new language to this final rule discussing direct historical aquatic habitat loss resulting from reservoir creation.

*(27) Comment:* Two commenters that expressed concern about our finding that forestry is a contributing threat to the Big Sandy and Guyandotte River crayfishes provided information on the implementation rates and effectiveness of forestry BMPs and cited various studies purported to demonstrate that forestry BMPs minimize erosion and sediment transport to streams below levels that degrade aquatic habitats and/or harm aquatic species, including the Big Sandy and Guyandotte River crayfishes. One of the commenters also expressed that our estimate of soil erosion from timber harvesting appears to be too high.

*Our Response:* We appreciate the commenters' support of forestry BMPs as a means of protecting water quality, and we concur that when properly implemented, forestry BMPs can reduce erosion and sedimentation levels, especially as compared to past forestry practices. However, as we noted in the April 7, 2015, proposed rule (80 FR 18710), the best available data indicate that even when forestry BMPs are properly implemented, erosion rates at timbered sites, skid trails, unpaved haul roads, and stream crossings are significantly higher than from undisturbed sites (80 FR 18710, p. 18728).

We concur that the best available data indicate that Statewide BMP implementation rates for commercial forestry operations in Kentucky, Virginia, and West Virginia are generally high. However, as we noted in the proposed rule, in Kentucky and West Virginia, some categories of forestry, such as tree clearing in advance of coal mining, gas drilling, or other construction activities, are specifically exempted from implementing forestry BMPs. Regardless of specific forestry BMP implementation rates or situational efficacies, the State water quality monitoring reports (WVDEP 2012; KDOW 2013; VADEQ 2014) list timber operations (along with mining, roads, urban development, agriculture, and riparian clearing) as contributing excess sediments to streams and rivers within the ranges of the Big Sandy and Guyandotte River crayfishes.

Although we do not have sufficient data to produce comprehensive sediment budgets for each land-disturbing activity, in the proposed rule we did use the best available data to estimate the annual erosion potential within the ranges of the two species and stated that ''. . . if the forest is undisturbed, about 3,906 tonnes (3,828 tons) of sediment will erode, while logging the same area will produce perhaps 67,158 to 149,436 tonnes (65,815 to 146,447 tons) of sediment'' (80 FR 18710, p. 18730). One commenter indicated these estimates appeared too high and used data from much older studies to produce lower estimates. This comment led to our discovering two errors in our original calculations. However, upon correcting these errors (one transcription error and one unit conversion error), we have revised the estimated erosion rate from an undisturbed forested site in the southern Appalachians from 0.31 tonnes per hectare (ha) per year (yr) (0.12 tons per acre (ac) per year (yr)) to 0.47 tonnes/ha/yr (0.21 tons/ac/yr). This results in our original estimate of erosion from undisturbed forest, ''3,906 tonnes (3,828 tons)'', being corrected to ''5,922 tonnes (6,456 tons).'' We also corrected a ''tonnes'' to ''tons'' conversion error (''65,815 to 146,447 tons'' is in error and should be ''73,173 to 162,641 tons''). As to the commenter's use of older studies (dated 1965 to 1979) to estimate lower erosion potentials, we concluded that the data we used (see Hood *et al.* 2002) rely on an improved methodology and constitute the best available data.

Based on our estimate of annual, ongoing soil erosion from rotational forestry within the ranges of the Big Sandy and Guyandotte River crayfishes, and because these species appear to be particularly sensitive to stream sedimentation and bottom embeddedness, we maintain that sedimentation resulting from forestry is likely a contributing threat to these species. We are also committed to working with State and Federal agencies, the timber industry, and landowners to help minimize erosion from commercial forestry operations and maintain the instream habitat quality for these species.

*(28) Comment:* Several commenters questioned our determination that the Big Sandy and Guyandotte River crayfishes are distinct species or expressed concern that the taxonomic change confounds the interpretation of earlier survey reports. Commenters stated that prior to our making a final listing determination, studies on possible interbreeding of the two crayfish populations or on variation in demographic traits among conspecific populations should be conducted.

*Our Response:* As we described in the April 7, 2015, proposed rule (80 FR 18710), our determination that the Big Sandy crayfish and the Guyandotte River crayfish are distinct species was based upon a peer-reviewed scientific article, which represented the best available scientific data. We did not receive any substantive data during the public comment period, nor are we aware of any new data, that contradict these genetic and morphological data demonstrating that the Big Sandy crayfish and Guyandotte River crayfish are distinct, reproductively isolated species. In addition, one of the peer reviewers conducted an independent analysis of the available genetic data and concluded that the taxonomic split is valid (see Comment 5, above).

We do not agree that the taxonomic split of the Big Sandy crayfish and the Guyandotte River crayfish confounds the interpretation of earlier survey reports. While historically the two species were identified collectively as *Cambarus veteranus,* we have little evidence that earlier surveys routinely confused *C. veteranus* with any other crayfish species (we discussed exceptions to this in the April 7, 2015, proposed rule, 80 FR 18710, pp. 18715–18716). As we described in the proposed rule, independent crayfish experts have examined all known museum specimens identified as *C. veteranus* from both the Big Sandy basin and the Upper Guyandotte basin along with more recently collected specimens from each river basin. These experts determined that in both the museum specimens and recent captures, the morphological characteristics that distinguish the Big Sandy crayfish from the Guyandotte River crayfish were consistent with the geographical location (*i.e.,* Big Sandy basin or Upper Guyandotte basin) where the specimens were acquired. As we noted in the proposed rule, when discussing the earlier survey work (pre-taxonomic revision) we ascribed the appropriate species name based on the river basin from which specimens were collected. Therefore, we conclude that the best available data identify the appropriate taxonomic entity such that we can accurately analyze the two species' status.

*(29) Comment:* Several commenters questioned our delineation of the historical range of the Big Sandy and Guyandotte River crayfishes and asserted that we discounted information that indicated the historical range of the two species included river systems outside of the Big Sandy and Upper Guyandotte basins, or that the two species co-occurred in the Big Sandy and Upper Guyandotte basins.

*Our Response:* We appreciate these commenters' concerns, but do not agree that we omitted or improperly analyzed the best available data in determining the historical ranges of the Big Sandy and Guyandotte River crayfishes. As we described in the April 7, 2015, proposed rule (80 FR 18710), we relied upon Statewide crayfish survey reports, targeted survey reports, range maps and descriptions from historical crayfish surveys, genetic evidence, data from State wildlife agencies, analysis of museum collections, and the best professional judgment of crayfish experts to determine the historical range of each species. In the proposed rule, we noted several erroneous or dubious crayfish records from outside of the Big Sandy or Upper Guyandotte River basins and discussed the evidence indicating why these records do not support the historical presence of either the Big Sandy or the Guyandotte River crayfish outside of these two river basins or the cross-basin presence (*i.e.,* Guyandotte River crayfish in the Big Sandy basin or Big Sandy crayfish in the Upper Guyandotte basin) of either species.

In addition, neither the peer reviewers, including two with extensive experience surveying for crayfish in the Appalachian region, nor the VDGIF or the WVDNR disagreed with our analysis and description of the historical ranges of the two species. We did not receive any new data during the public comment period that indicated either species historically occupied sites outside of their respective river basins. Therefore, the best available data indicate that the Big Sandy crayfish is endemic to the Big Sandy River basin and the Guyandotte River crayfish is endemic to the Upper Guyandotte River basin.

*(30) Comment:* Several commenters questioned our conclusions on the population status of the Big Sandy crayfish or stated that the map of Big Sandy crayfish occurrence locations (figure 4 in the April 7, 2015, proposed rule; 80 FR 18710, p. 18719) was confusing and that it actually indicated that the Big Sandy crayfish population had increased from pre-2006 levels to the present time.

*Our Response:* As we noted in the proposed rule and in responses to Comments 1 and 10, above, we relied on the best quantitative and qualitative data available at that time to determine the status of the Big Sandy crayfish, including crayfish surveys and habitat assessments, range maps, genetic evidence, analysis of museum specimens, and expert scientific opinion. While we agree that quantitative population trend data are sparse, these other lines of scientific evidence indicate that the range and population of the Big Sandy crayfish is reduced and that the existing subpopulations are fragmented from one another. We note also that this pattern is consistent with the severe range reduction observed in the closely related Guyandotte River crayfish, for which we had more data. And as we described under the discussions of Factors A and E in the proposed rule (80 FR 18710, pp. 18722–18731, and 18732–18735, respectively), and discussed below in this final rule, threats to the species continue.

In the proposed rule, figure 4 shows all known survey sites and occurrence locations for the Big Sandy crayfish, broken down by time period (pre-2006 and 2006 to 2014). We acknowledge that figure 4 could be perceived as showing that the range of the Big Sandy crayfish has expanded since 2006, but we emphasize that this is only an artifact resulting from greatly increased sampling effort since 2006, especially outside of the Russell Fork drainage basin. Along with the known occurrence locations (pre-2006), the more recent surveys included streams throughout the Big Sandy crayfish's range that were identified by crayfish experts as being likely to harbor the species. Because these new sites are not known to have been surveyed previously, they provide no direct evidence that the species' range or population has increased or decreased in recent years. Loughman (2015a, entire) expanded the survey coverage in the Big Sandy basin, especially in the lower Levisa Fork and Tug Fork systems. His work generally confirmed the previously known occurrence locations, but did note four new occurrence locations in the lower Tug Fork basin (one in the Tug Fork mainstem and three in the Pigeon Creek system). These areas had not been surveyed previously and provide no direct evidence on population trends.

However, as we described in the proposed rule (see text and Table 2a; 80 FR 18710, pp.18719–18721), the fact that researchers were unable to confirm the species' presence at most locations throughout its historical range (displayed as open circles on figure 4 of the proposed rule) indicates that the species' range and population is reduced and that the existing subpopulations are fragmented from each other. Additionally, at many sites where the Big Sandy crayfish does still exist, especially outside of the Russell Fork basin, the CPUE data indicate the species is found in relatively low numbers (see *Population Status,* below).

*(31) Comment:* One commenter provided preliminary results of the survey efforts funded by the Service and conducted in the Upper Guyandotte and Tug Fork basins of West Virginia.

*(32) Comment:* One commenter stated that the Big Sandy and Guyandotte River crayfishes are sensitive to elevated stream sedimentation and substrate embeddedness. Additionally, during the reopened comment period (December 15, 2015, to January 14, 2016), this commenter submitted an additional letter that supported both species receiving Federal protection and provided additional observations from the Service-funded 2015 rangewide surveys.

*Our Response:* We appreciate these observations regarding the preferred habitat and status of the Big Sandy and Guyandotte River crayfishes and have incorporated this new information into this final rule.

*(33) Comment:* One commenter disagreed with our determination that the Big Sandy crayfish population was in decline and described an abundance of crayfish on his property near Clintwood, Virginia (Pound River/Cranes Nest River drainage). The commenter described these crayfish as destroying his property by creating holes in the ground, thus presenting a hazard to individuals using his property.

*Our Response:* We appreciate the commenter's concern, but note that these observations appear to describe behavior of a burrowing crayfish species. As we described in the April 7, 2015, proposed rule (80 FR 18710), the best available data indicate the Big Sandy and Guyandotte River crayfishes are wholly aquatic species that naturally inhabit the faster moving portions of streams and rivers with abundant unembedded slab boulders for cover. As ''tertiary burrowers,'' these species are not known to construct burrows or dig holes in upland or semi-aquatic areas. Therefore, it is unlikely that the commenter's observations are related to Big Sandy or Guyandotte River crayfish.

*(34) Comment:* Two commenters described the effects of coal mining operations on streams adjacent to their properties. Both commenters provided anecdotal information on the degradation of water quality as a result of mine runoff and noted the disappearance of aquatic species, including unspecified crayfish species, following construction of the mines.

*Our Response:* While we have no data or details on these specific examples with which to respond further, the observations of these commenters appear similar to some of the findings described in the scientific literature on the effects that coal mining can have on aquatic resources (see the April 7, 2015, proposed rule's *Historical context, Current conditions,* and *Coal mining* sections under the *Factor A* discussion in Summary of Factors Affecting the Species (80 FR 18710).

*(35) Comment:* One commenter noted that we incorrectly implied that suitable habitat for the Big Sandy and Guyandotte River crayfishes includes ''headwater streams,'' which they described as small, nonperennial streams.

*Our Response:* We appreciate the commenter's observation and agree that, as we indicated in the April 7, 2015, proposed rule, based on the best available data, small, nonperennial streams are not suitable habitat for either species of crayfish. In the proposed rule, we described the historical range and distribution of the Big Sandy crayfish to include ''suitable streams throughout the basin, from the Levisa Fork/Tug Fork confluence to the headwaters.'' Our use of ''to the headwaters'' was intended to convey that the best available data suggest that the species likely occupied suitable habitat (*i.e.,* fast-flowing, medium-sized streams and rivers with an abundance of slab boulders on an unembedded bottom substrate) throughout the interconnected stream network of the larger river basin, up to, but not including the small, sometimes intermittent headwater streams.

*(36) Comment:* One commenter disagreed with our conclusion that pesticides and herbicides that may be present in the runoff from roads could degrade the habitat of the Big Sandy and Guyandotte River crayfishes. The commenter requested that we remove this discussion from the final rule.

*Our Response:* As we noted in the April 7, 2015, proposed rule (80 FR 18710), the best available data indicate that the primary threat to the Big Sandy and Guyandotte River crayfishes is excessive erosion and sedimentation that leads to stream bottom embeddedness. However, the data also suggest that other stressors, such as water quality degradation, may also contribute to the decline of these species. While the commenter correctly noted that we have no specific studies on the effects of road runoff contaminants to the Big Sandy and Guyandotte River crayfishes, the best available data do indicate that road runoff can contain a complex mixture of contaminants, including pesticides and herbicides, metals, organic chemicals, nutrients, and deicing salts and that these contaminants, alone or in combination, can degrade receiving waters and be detrimental to aquatic organisms (see ''Water Quality Degradation'' under the Factor A discussion, below). We note also that pesticides and herbicides may be released to roadways as a result of accidents or spills or in concentrations or mixtures contrary to U.S. Environmental Protection Agency (USEPA) pesticide registration labeled directions. Under such circumstances, these chemicals could pose a higher risk to aquatic species, including the Big Sandy and Guyandotte River crayfishes (Buckler and Granato 1999, entire; Boxall and Maltby 1997, entire; NAS 2005, pp. 72–75, 82–86).

*(37) Comment:* One commenter provided information on the reduction of forest cover within the range of the Guyandotte River crayfish between 1973 and 2013. The commenter reported that there was a 5.5 percent loss of forest cover within the Upper Guyandotte basin during that period and that the loss of forest cover was largely the result of coal mining. The commenter concluded that coal mining likely contributed to the decline of the Guyandotte River crayfish.

*Our Response:* The data on land use changes documented in the report (Arneson 2015) referenced by the commenter support the conclusion that, since 1973, coal mining has significantly reduced forest cover in the Upper Guyandotte River basin. At the subwatershed scale, Pinnacle Creek experienced the greatest loss of forest cover during the period. We appreciate this new scientific information that further supports our analysis in the proposed rule of land-disturbing activities occurring within the current range of the Guyandotte River crayfish.

*(38) Comment:* One commenter concurred with our determination that the crayfish population has declined (the commenter did not distinguish between Big Sandy crayfish and Guyandotte River crayfish), but disagreed that this decline was caused solely by construction, logging, or ORV use. The commenter advocated that plastic litter and/or the invasive plant kudzu (*Pueraria montana* var. *lobata*) could be causes of water contamination and should be investigated. The commenter also suggested that similar crayfish from other areas could be introduced to areas where Big Sandy or Guyandotte River crayfishes (presumably) are rare or absent. The commenter also expressed concern that Federal listing of these species could cause economic harm to the region or the Hatfield-McCoy ORV trail system.

*Our Response:* As we described in the April 7, 2015, proposed rule (80 FR 18710), the best available data indicate the primary threat to the Big Sandy and Guyandotte River crayfishes is excessive erosion and sedimentation that leads to stream bottom embeddedness. We also described a variety of land-disturbing activities, in addition to those listed by the commenter, known to cause erosion and sedimentation within the ranges of the species. The commenter did not provide any supporting information that kudzu could degrade water quality, and we were unable to locate any such data. And, while we acknowledge plastic litter is an aesthetic concern that may pose a physical hazard to some species (*e.g.,* from entanglement or perhaps ingestion), we found no information indicating that plastic debris is related to the decline of the Big Sandy or Guyandotte River crayfishes, nor did the commenter provide such supporting information.

While we appreciate the concern about potential management actions that may result from listing the Big Sandy and Guyandotte River crayfishes, the Act does not allow us to factor those economic concerns into our listing decision (see our response to Comment 21, above). However, we must consider economic impacts into designations of critical habitat, should critical habitat be proposed for either or both species.

## Summary of Changes From the Proposed Rule

This final rule incorporates appropriate changes to our proposed listing based on the comments we received, as discussed above, and newly available scientific and commercial data. The main substantive change is that, based on new data on the Big Sandy crayfish's distribution, its habitat, and analysis of the species' redundancy and resiliency, we have determined that the Big Sandy crayfish does not meet the definition of an endangered species, contrary to our proposed rule published on April 7, 2015 (80 FR 18710). Specifically, the 2009 to 2015 survey data, which became available after the proposed rule was published, indicate: The species is known to occur in an additional population in the lower Tug Fork subwatershed; some occurrences in all four subwatersheds are supported by good quality habitat; and in some streams, especially in the Russell Fork, the species likely occurs throughout the entire stream rather than only in discrete sections. We conclude that the species has additional redundancy above what was known when we published the proposed rule. This increase in redundancy also contributes to the species' overall resiliency to the ongoing threats in its range, all of which indicates that the Big Sandy crayfish is not currently in danger of extinction. Therefore, this final rule lists the Big Sandy crayfish as a threatened, rather than an endangered, species. As in the proposed rule, this final rule lists the Guyandotte River crayfish as an endangered species. See the *Population Status* and Determination sections, below, for more detail.

Other substantive changes include the following: (1) We incorporated the results of new crayfish survey efforts, including new occurrence records for the Big Sandy crayfish and the Guyandotte River crayfish, into this final rule; and (2) we analyzed several additional potential threats to both species, including instream projects, dams, climate change, unstable streams, and transportation spills.

**Background**

The information in the following sections is summarized from the proposed listing rule for the Big Sandy crayfish and the Guyandotte River crayfish (80 FR 18710; April 7, 2015) and its citations are incorporated by reference unless otherwise noted. For a complete summary of the species' information, please see the proposed listing rule.

*Species Information*

The Big Sandy crayfish (*Cambarus callainus*) and the Guyandotte River crayfish (*C. veteranus*) are freshwater, tertiary burrowing crustaceans of the Cambaridae family. Tertiary burrowing crayfish do not exhibit complex burrowing behavior; instead, they shelter in shallow excavations under loose cobbles and boulders on the stream bottom. The two species are closely related and share many basic physical characteristics and behaviors. Adult body lengths range from 75.7 to 101.6 millimeters (mm) (3.0 to 4.0 inches (in)), and the cephalothorax (main body section) is streamlined and elongate, and has two well-defined cervical spines. The elongate convergent rostrum (the beak-like shell extension located between the crayfish's eyes) lacks spines or tubercles (bumps). The gonopods (modified legs used for reproductive purposes) of Form I males (those in the breeding stage) are bent 90 degrees to the gonopod shaft (Loughman 2014, p. 1). Diagnostic characteristics that distinguish the Big Sandy crayfish from the Guyandotte River crayfish include the former's narrower, more elongate rostrum; narrower, more elongate chelea (claw); and lack of a well-pronounced lateral impression at the base of the claw's immovable finger (Thoma *et al.* 2014, p. 551).

Thoma (2009, entire; 2010, entire) reported demographic and life-history observations for the Big Sandy crayfish in Virginia and Kentucky. He concluded that the general life cycle pattern of the species is 2 to 3 years of growth, maturation in the third year, and first mating in midsummer of the third or fourth year. Following midsummer mating, the annual cycle involves egg laying in late summer or fall, spring release of young, and late spring/early summer molting. Thoma hypothesized the likely lifespan of the Big Sandy crayfish to be 5 to 7 years, with the possibility of some individuals reaching 10 years of age. There is less information available specific to the life history of the Guyandotte River crayfish, but based on other shared characteristics with the Big Sandy crayfish, we conclude the life span and age to maturity are similar. The best available data indicate both species are opportunistic omnivores, feeding on plant and animal matter (Thoma 2009b, pp. 3, 13; Loughman 2014, pp. 20–21).

The best available data indicate that the historical range of the Guyandotte River crayfish is limited to the Upper Guyandotte River basin in West Virginia and that the historical range of the Big Sandy crayfish is limited to the upper Big Sandy River basin in eastern Kentucky, southwestern Virginia, and southern West Virginia. Both river basins are in the Appalachian Plateaus physiographic province, which is characterized by rugged, mountainous terrain with steep hills and ridges dissected by a network of deeply incised valleys (Ehlke *et al.* 1982, pp. 4, 8; Kiesler *et al.* 1983, p. 8). The dominant land cover in the two basins is forest, with the natural vegetation community being characterized as mixed mesophytic (moderately moist) forest and Appalachian oak forest (McNab and Avers 1996, section 221E).

Suitable habitat for both species is generally described as clean, third order or larger (width of 4 to 20 meters (m) (13 to 66 feet (ft))), fast-flowing, permanent streams and rivers with an abundance of large, unembedded slab boulders on a sand, cobble, or bedrock stream bottom (Jezerinac *et al.* 1995, p. 171; Channell 2004, pp. 21–23; Taylor and Shuster 2004, p. 124; Thoma 2009b, p. 7; Thoma 2010, pp. 3–4, 6; Loughman 2013, p. 1; Loughman 2014, pp. 22–23; Loughman 2015a, pp. 1, 29, 41–43; Loughman 2015b, pp. 1, 9–12, 28–30, 35–36). Under natural (*i.e.,* undegraded) conditions, this habitat was common in streams throughout the entire upper Big Sandy and Upper Guyandotte River basins, and historically, both species likely occurred throughout their respective ranges where this habitat existed. However, by the late 1800s, commercial logging and coal mining, coupled with rapid human population growth and increased development in the narrow valley riparian zones, began to severely degrade the aquatic habitat throughout both river basins. We conclude, based on the best available data, this widespread habitat degradation, most visible as stream bottom embeddedness, likely led to each species' decline and their eventual extirpation from many streams within much of their respective historical ranges.

Both species appear to be intolerant of excessive sedimentation and embeddedness of the stream bottom substrate. This statement is based on observed habitat characteristics from sites that either formerly supported the Big Sandy or Guyandotte River crayfish or from sites within either of the species' historical ranges that were predicted to be suitable for the species, but where neither of the species (and in some cases no crayfish from any species) were observed (Jezerinac *et al.* 1995, p. 171; Channell 2004, pp. 22–23; Thoma 2009b, p. 7; Thoma 2010, pp. 3–4; Loughman 2013, p. 6; Loughman 2015a, pp. 29, 41–43; Loughman 2015b, pp. 28–30, 35–36). See Summary of Factors Affecting the Species, below, for additional information.

**Summary of Biological Status and Threats**

Here, we summarize the two species' distribution, abundance, and threats information that was previously provided in the proposed rule (80 FR 18710; April 7, 2015) and has been updated as appropriate from new information we received since the proposed rule's publication. Unless otherwise noted, citations for the summarized information are from the proposed rule and incorporated by reference. See Summary of Changes from the Proposed Rule, above, for what has been updated.

*Big Sandy Crayfish*

Historically (prior to 2006), the Big Sandy crayfish was known from 11 stream systems in the 4 larger subwatersheds in the upper Big Sandy River watershed: Tug Fork, Levisa Fork, Upper Levisa Fork, and Russell Fork (see figure 1, below). However, pre-2006 survey data for the species is sparse, with only 25 surveyed sites in 13 stream systems. Most of these records were from the Russell Fork subwatershed (with multiple records dating back to 1937), and single records were available from the Levisa Fork, Upper Levisa Fork, and Tug Fork subwatersheds (all confirmed between 1999 and 2002).

The Big Sandy crayfish is currently known from a total of 21 stream systems in the same four subwatersheds. However, we emphasize this apparent increase in occupied stream systems is an artifact of increased sampling effort, and not necessarily an increase in the species' redundancy. From 2006 to 2015, a series of surveys were conducted that effectively covered the species' historical range, including the first comprehensive rangewide survey for the species, which was funded by the Service in 2015 (see Loughman 2015a, entire). During this period, a total of 276 sites (including all historical locations and additional ''semi-random'' locations (*e.g.,* appropriately-sized streams for the species)) were surveyed throughout the Tug Fork, Levisa Fork, Upper Levisa Fork, and Russell Fork watersheds. The Big Sandy crayfish was confirmed at 86 of the surveyed sites (31 percent) and in 21 of the 55 surveyed stream systems (38 percent). A notable result of the 2015 rangewide survey was confirmation of the species' presence in the lower Tug Fork basin, where a single occurrence was found in the Tug Fork mainstem and three occurrences were noted in the Pigeon Creek system.

While the species is still found in all four subwatersheds, current data (2006 to 2015) indicate notable differences in the species' distribution in each subwatershed. In the Russell Fork subwatershed, the Big Sandy crayfish was found in 92 percent of the stream systems surveyed (52 percent of sites). In the other subwatersheds, the species was less well distributed. In the Levisa Fork and Upper Levisa Fork watersheds, only 13 percent of the surveyed stream systems were occupied (19 and 24 percent of sites, respectively) and in the Tug Fork subwatershed, 35 percent of surveyed stream systems were occupied (23 percent of sites) (see figure 1 and tables 1a through 1d, below).

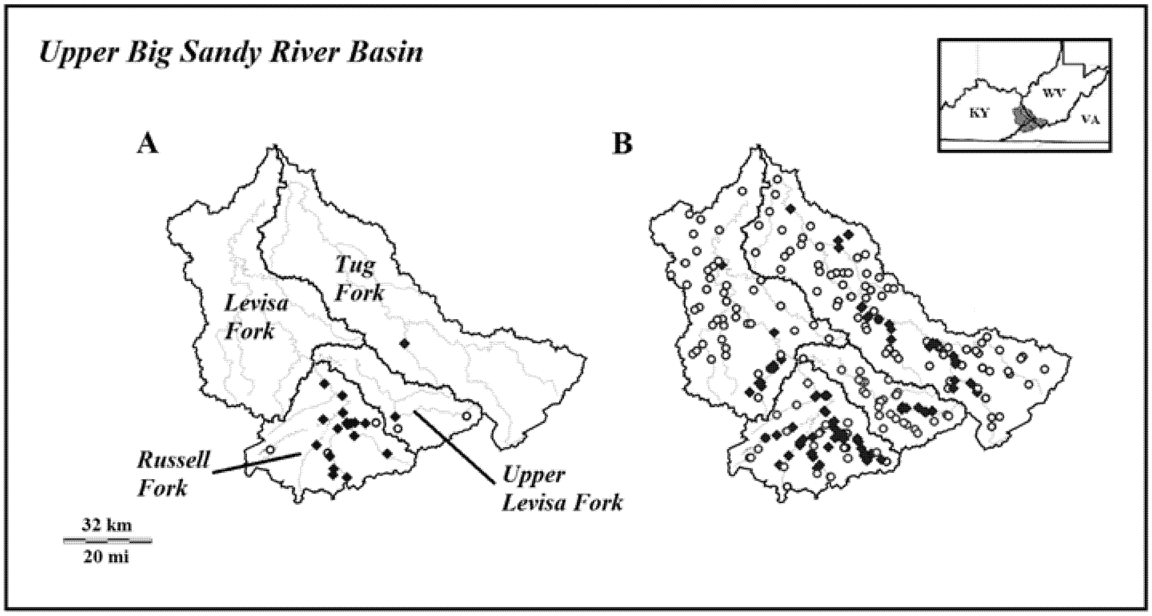


**Figure 1**. Historical and current survey results for the Big Sandy crayfish. A. Pre-2006 survey results; B. 2006 through 2015 survey results. Positive species occurrences are indicated by black diamonds, negative results are open circles.

**Tables 1a, 1b, 1c, 1d.** Survey effort and results for the four subwatersheds.

**1a** Levisa Fork

| | Sites Surveyed | Positive for *C. callainus* | Percent Positive | Streams Surveyed | Positive for *C. callainus* | Percent Positive |
|---|---|---|---|---|---|---|
| 1999 to 2005 | 1 | 1 | 100% | 1 | 1 | 100% |
| 2006 to 2015 | 59 | 11 | 19% | 15 | 2 | 13% |

**1b** Upper Levisa Fork

| | Sites Surveyed | Positive for *C. callainus* | Percent Positive | Streams Surveyed | Positive for *C. callainus* | Percent Positive |
|---|---|---|---|---|---|---|
| 2001 to 2005 | 3 | 1 | 33% | 3 | 1 | 33% |
| 2006 to 2015 | 37 | 9 | 24% | 8 | 1 | 13% |

**1c** Russell Fork

| | Sites Surveyed | Positive for *C. callainus* | Percent Positive | Streams Surveyed | Positive for *C. callainus* | Percent Positive |
|---|---|---|---|---|---|---|
| 1937 to 2005 | 20 | 17 | 85% | 8 | 8 | 100% |
| 2006 to 2015 | 82 | 43 | 52% | 12 | 11 | 92% |

**1d** Tug Fork

| | Sites Surveyed | Positive for *C. callainus* | Percent Positive | Streams Surveyed | Positive for *C. callainus* | Percent Positive |
|---|---|---|---|---|---|---|
| 2002 to 2005 | 1 | 1 | 100% | 1 | 1 | 100% |
| 2006 to 2015 | 98 | 23 | 23% | 20 | 7 | 35% |

*Guyandotte River Crayfish*

In the April 7, 2015, proposed rule, we indicated that the Guyandotte River crayfish was historically known from nine individual streams in the Upper Guyandotte River basin (80 FR 18710, pp. 18717–18720); we have since revised this to be six individual streams (or stream systems where their smaller tributaries were also surveyed). Based on the best available data at the time of the proposed rule, we considered the species' distribution based on its occupancy status in each individually named stream. On closer analysis of the watershed, we determined that some of these individually named streams were actually smaller tributaries connected into a primary tributary stream (*i.e.,* the streams that connect directly to the Upper Guyandotte River mainstem). Therefore, for the purpose of understanding the species' overall distribution, we concluded that primary streams and their tributaries should be considered together as a ''stream system.'' Previous surveys (see Jezerinac *et al.* 1995) identified a species occurrence in ''Little Indian Creek.'' However, based on the site description provided in the report and our analysis of the relevant U.S. Geological Survey topographic maps, we have determined that this creek is not unique, but a misnamed section of Indian Creek. Also, for the purpose of assessing the status of the Guyandotte River crayfish, we determined that Brier Creek, a tributary to Indian Creek, is more appropriately considered part of the larger Indian Creek system. Finally, the two museum specimens collected from Little Huff Creek in 1971, and previously identified as *Cambarus veteranus,* were re-examined in 2014, and determined to be *C. theepiensis* (National Museum of Natural History *http://collections.nmnh.si.edu/search/iz/*; accessed December 21, 2015). Therefore, Little Huff Creek is no longer a known occurrence location for the Guyandotte River crayfish. Regardless of this revised information, multiple survey efforts dating back to 1900 show a significant reduction in the number of occupied streams. Rangewide surveys in 1988 and 1989 confirmed the species in two stream systems, the historical Huff Creek system and a new stream record, Pinnacle Creek. In 2002, a study failed to confirm the species at any historical site (Channell 2004, pp. 17–18), but a more comprehensive survey in 2009 did find several individuals in Pinnacle Creek (Loughman 2013, p. 6) (see figure 2, below).

The Guyandotte River crayfish is currently known from two disjunct stream systems in the Upper Guyandotte River basin. In 2015, the Service funded additional rangewide surveys for the species (see Loughman 2015b). A total of 71 likely sites (in 21 stream systems) were surveyed throughout the Upper Guyandotte River basin, including all historical locations and additional ''semi-random'' locations). The species was confirmed at 10 individual sites (in two stream systems). In Pinnacle Creek, the last known occupied stream, the species was found at 4 of 9 sites surveyed. And in Clear Fork, which is a new stream record for the species, the Guyandotte River crayfish was found at 6 of 9 sites (see figure 2 and table 2, below).

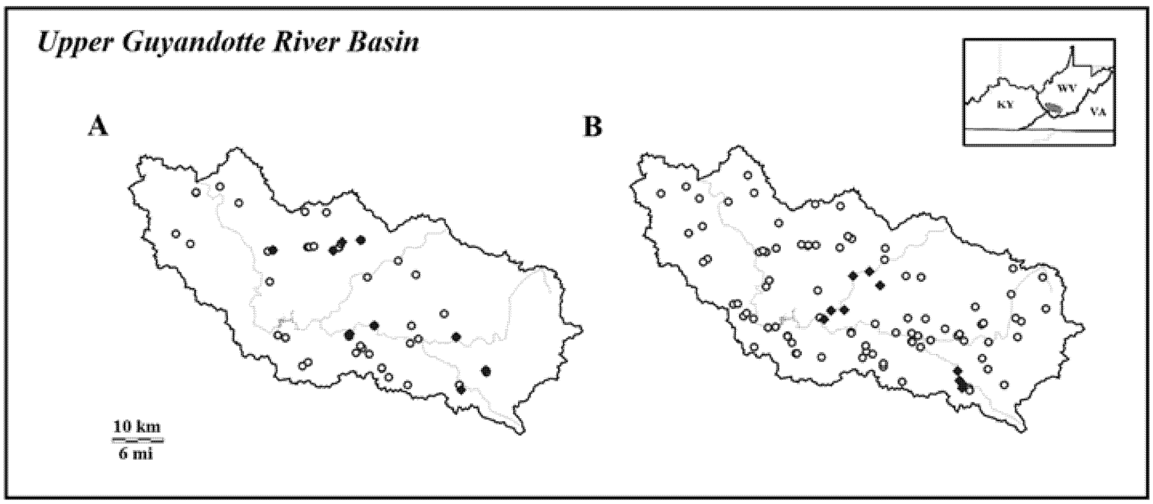


**Figure 2.** Historical and current survey results for the Guyanadotte River crayfish. A. Pre-2006 survey results; B. 2006 through 2015 survey results. Positive species occurrences are indicated by black diamonds, negative results are open circles.

**Table 2.** Survey effort and results for the Guyandotte River crayfish. Historical data are presented on the top row, current data are presented on the bottom row.

| | Upper Guyandotte Basin | | | | | |
|---|---|---|---|---|---|---|
| | Sites Surveyed | Positive for *C. veteranus* | Percent Positive | Streams Surveyed | Positive for *C. veteranus* | Percent Positive |
| **1900 to 2005** | 56 | 10 | 18% | 15 | 6 | 40% |
| **2006 to 2015** | 103 | 12 | 12% | 24 | 2 | 8% |

*Population Status*

There are no historical or current total population estimates for the Big Sandy crayfish or Guyandotte River crayfish. However, the best available data provide information on the distribution and abundance of each species. Historical survey information, historical stream connectedness, current distribution data, genetic evidence, and expert opinion support that these species once occupied most, perhaps all, third order or larger stream systems throughout their respective ranges. The evidence further supports the conclusion that, under natural (*i.e.,* undegraded) conditions, these species likely occur (or occurred) along the stream continuum wherever suitable slab boulder habitat exists (Appalachian Technical Services, Inc. (ATS) 2010, entire; ATS 2012a, entire; ATS 2012b, entire; Loughman 2015a, p. 23; Loughman 2015b, pp. 9–10). Historically, this slab boulder habitat was common throughout most of both species' ranges, however it may be naturally patchy in some streams in the lower Levisa Fork and Tug Fork subwatersheds in the Big Sandy River basin and in some of the lower tributary streams in the Upper Guyandotte River basin (Loughman 2015a, pp. 5–29; Loughman 2015b, pp. 9–25). Currently, suitable slab boulder habitat is limited by anthropogenic degradation (discussed below under *Factor A*).

Survey data from 1900 (prior to the widespread industrialization of the region) and from current occupied streams that maintain high-quality habitat indicate that unrestricted sampling at a ''healthy'' site should produce 20 to 25 individual Big Sandy or Guyandotte River crayfish specimens (Faxon 1914, pp. 389–390; Thoma 2009a, p. 10; ATS 2010, entire; ATS 2012a, entire; ATS 2012b, entire; Virginia Department of Transportation (VDOT) 2014b, entire; VDOT 2015, entire). Between 2006 and 2015, where possible, survey data were normalized to a common metric, ''catch per unit effort'' (CPUE). In general, sites described as ''robust'' or ''healthy'' maintained CPUE values of 5 or more crayfish per hour (Thoma 2009, pp. 17–18; Thoma 2010, p. 6; Loughman 2014, p. 15).

In 2015, 39 sites in the Big Sandy River basin (representing 25 percent of those surveyed) were positive for the Big Sandy crayfish. The *actual* CPUE values for these occupied sites ranged from 1 to 5 Big Sandy crayfish per hour (mean 2.1 crayfish per hour). However, only four sites had ''robust'' CPUE values of 5, and approximately half (n=19) of occupied sites had a CPUE value of 1, indicating low Big Sandy crayfish abundance. The basinwide *average* CPUE value (including occupied and unoccupied sites) was 0.5 Big Sandy crayfish per hour. Where data exist to make a temporal comparison, between 2007 and 2015, seven stream systems showed a decline in CPUE values and four stream systems did not appear to change (see table 3, below).

In 2015, 10 sites in the Upper Guyandotte River basin (representing 14 percent of those surveyed) were positive for the Guyandotte River crayfish. The *actual* CPUE values for these occupied sites ranged from 2 to 15 Guyandotte River crayfish per hour (mean 5.0 crayfish per hour). In Pinnacle Creek, none of the occupied sites had a CPUE value indicative of a ''robust'' Guyandotte River crayfish population; the highest CPUE value in Pinnacle Creek was 4 crayfish per hour (mean 2.8 crayfish per hour, n=4). In Clear Fork, four of the sites had CPUE values indicative of ''robust'' Guyandotte River crayfish populations; the highest CPUE value was 15 crayfish per hour (mean 6.5 crayfish per hour, n=6). The basinwide *average* CPUE (including occupied and unoccupied sites) was 0.7 Guyandotte River crayfish per hour. The temporal data for Pinnacle Creek do not indicate a significant change in CPUE values between 2009 and 2015 (see table 3).

**Table 3.** The CPUE values for streams where multi-year data exists. Streams with multiple positive sites are reported as averages ("n" represents the number of positive occurrences used to calculate the average); CPUE values without an "n" indicates a single site.

| Species | Watershed | Stream System | 2007 | 2009 | 2011 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| Big Sandy crayfish | Levisa Fork | Shelby Creek | | 6 (n=3) | | | 1.8 (n=5) |
| | Upper Levisa Fork | Dismal Creek | 5.3 (n=4) | | | | 5 (n=2) |
| | Russell Fork | Elkhorn Creek | | 1 | | | 1 |
| | | Russell Fork | 12 (n=5) | 13.5 (n=2) | | | 1.8 (n=5) |
| | | McClure River | 12 (n=5) | | | | 2 (n=3) |
| | | Pound River | 21.7 (n=3) | | | | 3 |
| | | Cranes Nest River | 12 (n=2) | | | | 2.7 (n=3) |
| | Tug Fork | Dry Fork | | 3 | 3.6 | 9 (n=2) | 1.4 (n=5) |
| | | Blackberry Creek | | 1 | | | 1 |
| | | Tug Fork | | | 3.2 | | 2.7 (n=3) |
| | | Knox Creek | | 7 | | | 3 (n=2) |
| Guyandotte River crayfish | Upper Guyandotte | Pinnacle Creek | | 2 | 2.5 | | 2.8 (n=4) |

As with the distribution data discussed above, the 2015 survey data indicate differences in CPUE values and overall habitat quality (as measured by the standard QHEI) between the four major subwatersheds (see tables 4a, 4b, 4c, and 4d, below). In the Russell Fork basin, the *average* CPUE value (including occupied and unoccupied sites) was 1.1 Big Sandy crayfish per hour and the *average* QHEI score was 74. In the Upper Levisa Fork basin, the *average* CPUE value was 0.7 and the *average* QHEI score was 73. The Tug Fork and Levisa Fork basins appeared to be less ''healthy,'' with *average* CPUE values of 0.4 and 0.2, respectively, and *average* QHEI scores of 65 and 61, respectively.

**Tables 4a, 4b, 4c, 4d.** Comparison of average CPUE values and average QHEI scores in the four upper Big Sandy River basin subwatersheds.

**4a Levisa Fork**

| *C. callainus* Site Status | n | CPUE Mean | CPUE Range | QHEI Mean | QHEI Range |
|---|---|---|---|---|---|
| Positive | 5 | 1.8 | 1-3 | 69 | 64-74 |
| Negative | 38 | n/a | n/a | 60 | 32-82 |
| Overall | 43 | 0.2 | n/a | 61 | 32-82 |

**4b Upper Levisa Fork**

| *C. callainus* Site Status | n | CPUE Mean | CPUE Range | QHEI Mean | QHEI Range |
|---|---|---|---|---|---|
| Positive | 2 | 5.0 | 5 | 73 | 66-80 |
| Negative | 12 | n/a | n/a | 73 | 63-86 |
| Overall | 14 | 0.7 | n/a | 73 | 63-86 |

**4c Russell Fork**

| *C. callainus* Site Status | n | CPUE Mean | CPUE Range | QHEI Mean | QHEI Range |
|---|---|---|---|---|---|
| Positive | 16 | 2.2 | 1-4 | 75 | 60-91 |
| Negative | 15 | n/a | n/a | 72 | 60-89 |
| Overall | 31 | 1.1 | n/a | 74 | 60-91 |

**4d Tug Fork**

| *C. callainus* Site Status | n | CPUE Mean | CPUE Range | QHEI Mean | QHEI Range |
|---|---|---|---|---|---|
| Positive | 16 | 1.7 | 1-5 | 72 | 62-89 |
| Negative | 49 | n/a | n/a | 63 | 44-90 |
| Overall | 65 | 0.4 | n/a | 65 | 44-90 |

Additionally, Big Sandy crayfish relocation surveys conducted in the Russell Fork basin between 2009 and 2015 indicate that, in the relatively high quality streams of this subwatershed, the species appears to occur along significant stream distances, not necessarily just discrete locations. During these relocation surveys, the species was also collected in high numbers at many sites. Based on these relocation survey data and the distribution data that indicated 92 percent of the streams in the Russell Fork basin are occupied (see table 1c, above), we conclude that the population of Big Sandy crayfish in the Russell Fork subwatershed is likely more resilient than indicated by the data available at the time we published the April 7, 2015, proposed rule (80 FR 18710).

*Summary*

The best available data indicate that the distribution and abundance of both the Big Sandy crayfish and the Guyandotte River crayfish are reduced from their historical levels. The Big Sandy crayfish currently occupies approximately 38 percent of the presumed historically suitable stream systems within its historical range. Within these stream systems, the most recent survey data indicate that the species occupies 31 percent of the surveyed sites. However, as described above, this percentage varies markedly among the four major subwatersheds, with the species being poorly represented in the Levisa Fork and Upper Levisa Fork subwatersheds. The Guyandotte River crayfish currently occupies only two streams, or approximately 8 percent of the presumed historically suitable stream systems within its historical range. Within these two streams, the species is currently found at 12 percent of the individual sites surveyed. The CPUE data also indicate that, at currently occupied sites, both species are generally found in low numbers, with few sites indicating ‘‘robust’’ populations of Big Sandy crayfish or Guyandotte River crayfish. It is possible that additional occurrences of either species could be found, but not probable given the extent of the current survey efforts (see figures 1 and 2, above) combined with habitat quality information (either natural or human mediated conditions) discussed below. In addition to occupying fewer streams and sites within streams, the species’ stream occurrences are fragmented and isolated from each other (see figures 3 and 4, below).

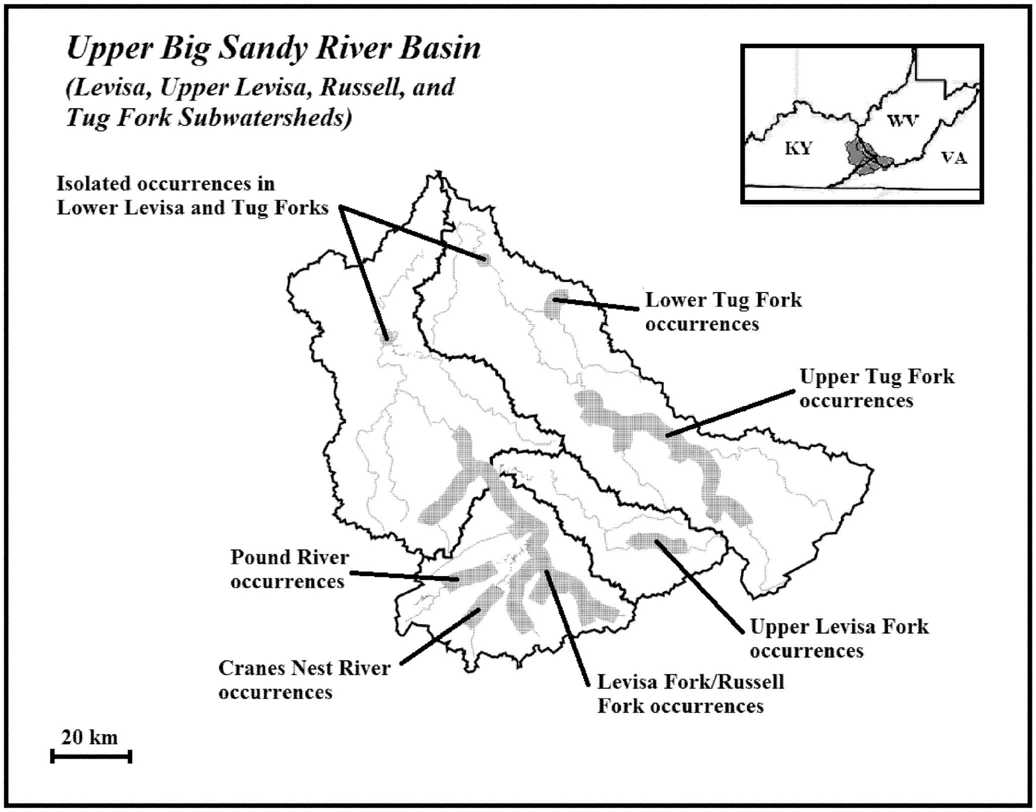


**Figure 3**. Fragmentation of the existing Big Sandy crayfish subpopulations. Based on the reasonable assumption that suitable habitat should exist within the shaded areas to permit crayfish movement and/or occupation between current confirmed survey sites.

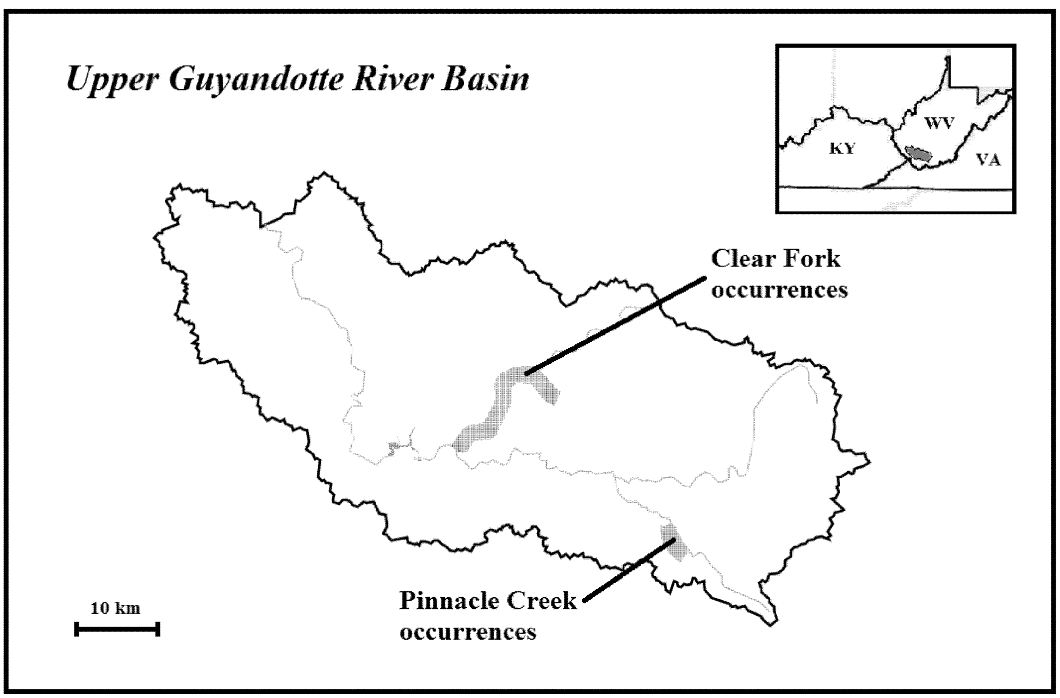


**Figure 4**. Fragmentation of the existing Guyandotte River crayfish subpopulations. Based on the reasonable assumption that suitable habitat should exist within the shaded areas to permit crayfish movement and/or occupation between current confirmed survey sites.

**Summary of Factors Affecting the Species**

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

Within the historical range of both the Big Sandy and the Guyandotte River crayfish, the aquatic habitat has been severely degraded by past and ongoing human activities (Hunt *et al.* 1937, p. 7; Eller 1982, pp. 162, 184–186; Jezerinac *et al.* 1995, p. 171; Channell 2004, pp. 16–23; Thoma 2009b, p. 7; Thoma 2010, pp. 3–4; Loughman 2013, p. 6; Loughman and Welsh 2013, p. 23; Loughman 2014, pp. 10–11). Visual evidence of habitat degradation, such as excessive bottom sedimentation, discolored sediments, or stream channelization and dredging, is often obvious, while other water quality issues such as changes in pH, low dissolved oxygen levels, high dissolved solids, high conductivity, high metals concentrations, and changes in other chemical parameters are less visibly obvious. Within the range of each species, water quality monitoring reports, most recently from the Kentucky Division of Water (KDOW) (2013, entire), the U.S. Environmental Protection Agency (USEPA) (2004, entire), the Virginia Department of Environmental Quality (VADEQ 2012, entire), and the West Virginia Department of Environmental Protection (WVDEP 2014, entire), have linked these widespread and often interrelated direct and indirect stressors to coal mining and abandoned mine land (AML), commercial timber harvesting, residential and commercial development, roads, and sewage discharges.

The best available data indicate that the presence and abundance of both the Big Sandy crayfish and Guyandotte River crayfish are correlated with habitat quality, specifically streams with slab boulders and low levels of sedimentation and substrate embeddedness (Jezerinac *et al.* 1995, entire; Channell 2004, pp. 22–24; Thoma 2009b, p. 7; Thoma 2010, pp. 3, 6; Loughman 2014, pp. 22–23; Loughman 2015a, pp. 29–30; Loughman 2015b, pp. 25–30). In 2015, rangewide surveys for both species measured habitat quality using the QHEI that includes measures of substrate quality and embeddedness (Loughman 2015a, entire; Loughman 2015b, entire). Based on QHEI scores, 31 percent of sites occupied by the Big Sandy crayfish (n=39) and 80 percent of sites occupied by the Guyandotte River crayfish (n=10) had habitats classified as ''Excellent.'' Habitats at all remaining occupied sites were classified as ''Good.'' No Big Sandy crayfish or Guyandotte River crayfish were collected at sites classified as ''Fair,'' ''Poor,'' or ''Very Poor.''

Coal Mining

The past and ongoing effects of coal mining in the Appalachian Basin are well documented, and both underground and surface mines are reported to degrade water quality and stream habitats (Matter and Ney 1981, pp. 67–70; Williams *et al.* 1996, pp. 41–46; Sams and Beer 2000, entire; Demchak *et al.* 2004, entire; Hartman *et al.* 2005, pp. 94–100; Pond *et al.* 2008, entire; Lindberg *et al.* 2011, entire; Merriam *et al.* 2011, entire; Pond 2011, entire; USEPA 2011b, entire; Bernhardt *et al.* 2012, entire; Hopkins *et al.* 2013, entire; Wang *et al.* 2013, entire; Palmer and Hondula 2014, entire). The common physical changes to local waterways associated with coal mining include increased erosion and sedimentation, changes in flow, and in many cases the complete burial of headwater streams (USEPA 1976, pp. 3–11; Matter and Ney 1981, entire; Hartman *et al.* 2005, pp. 91–92; Pond *et al.* 2008, pp. 717–718; USEPA 2011b, pp. 7–9). These mining-related effects, which can contribute to stream bottom embeddedness, are commonly noted in the streams and rivers within the ranges of the Big Sandy and the Guyandotte River crayfishes (USEPA 2004; WVDEP 2012; KDOW 2013; VADEQ 2014) and are of particular concern for these species, which, as tertiary burrowers, rely on unembedded slab boulders for shelter.

Underground mining accounts for most of the coal excavated in the region, but since the 1970s, surface mining (including ''mountaintop removal mining'' or MTR) has become more prevalent. Mountaintop removal mining is differentiated from other mining techniques by the shear amount of overburden (*i.e.,* rock and other geologic material) that is removed to access the coal seams below and the use of ''valley fills'' to dispose of the overburden. This practice has occurred and continues to occur within the two species' ranges and results in the destruction of springs and headwater streams and can lead to water quality degradation in downstream reaches (USEPA 2011, pp. 7–10).

The best available data indicate that much of the residual erosion and sedimentation effects from surface coal mining are likely to continue indefinitely. The geology of the mountain ridges in the Appalachian Plateaus physiographic province makes them resistant to erosion. However surface coal mining, and especially MTR mining, breaks down this inherently erosion-resistant bedrock into unconsolidated ''spoil'' material that is much more vulnerable to erosional forces, especially flowing water. Through the removal of this stable bedrock material in order to access coal seams, and subsequent disposal of the unconsolidated mine spoil in adjacent valley fills, surface coal mining causes significant geomorphic disturbances with long-term consequences for the region's streams (Kite 2009, pp. 4, 6–9).

The legacy effects of surface coal mining persist long after active mining ceases. While post-Surface Mining Control and Reclamation Act of 1977 (SMCRA) mine reclamation techniques help reduce erosion following mine closure, especially as compared to pre-SMCRA conditions, comparisons of recently mined and reclaimed watersheds to unmined watersheds indicate streams below reclaimed MTR sites can be unstable (Fox 2009, pp. 1286–1287; Jaeger 2015, pp. 30–32). For example, research indicates that after surface coal mining reclamation is complete, the altered geomorphology and hydrology in the watershed causes streams to adjust to these new conditions (Fox 2009, pp. 1286–1287). This adjustment process includes streambank erosion that contributes sediments to streams downstream of the mined watersheds. Other indicators of unstable streams downstream of mined sites include increased maximum stream depth, changes in stream profile, more exposed bedrock, and increased frequency of fine sediment loads (Jaeger 2015, pp. 30–32).

The sedimentation effects from stream instability differ from site to site, and there is uncertainty as to the time required for streams to reach a new equilibrium after surface mining ends. Additionally, numerous failures (*i.e.,* major erosion events) of reclaimed slopes have been observed following heavy rainfall events, and the long-term durability of reclaimed mine land in the absence of active reclamation maintenance has not been tested (Kite 2009, pp. 6–7). The historical effects of pre-SMCRA mining continue to cause stream instability and sedimentation throughout the Appalachian coalfields (Kite 2009, p. 9; Witt 2015, entire). In 2015, the Virginia Department of Mines, Minerals, and Energy reported a series of debris slides and flows originating from mine spoils associated with abandoned, pre-1981, coal mines. One of these debris flows in the Upper Levisa basin inundated an area of approximately 8,100 square meters ($m^2$) (0.8 hectares (ha)) (2 acres (ac)) and was ''actively shedding mud and fine debris'' into a headwater tributary, which then caused sedimentation in an amount sufficient to obstruct flow in a downstream tributary of Elkins Branch (Witt 2015, entire).

Of particular concern to the Guyandotte River crayfish are several active surface coal mines in the Pinnacle Creek watershed that may pose an immediate threat to the continued existence of that subpopulation, one of only two known to exist. These mines are located either on Pinnacle Creek (*e.g.,* encroaching to within 0.5 kilometers (km) (0.31 miles (mi)) of the creek) and directly upstream (*e.g.,* within 7.0 km (4.4 mi)) of the Guyandotte River crayfish occurrence locations or on tributaries that drain into Pinnacle Creek upstream of the occurrence locations (WVDEP 2014a; WVDEP 2014b; WVDEP 2014c; WVDEP 2014d). Some of these mines have reported violations related to mandatory erosion and sediment control measures (*e.g.,* 3 to 37 violations) within the last 3 years (WVDEP 2014a; WVDEP 2014b; WVDEP 2014d).

Historically, coal mining has been ubiquitous within the ranges of both the Big Sandy and Guyandotte River crayfishes. While coal extraction from the southern Appalachian region has declined from the historical highs of the 20th century, and is unlikely to ever return to those levels (Milici and Dennen 2009, pp. 9–10; McIlmoil *et al.* 2013, pp. 1–8, 49–57), significant mining still occurs within the ranges of both species. The U.S. Department of Energy (2013, table 2) reports that in 2012, there were 192 active coal mines (119 underground mines and 73 surface mines) in the counties that constitute the core ranges of the Big Sandy and Guyandotte River crayfishes. Because of the scale of historical coal mining in the region and the magnitude of the geomorphological changes in mined areas, we conclude that the erosion and sedimentation effects of coal mining will continue indefinitely.

Forestry

The dominant land cover within the ranges of the Big Sandy and Guyandotte River crayfishes is forest. Commercial timber harvesting occurs throughout the region and, especially in areas directly adjacent to, or on the steep slopes above, streams and rivers, has the potential to degrade aquatic habitats, primarily by increasing erosion and sedimentation (Arthur *et al.* 1998, entire; Stone and Wallace 1998, entire; Stringer and Hilpp 2001, entire; Swank *et al.* 2001, entire; Hood *et al.* 2002, entire). Based on the best available data (Cooper *et al.* 2011a, p. 27; Cooper *et al.* 2011b, pp. 26–27; Piva and Cook 2011, p. 46), we estimate that within the ranges of the Big Sandy and Guyandotte River crayfishes, approximately 12,600 ha (30,745 ac) of forest are harvested annually, representing approximately 1.9 percent of the total forest cover within this area.

Erosion rates from logged sites in the mountainous terrain of the southern Appalachians are significantly higher than from undisturbed forest sites (Hood *et al.* 2002, entire). Applying the erosion rates from Hood *et al.* (2002, entire) to the estimated harvested area above indicates that timber harvesting within the ranges of the Big Sandy and Guyandotte River crayfishes could produce 67,158 to 149,436 tonnes (73,173 to 162,641 tons) of sediment annually, as compared to an estimated 5,922 tonnes (6,456 tons) of sediment from undisturbed forest of the same area. Hood *et al.* (2002, p. 54) provide the caveat that the model they used does not account for additional erosion associated with forest disturbance, such as gully erosion, landslides, soil creep, stream channel erosion, or episodic erosion from single storms, and therefore, their estimates of actual sediment transport are low. Therefore, our analysis of potential erosion within the ranges of the two species likely underestimates actual erosion rates.

Forestry ''best management practices'' (BMPs) are designed to reduce the amount of erosion at logging sites, however the rates of BMP adherence and effectiveness at logging sites within the ranges of the Big Sandy and Guyandotte River crayfishes vary. The best available data indicate that BMP implementation rates in the region range from about 80 to 90 percent; however, we could not locate current data on the actual efficacy of BMPs in the steep terrain that characterizes Big Sandy and Upper Guyandotte River basins. Additionally, the implementation of forestry BMPs is not required for certain timber cutting operations. For example, in Kentucky, tree clearing incidental to preparing coal mining sites is specifically exempted, and in West Virginia, tree-clearing activities incidental to ground-disturbing construction activities, including those related to oil and gas development, are exempted (Kentucky Division of Forestry undated fact sheet, downloaded February 5, 2015; West Virginia Division of Forestry 2014, pp. 3–4).

While Hood *et al.* (2002, entire) found that erosion rates improved quickly in subsequent years following logging, Swank, *et al.* (2001, pp. 174–176) studied the long-term effects of timber harvesting at a site in the Blue Ridge physiographic province in North Carolina, and determined that 15 years postharvest, the annual sediment yield was still 50 percent above predisturbance levels. While we do not have specific information on timber harvesting in areas directly adjacent to, or upslope from, streams historically occupied, currently occupied, or likely to be occupied by the Big Sandy or Guyandotte River crayfishes, we do know based on past practices that timber harvesting occurs year to year on a rotational basis throughout the Big Sandy and Upper Guyandotte watersheds. Excess sedimentation from timber harvested sites may take decades to flush from area streams. Based on the rotational nature of timber harvesting, we conclude that commercial timber harvesting in the region is likely relatively constant, ongoing, and likely to continue. We also conclude that timber harvesting, particularly when harvesters do not use sufficient erosion control measures, is likely to continually degrade the aquatic habitat required by the Big Sandy and Guyandotte River crayfishes.

Gas and Oil Development

The Appalachian Plateaus physiographic province is underlain by numerous geological formations that contain natural gas and, to a lesser extent, oil. The Marcellus shale formation underlies the entire range of the Guyandotte River crayfish and a high proportion of the range of the Big Sandy crayfish, specifically McDowell County, West Virginia, and part of Buchanan County, Virginia (U.S. Department of Energy (USDOE) 2011, p. 5), and various formations that make up the Devonian Big Sandy shale gas play (*e.g.,* a favorable geographic area that has been targeted for exploration) underlie the entire range of the Big Sandy crayfish and some of the range of the Guyandotte River crayfish (USDOE 2011, p. 9). In addition to these shale gas formations, natural gas also occurs in conventional formations and in coal seams (referred to as ''coal bed methane'' or CBM) in each of the counties making up the ranges of the two species. The intensity of resource extraction from these geological formations has varied over time depending on market conditions and available technology, but since the mid- to late 20th century, many thousands of gas and oil wells have been installed within the ranges of the Big Sandy and Guyandotte River crayfishes (Kentucky Geological Survey (KGS) 2015; Virginia Department of Mines, Minerals and

Energy (VDMME) 2015; West Virginia Department of Environmental Protection (WVDEP) 2015).

Numerous studies have reported that natural gas development has the potential to degrade aquatic habitats (Boelter *et al.* 1992, pp. 1192–1195; Adams *et al.* 2011, pp. 8–10, 18; Drohan and Brittingham, 2012, entire; McBroom *et al.* 2012, pp. 953–956; Olmstead *et al.* 2013, pp. 4966–4967; Papoulias and Velasco 2013, entire; Vidic *et al.* 2013, entire; Warner *et al.* 2013, entire; USEPA 2014, entire; Vegosh *et al.* 2014, pp. 8339–8342; Harkness *et al.* 2015, entire). The construction of well pads and related infrastructure (*e.g.,* gas pipelines, compressor stations, wastewater pipelines and impoundments, and access roads) can increase erosion and sedimentation, and the release of drilling fluids, other industrial chemicals, or formation brines can contaminate local streams.

Within the ranges of the Big Sandy and Guyandotte River crayfishes, the topography is rugged and the dominant land cover is forest; therefore, the construction of new gas wells and related infrastructure usually involves timber cutting and significant earth moving to create level well pads, access roads, and pipeline rights-of-way, all of which increases the potential for erosion. For example, Drohan and Brittingham (2012, entire) analyzed the runoff potential for shale gas development sites in the Allegheny Plateau region of Pennsylvania, and found that 50 to 70 percent of existing or permitted pad sites had medium to very high runoff potential and were at an elevated risk of soil erosion. McBroom *et al.* (2012, entire) studied soil erosion from two well pads constructed in a forested area in the Gulf Coastal Plain of east Texas and determined a significant increase in erosion from the well pads as compared to undisturbed forested sites. Based on this information, which represents the lower end of the potential risk given the less mountainous topography where these studies took place, it is reasonable to conclude that erosion from well sites within the ranges of the Big Sandy and Guyandotte River crayfishes is significantly higher than from undisturbed sites, especially when those sites do not use sufficient erosion control measures and are directly adjacent to, or upslope from, streams occupied or likely to be occupied by either species.

We anticipate the rate of oil and gas development within the ranges of the Big Sandy and Guyandotte River crayfishes to increase based on projections from a report by IHS Global, Inc. (2013, p. 4), produced for the American Petroleum Institute, which indicate that the ''recent surge in oil and gas transportation and storage infrastructure investment is not a short lived phenomenon. Rather, we find that a sustained period of high levels of oil and gas infrastructure investment will continue through the end of the decade.'' While this projection is generalized across all oil and gas infrastructure within the United States, an increase of new infrastructure within the ranges of the Big Sandy and Guyandotte River crayfishes is also anticipated because of the yet untapped Marcellus and Devonian Big Sandy shale resources discussed above.

On- and Off-Road Transportation

*Unpaved Roads*—Unpaved forest roads (*e.g.,* haul roads, access roads, and skid trails constructed by the extractive industries or others) can degrade the aquatic habitat required by the Big Sandy and Guyandotte River crayfishes. In this region, these roads are often located on the steep hillsides and are recognized as a major source of sediment loading to streams and rivers (Greir *et al.* 1976, pp. 1–8; Stringer and Taylor 1998, entire; Clinton and Vose 2003, entire; Christopher and Visser 2007, pp. 22–24; MacDonald and Coe 2008, entire; Morris *et al.* 2014, entire; Wade *et al.* 2012, pp. 408–409; Wang *et al.* 2013, entire). In addition to erosion from unpaved road surfaces, unpaved road stream crossings can contribute significant sediment loading to local waters (Wang *et al.* 2013, entire). These unpaved roads and stream crossings, often associated with mining, forestry, and oil and gas activities, are ubiquitous throughout the range of the Big Sandy and Guyandotte River crayfishes. We anticipate the number of unpaved roads throughout the crayfishes' ranges to remain the same or expand as new oil and gas facilities are built, new areas are logged, and new off-road vehicle (ORV) trails are constructed.

*Off-road Vehicles*—Recreational ORV use contributes to the erosion and sedimentation problems associated with unpaved roads and stream crossings and has become increasingly popular in the region (see *http://www.riderplanet-usa.com,* last accessed March 1, 2016). Recreational ORV use, which includes the use of unimproved stream crossings, stream channel riding, and ''mudding'' (the intentional and repeated use of wet or low-lying trail sections that often results in the formation of deep ''mud holes''), may cause increased sediment loading to streams and possibly kill benthic organisms directly by crushing them (Chin *et al.* 2004, entire; Ayala *et al.* 2005, entire; Christopher and Visser 2007, p. 24; YouTube.com 2008; YouTube.com 2010; YouTube.com 2011; Switalski and Jones 2012, pp. 14–15; YouTube.com 2013). Nearly all of the land within the ranges of the Big Sandy and Guyandotte River crayfishes is privately owned, and ORV use on private land is largely unregulated. We found no comprehensive information on the extent of off-road ridership or the effects to local streams. However, the Hatfield-McCoy Trail system, which was created in 2000 to promote tourism and economic development in southern West Virginia, may provide some insight into the scale of ORV recreation within the ranges of the Big Sandy and Guyandotte River crayfishes (Pardue *et al.* 2014, p. 1). As of 2014, the Hatfield-McCoy Trail system had eight individual trail networks totaling more than 1,127 km (700 mi) of cleared trails, with the stated long-term goal being approximately 3,219 km (2,000 mi) of accessible trails (Pardue *et al.* 2014, pp. 4–5), and in 2013, 35,900 trail permits were sold (Hatfield-McCoy presentation 2013, p. 8). Two of the designated Hatfield-McCoy trail networks, Pinnacle Creek and Rockhouse, are located in the Upper Guyandotte basin, and one, Buffalo Mountain, is in the Tug Fork basin.

The Pinnacle Creek Trail System, opened in 2004, is located entirely within the Pinnacle Creek watershed and may pose a significant threat to the continued existence of the Guyandotte River crayfish population in this stream. Approximately 13 km (8.0 mi) of the Pinnacle Creek trail is located in the riparian zone adjacent to the stream reach that currently harbors the Guyandotte River crayfish. At several locations along this section of trail, riders are known to operate their vehicles in the streambed or in adjacent ''mud holes'' (You Tube 2008; You Tube 2010; You Tube 2011; You Tube 2013; Loughman, pers. comm., October 24, 2014). It is reasonable to conclude that these activities increase erosion and sedimentation in Pinnacle Creek and degrade the habitat of the Guyandotte River crayfish. In addition, the instream operation of ORVs in Pinnacle Creek has the potential to crush or injure individual crayfish directly.

*Road Construction*—The construction of new roads also has the potential to further degrade the aquatic habitat in the region, primarily by increasing erosion and sedimentation, especially when the new roads do not use sufficient erosion control measures and are directly adjacent to, or upslope from, streams occupied or likely to be occupied by the Big Sandy crayfish or

Guyandotte River crayfish. In addition, roadways are also known to introduce contaminants to local streams (see ''Water Quality Degradation,'' below). Two new, multi-lane highway projects totaling 330 km (205 mi), the King Coal Highway and the Coalfields Expressway, are in various stages of development within the Big Sandy and Upper Guyandotte River watersheds (VDOT 2015; West Virginia Department of Transportation (WVDOT) 2015a; WVDOT 2015b) (see figure 5, below). In West Virginia, the King Coal Highway right-of-way runs along the McDowell and Wyoming County line, the dividing line between the Tug Fork and Upper Guyandotte watersheds, and continues into Mingo County (which is largely in the Tug Fork watershed). This highway project will potentially affect the current occupied habitat of both crayfish species, but is of particular concern for the Guyandotte River crayfish because of a section that will parallel and cross Pinnacle Creek, one of two known locations for the species.

In West Virginia, the Coalfields Expressway right-of-way crosses Wyoming and McDowell Counties roughly perpendicular to the King Coal Highway and continues into Buchanan, Dickenson, and Wise Counties, Virginia (see figure 5, below). This project runs through the Upper Guyandotte, Tug Fork, Levisa Fork, and Russell Fork watersheds and has the potential to affect the aquatic habitats in each basin. Of particular concern are sections of the Coalfields Expressway planned through perhaps the most robust Big Sandy crayfish populations in Dickenson County, Virginia, especially when those populations are directly adjacent to, or downslope from, the construction sites and if those construction sites do not use sufficient erosion control measures.

Both highways will also have a yet undetermined number of feeder roads connecting completed segments to other existing roadways. Some of these feeder roads will further bisect the two species' ranges and will likely be a source of additional sedimentation, especially if these roads do not use sufficient erosion control measures and are directly adjacent to, or upslope from, streams occupied or likely to be occupied by the Big Sandy crayfish or Guyandotte River crayfish. Because the highways are being built in phases when funding is available, the original planned completion schedule of approximately 2018 has been delayed, and we anticipate construction will continue until approximately 2030 (see *http://www.wvkingcoal.com/; http://www.virginiadot.org/projects/bristol/route_121.asp; http://www.transportation.wv.gov/highways/highways-projects/coalfieldsexpressway/,* last accessed March 3, 2016).

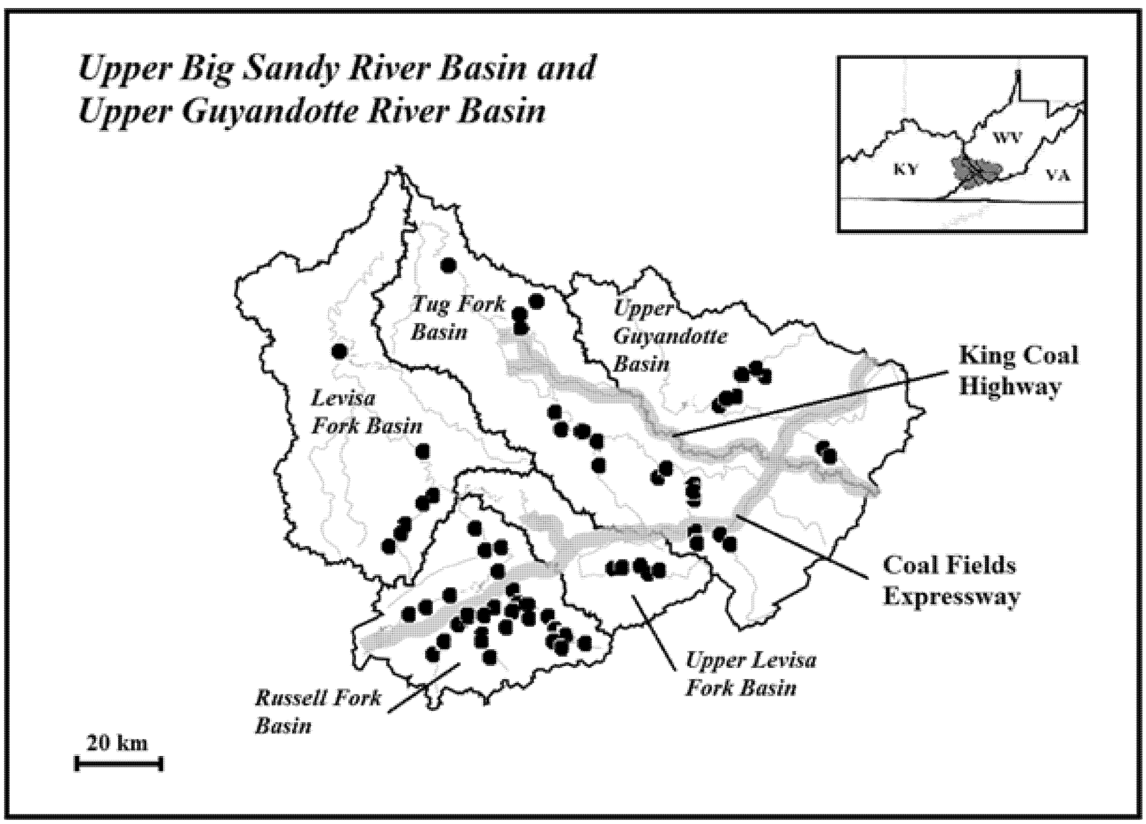


**Figure 5**. New highway corridors in the upper Big Sandy and Upper Guyandotte River basins. Highway corridors indicated by gray shading, black circles indicate current (2006 to 2015) Big Sandy crayfish or Guyandotte River crayfish occurrence locations.

*Instream Construction*—Since 2009, the VDGIF has requested companies or other agencies undertaking construction activities (*e.g.,* pipeline stream crossings, bridge replacements, bank stabilization work) in or adjacent to known or suspected Big Sandy crayfish streams to conduct crayfish surveys prior to any construction activities (Brian Watson, VDGIF 2016, pers. comm.; Va. Code sec. 29.1–563 to 570). If the species is discovered within the construction area, agencies are required to capture and relocate Big Sandy crayfish to suitable habitats outside of the affected area, typically upstream of the disturbance. While these efforts likely afford individual crayfish protection from the direct effects of the construction activities, it is unknown if relocated crayfish survive and successfully establish in their new locations.

Data indicate that between 2009 and 2015, 12 projects were conducted in the Russell Fork and upper Levisa Fork subwatersheds of Virginia that involved the potential relocation of Big Sandy crayfish (Appalachian Energy 2009; ATS 2009, entire; ATS 2010, entire; D.R. Allen and Associates 2010, entire; Vanasse Hangen Brustlin, Inc. 2011, entire; ATS 2012a, entire; ATS 2012b, entire; VDOT 2014a, entire; VDOT 2014b, entire; VDOT 2014c, entire; VDOT 2014d, entire; VDOT 2015, entire). While these data indicate instream projects occur within the range of the Big Sandy crayfish, we do not have any information on the total number of instream projects within the Kentucky or West Virginia areas of the species' range, nor do we have this information for the Guyandotte River crayfish, because the two crayfish are not State-listed species in Kentucky or West Virginia (see further discussion below under *Factor D*). However, existing pipelines, bridges, and culverts have scheduled maintenance and replacement schedules, in addition to ad hoc work when those structures are damaged. While we do not have information to project the scope and magnitude of new instream projects within the two species' ranges, the maintenance and repair activities of existing infrastructure are expected to continue indefinitely.

*Summary of On- and Off-Road Transportation*—We conclude that erosion and sedimentation from unpaved roads and trails, ORV use, road construction projects, and potential injury resulting from instream construction projects within the ranges of the Big Sandy and Guyandotte River crayfishes are ongoing threats to each species.

Residential/Commercial Development and Associated Stream Modifications

*Residential and Commercial Development*—Because of the rugged topography within the ranges of the Big Sandy and the Guyandotte River crayfishes, most residential and commercial development and the supporting transportation infrastructure is confined to the narrow valley floodplains (Ehlke *et al.* 1982, p. 14; Kiesler *et al.* 1983, p. 14). The close proximity of this development to the region's streams and rivers has historically resulted in the loss of riparian habitat and the continued direct discharge of sediments, chemical pollutants, sewage, and other refuse into the aquatic systems (WVDEP 2012, entire; KDOW 2013, entire; VADEQ 2014, entire), which degrades habitat quality and complexity (Merriam *et al.* 2011, p. 415). The best available data indicate that the human population in these areas will continue to decrease over the next several decades (University of Louisville 2011, entire; University of Virginia 2012, entire; West Virginia University 2012, entire). However, while the human populations may decline, the human population centers are likely to remain in the riparian valleys.

*Stream Channelization and Dredging*—Flooding is a recurring problem for people living in the southern Appalachians, and many individuals and mountain communities have resorted to unpermitted stream dredging or bulldozing to deepen channels and/or remove obstructions in an attempt to alleviate damage from future floods (West Virginia Conservation Agency (WVCA), pp. 4, 36–38, 225–229). In fact, as recently as 2009, Loughman (pers. comm., October 24, 2014) observed heavy equipment being operated in stream channels in the Upper Guyandotte basin. Unfortunately, these unpermitted efforts are rarely effective at reducing major flood damage and often cause other problems such as streambank erosion, lateral stream migration, channel downcutting, and sedimentation (WVCA, pp. 225–229). Stream dredging or bulldozing also causes direct damage to the aquatic habitat by removing benthic structure, such as slab boulders, and likely kills benthic organisms by crushing or burial. Because these dredging and bulldozing activities are unpermitted, we have little data on exactly how widespread or how often they occur within the ranges of the Big Sandy or Guyandotte River crayfishes. However, during their 2009 survey work for *Cambarus veteranus* in the Upper Guyandotte and Tug Fork basins, Loughman and Welsh (2013, p. 23) noted that 54 percent of the sites they surveyed (these were sites predicted to be suitable to the species) appeared to have been dredged, evidenced by monotypic gravel or cobble bottoms and a conspicuous absence of large slab boulders. These sites were thus rendered unsuitable for occupation by *C. veteranus* and confirmed so by the absence of the species.

*Stream Channel Instability*—Under the Factor A discussion in the April 7, 2015, proposed rule (80 FR 18710, pp. 18722–18731), we discussed multiple activities that increase erosion and sedimentation within the ranges of the Big Sandy and Guyandotte River crayfishes. Under the *Stream channelization and dredging* category, we stated that channel modification for flood control activities can cause streambank erosion, lateral stream migration, channel downcutting, and sedimentation (80 FR 18710, p. 18730). However, such ''stream instability'' concerns can also be caused by stream modifications associated with residential and commercial development activities and by the large-scale topographic alterations resulting from surface coal mining.

As noted above, within the ranges of the Big Sandy and Guyandotte River crayfishes, most development occurs adjacent to streams and rivers within the narrow valleys and can alter the local hydrology and lead to increased erosion and sedimentation from disturbed land surfaces (80 FR 18710, pp. 18723–18724, 18728; April 7, 2015). Because human infrastructure and streams are in close proximity to each other, streams are often realigned and/or channelized to increase the amount of usable land area or to protect existing structures through the aforementioned flood control. These modifications, such as straightening, dredging, and armoring stream channels, increases stream flow velocities, or stream energy, and often leads to increased bed and bank erosion either in the modified stream reach or in downstream reaches (Keller 1978, pp. 119, 124–125; Brooker 1985, p. 1; Edwards *et al.* 2015, p. 67). Because these types of historical channel modifications are common in both watersheds, the total continual sediment contribution from unstable channels is likely considerable (Loughman and Welsh 2013, p. 23; WVCA undated, pp. 227–231). For example, a proposed stream restoration project on the Cranes Nest River (Russell Fork basin) estimated that approximately 3,530 ft (1.1 km) of historical stream channelization and resultant bank erosion at a small homestead annually contributes 140 tons of excess sediment to the Cranes Nest River (U.S. Department of Transportation 2015, entire). In addition, documentation from the 2015 Big Sandy crayfish surveys indicate that Prater Creek in the Lower Levisa Fork of Kentucky show incised and eroding streambanks, and at least 23 surveyed sites in the Levisa Fork, as well as in Pigeon Creek of the Tug Fork, were reported to have visible bank erosion (Loughman 2015a, entire).

*Summary of Residential/Commercial Development and Associated Stream Modification*—We conclude that stream channel instability caused by historical stream channel modifications associated with human development is a source of sediments in the streams and rivers within the range of the Big Sandy and Guyandotte River crayfishes. Because of the presumed permanence of human-occupied areas, we conclude that these effects will continue indefinitely.

Water Quality Degradation

While the best available data indicate that erosion and sedimentation leading to stream substrate embeddedness is the primary threat to both the Big Sandy and Guyandotte River crayfishes, other pollutants also degrade the streams and rivers within the ranges of these species and likely contributed to their decline and continued reduced distribution and abundance. As described in the April 7, 2015, proposed rule, the best available data indicate widespread water quality problems throughout the Big Sandy River basin and the Upper Guyandotte River basin (USEPA 2004, entire; WVDEP 2012, pp. 32–33; KDOW 2013, appendix E; VADEQ 2014, pp. 1098–1124). The pollutants commonly cited are metals (*e.g.,* selenium) and pH impairments associated with coal mining and bacteria related to sewage discharges. The response of aquatic species to these and other pollutants are often observed as a shift in a stream's macroinvertebrate (*e.g.,* insect larva or nymphs, aquatic worms, snails, clams, crayfish) or fish community structure and resultant loss of sensitive taxa and an increase in tolerant taxa (Diamond and Serveiss 2001, pp. 4714–4717; Hartman *et al.* 2005, pp. 96–97; Hitt and Chambers 2014, entire; Lindberg *et al.* 2011b, p. 1; Matter and Ney 1981, pp. 66–67; Pond *et al.* 2008).

*Mining-related Issues*—High salinity, caused by increased concentrations of sulfate, calcium, and other ions associated with coal mining runoff, is a widespread problem in Appalachian streams (USEPA 2011a, pp. 35–38). A study of crayfish distributions in the heavily mined upper Kanawha River basin in southern West Virginia did not determine a relationship between conductivity levels (a measure of salinity) and the presence or absence of the species studied (Welsh and Loughman 2014, entire). However the author's noted that stream conductivity levels can vary seasonally or with flow conditions, making assumptions regarding species' presence or absence at the time of surveys difficult to correlate with prior ephemeral conductivity conditions. In 2015, Service-funded crayfish surveys in the Big Sandy and Upper Guyandotte River basins determined electrical conductivity levels at each survey site (n=225) (Loughman 2015a, entire; Loughman 2015b; entire). While these studies found no correlation between high conductivity levels and the absence of the Big Sandy crayfish and a statistically weak correlation for the Guyandotte River crayfish, we note that 90 percent (n=139) of the sites in the Big Sandy River basin and 86 percent (n=61) of the sites in the Upper Guyandotte River basin exceeded the USEPA's freshwater aquatic life benchmark for conductivity, which is a level intended to protect aquatic life specifically in Appalachian streams and rivers (USEPA 2011a, p. xv).

Species presence/absence may be a poor measure for assessing the potential for high salinity levels (measured as conductivity) to affect the Big Sandy and Guyandotte River crayfishes. The studies described above provide no data on potential sublethal effects (*e.g.,* reduced reproductive success, physiological stress, reduced fitness) or the potential lethal effects to the species at various life stages (*e.g.,* juvenile survival, survival during ecdysis (molting, a particularly vulnerable stage in the animal's lifecycle)). The potential for high conductivity levels to be associated with these more subtle effects is supported by an Ohio study using juvenile Appalachian brook crayfish (*Cambarus bartonii cavatus*), a stream-dwelling species in the same genus as the Big Sandy and Guyandotte River crayfishes. This study found that high conductivity levels during ecdysis caused the crayfish difficulties in completing their molt, with subsequent increased mortality (Gallaway and Hummon 1991, pp. 168–170).

Based on the best available data, we conclude that elevated conductivity levels, which are common throughout the Big Sandy and Upper Guyadotte River basins, may cause physiological stress in the Big Sandy and Guyandotte River crayfishes. This stress may result in subtle, perhaps sublethal, effects that contribute to the decline and continued poor distribution and abundance of these species.

Other common byproducts of coal mining, such as dissolved manganese and iron, may also affect the Big Sandy and Guyandotte River crayfishes. Manganese and iron can be absorbed by crayfish through gill respiration or ingestion and may cause sublethal effects such as reduced reproductive capacity (Baden and Eriksson 2006, p. 73). Iron and manganese also physically bond to crayfish exoskeletons, which may interfere with crayfish sensory sensila (*e.g.,* receptors) (Loughman 2014, p. 27). While manganese encrustations have been found on both Guyandotte River and Big Sandy crayfish specimens, we are uncertain the extent to which these deposits occur across the species' ranges or if and to what extent the effects of the manganese and iron exposure has contributed to the decline of the Big Sandy or Guyandotte River crayfishes.

Ancillary to the coal mines are the processing facilities that use various mechanical and hydraulic techniques to separate the coal from rock and other geological waste material. This process results in the creation of large volumes of ''coal slurry,'' a blend of water, coal fines, and sand, silt, and clay particles, which is commonly disposed of in large impoundments created in the valleys near the coal mines. In multiple instances, these impoundments have failed catastrophically and caused substantial damage to downstream aquatic habitats (and in some cases the loss of human life) (Michalek *et al.* 1997, entire; Frey *et al.* 2001, entire; National Academy of Sciences (NAS) 2002, pp. 23–30; Michael *et al.* 2010, entire). In 2000, a coal slurry impoundment in the Tug Fork watershed failed and released approximately 946 million liters (250 million gallons) of viscous coal slurry to several tributary creeks of the Tug Fork, which ultimately affected 177.5 km (110.3 mi) of stream length, including the Tug Fork and Levisa Fork mainstems (Frey *et al.* 2001, entire). The authors reported a complete fish kill in 92.8 km (57.7 mi) of stream length, and based on their description of the instream conditions following the event, it is reasonable to conclude that all aquatic life in these streams was killed, including individuals of the Big Sandy crayfish, if they were present at that time. Coal slurry impoundments are common throughout the ranges of the Big Sandy and Guyandotte River crayfishes, and releases have been documented in each of the States within these ranges (NAS 2002, pp. 25–30).

*Natural Gas Development*—Natural gas well drilling and well stimulation, especially the technique of hydraulic fracturing, can also degrade aquatic habitats when drilling fluids or other associated chemicals or high salinity formation waters (*e.g.,* flowback water and produced water) are released, either intentionally or by accident, into local surface waters (McBroom *et al.* 2012, p. 951; Papoulias and Velasco 2013, entire; Vidic *et al.* 2013, entire; Warner *et al.* 2013, entire; USEPA 2014, entire; Harkness *et al.* 2015, entire). As described above, the intensity of oil and gas development is expected to increase throughout the species' ranges, which increases the risk of spills of contaminants and degradation of the species' habitat.

*Highway Runoff*—Paved roads, coincident with and connecting areas of residential and commercial development, generally occur in the narrow valley bottoms adjacent to the region's streams and rivers. Runoff from these paved roads can include a complex mixture of metals, organic chemicals, deicers, nutrients, pesticides and herbicides, and sediments that, when washed into local streams, can degrade the aquatic habitat and have a detrimental effect on resident organisms (Boxall and Maltby 1997, entire; Buckler and Granato 1999, entire; NAS 2005, pp. 72–75, 82–86). We are not aware of any studies specific to the effects of highway runoff on the Big Sandy or Guyandotte River crayfishes; however, one laboratory study from Khan *et al.* (2006, pp. 515–519) evaluated the effects of cadmium, copper, lead, and zinc exposure on juvenile *Orconectes immunis,* a species of pond crayfish. These particular metals, which are known constituents of highway runoff (Sansalone *et al.* 1996, p. 371), were found to inhibit oxygen consumption in *O. immunis.* We are uncertain to what extent these results may be comparable to how Big Sandy or Guyandotte River crayfishes may react to these contaminants, but it was the only relevant study exploring the topic in crayfish. Boxall and Maltby (1997, pp. 14–15) studied the effects of roadway contaminants (specifically the polycyclic aromatic hydrocarbons or PAHs) on *Gammarus pulex,* a freshwater amphipod crustacean commonly used in toxicity studies. The authors noted an acute toxic response to some of the PAHs, and emphasized that because of possible interactions between the various runoff contaminants, including deicing salts and herbicides, the toxicity of road runoff likely varies depending on the mixture. We are uncertain to what extent these results may be comparable to how Big Sandy or Guyandotte River crayfishes may react to these contaminants. However, as discussed above, the number of roads within the species' ranges is increasing, thus potentially increasing contaminated runoff into the species habitat.

*Summary of Water Quality Degradation*—The best available data indicate that water quality in much of the Big Sandy and Upper Guyandotte River basins is degraded from a variety of sources. While it is difficult to attribute the decline or general low abundance of the Big Sandy and Guyandotte River crayfishes to a specific contaminant, or combination of contaminants, it is likely that poor water quality is an ongoing stressor to both species throughout much of their existing range.

Dams

In the April 7, 2015, proposed rule (80 FR 18710, pp. 18732–18734), we discussed the effects of habitat fragmentation caused by dams and reservoirs within the ranges of the Big Sandy and Guyandotte River crayfishes. We did not, however, address the potential for dams to cause direct effects to the aquatic habitat, which was brought to our attention by a peer reviewer. The most obvious change caused by dam construction is the conversion of flowing riverine habitat to lacustrine (lake) habitat, thereby making it unsuitable for the Big Sandy or Guyandotte River crayfishes (see our response to Comment 2, above). Our analysis indicates that in the upper Big Sandy basin, the three major flood control dams created reservoirs that inundated approximately 89 km (55 mi) of riverine habitat. The Dewey Dam, in Floyd County, Kentucky, was built in 1949, and inundated 29 km (18 mi) of Johns Creek (in the Levisa Fork subwatershed). The Fishtrap Dam, in Pike County, Kentucky, was built in 1969, and inundated 27 km (16.5 mi) of the Levisa Fork. The Flannagan Dam in Dickenson County, Virginia, was built in 1964, and inundated an estimated 33 km (20.5 mi) of the Pound and Cranes Nest Rivers. In the Upper Guyandotte River basin, the R.D. Bailey Dam in Wyoming County, West Virginia, was built in 1980, and inundated approximately 13 km (8.1 mi) of the Guyandotte River. These estimates of altered habitat are conservative, as they do not include any tributary streams inundated or account for changes in stream geomorphology and flow conditions directly upstream of the reservoir pools or below the dams that likely also make these areas less suitable for either crayfish species. Additionally, numerous scientific studies note significant ecological and water quality changes downstream of dams, including increased or decreased water temperatures, lower dissolved oxygen concentrations, elevated levels of certain metals or nutrients, and shifts in fish and macroinvertebrate community structure (Power *et al.* 1996, entire; U.S. Army Corps of Engineers 1996, p. 12; Baxter 1997, pp. 271–274; Lessard and Hayes 2003, pp. 90–93; Arnwine *et al.* 2006, pp. 149–154; Hartfield 2010, pp. 43–44; Adams 2013, pp. 1324–1330).

Therefore, we conclude that the past construction of flood control dams within the ranges of the Big Sandy and Guyandotte River crayfishes not only fragmented the species' available habitat, but also caused a decrease in available habitat within their historical ranges. However, we consider the loss-of-habitat effect to be historical and to have already influenced the species' current distribution. The fragmentation effects are ongoing and contribute to the threat of small population sizes addressed below under *Factor E.*

Summary of Factor A

The best available data indicate that the primary threats to both the Big Sandy and Guyandotte River crayfishes throughout their respective ranges are land-disturbing activities that increase erosion and sedimentation, which degrades the stream habitat required by both species. Identified sources of ongoing erosion and sedimentation that occur throughout the ranges of the species include active surface coal mining, commercial forestry, unpaved roads, gas and oil development, road construction, and stream modifications that cause channel instability. These activities are ongoing (*e.g.,* imminent) and expected to continue at variable rates into the future. For example, while active coal mining may decline, the legacy effects will continue, and oil and gas activities and road construction are expected to increase. An additional threat specific to the Guyandotte River crayfish is the ongoing operation of ORVs in and adjacent to one of only two known locations for the species; this ORV use is expected to continue.

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

In the April 7, 2015, proposed rule, we found no information indicating that overutilization has led to the loss of populations or a significant reduction in numbers of individuals for either the Big Sandy crayfish or Guyandotte River crayfish. No new information from peer review or public comments indicates that overutilization is a concern for either of these species. In addition, when this final listing becomes effective (see DATES, above), research and collection of these species will be regulated through scientific permits issued under section 10(a)(1)(A) of the Act.

*Factor C. Disease or Predation*

In the April 7, 2015, proposed rule, we found no information indicating that disease or predation has led to the loss of populations or a significant reduction in numbers of individuals of the Big Sandy crayfish or Guyandotte River crayfish. No new information from peer review or public comments indicates that disease or predation is a concern for either of these species.

*Factor D. The Inadequacy of Existing Regulatory Mechanisms*

Few existing Federal or State regulatory mechanisms specifically protect the Big Sandy or Guyandotte River crayfishes or the aquatic habitats where they occur. The species' habitats are afforded some protection from water quality and habitat degradation under the Federal Clean Water Act (CWA) (33 U.S.C. 1251 *et seq.*) and the SMCRA (30 U.S.C. 1201 *et seq.*), along with State laws and regulations such as the Kentucky regulations for water quality, coal mining, forest conservation, and natural gas development (401 KAR, 402 KAR, 405 KAR, 805 KAR); the Virginia State Water Control Law (Va. Code sec. 62.1–44.2 *et seq.*); and the West Virginia Water Pollution Control Act (WVSC sec. 22–11) and Logging and Sediment Control Act (WVSC sec. 19–1B). Additionally, the Big Sandy crayfish is listed as endangered by the State of Virginia (Va. Code sec. 29.1–563 to 570), which provides that species some direct protection within the Virginia portion of its range. However, while water quality has generally improved since 1977, when the CWA and SMCRA were enacted or amended, there is continuing, ongoing degradation of habitat for both species, as detailed in the proposed rule (80 FR 18710; April 7, 2015) and under the Factor A discussion, above. Therefore, despite the protections afforded by these laws and implementing regulations, both the Big Sandy and Guyandotte River crayfishes continue to be affected by degraded water quality and habitat conditions.

In 1989, 12 years after enactment of the CWA and SMCRA, the Guyandotte River crayfish was known to occur in low numbers in Huff Creek and Pinnacle Creek (Jezerinac *et al.* 1995, p. 170). However, surveys since 2002 indicate the species has been extirpated from Huff Creek and continues to be found only in low numbers in Pinnacle Creek. Despite more than 35 years of CWA and SMCRA regulatory protection, the range of the Guyandotte River crayfish has declined substantially, and the two known populations contain small numbers of individuals (see Loughman 2015b, entire). Information about the Big Sandy crayfish indicates that the species' current range is reduced from its historical range (see Loughman 2015a, entire), and, as discussed above, that much of the historical habitat continues to be degraded by sediments and other pollutants. In addition, at many of the sites that do continue to harbor the species, the Big Sandy crayfish is generally found only in low numbers, with individual crayfish often reported to be in poor physical condition (Thoma 2010, p. 6; Loughman, pers. comm., October 24, 2014; Loughman 2015a, entire). Reduction in the range of the Big Sandy crayfish and continued degradation of its habitat lead us to conclude that neither the CWA nor the SMCRA has been adequate in protecting this species.

As discussed in the April 7, 2015, proposed rule (80 FR 18710) and in this rule, erosion and sedimentation caused by various land-disturbing activities, such as surface coal mining, roads, forestry, and oil and gas development, pose an ongoing threat to the Big Sandy and Guyandotte River crayfishes. State efforts to address excessive erosion and sedimentation involve the implementation of BMPs; however, as discussed in detail in the April 7, 2015, proposed rule (80 FR 18710) and under *Factor A,* above, BMPs are often not strictly applied, are sometimes voluntary, or are situationally ineffective. Additionally, studies indicate that, even when BMPs are properly applied and effective, erosion rates at disturbed sites are still significantly above erosion rates at undisturbed sites (Grant and Wolff 1991, p. 36; Hood *et al.* 2002, p. 56; Christopher and Visser 2007, pp. 22–24; McBroom *et al.* 2012, pp. 954–955; Wang *et al.* 2013, pp. 86–90).

Although the majority of the land throughout the ranges of the two species is privately owned, publicly managed lands in the region include a portion of the Jefferson National Forest in Virginia, and 10 State wildlife management areas and parks in the remainder of the Big Sandy and Upper Guyandotte watershed (1 in Russell Fork, 3 in Levisa Fork, 4 in Tug Fork, 2 in Upper Guyandotte). However, three of these parcels surround artificial reservoirs that are no longer suitable habitat for either the Big Sandy crayfish or Guyandotte River crayfish, and six others are not in known occupied crayfish habitat. Only the Jefferson National Forest and the Breaks Interstate Park in the Russell Fork watershed at the Kentucky/Virginia border appear to potentially offer additional protections to extant Big Sandy crayfish populations, presumably through stricter management of land-disturbing activities that cause erosion and sedimentation. However, the extent of publically owned land adding to the protection of the Big Sandy and Guyandotte River crayfishes is minimal and not sufficient to offset the rangewide threats to either species.

Summary of Factor D

Degradation of Big Sandy and Guyandotte River crayfish habitat (Factor A) is ongoing despite existing regulatory mechanisms. While these regulatory efforts have led to some improvements in water quality and aquatic habitat conditions, the declines of the Big Sandy and Guyandotte River crayfishes within most of their ranges have continued to occur. In addition, there are no existing regulatory mechanisms that address effects to the species associated with the species' endemism and their isolated and small population sizes, as well as the contributing stressor of climate change (discussed below under *Factor E*).

*Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence*

Locally Endemic, Isolated, and Small Population Size

It is intuitive and generally accepted that the key factors governing a species' risk of extinction include small population size, reduced habitat size, and fragmented habitat (Pimm *et al.* 1988, pp. 757, 774–777; Lande 1993, entire; Hakoyama *et al.* 2000, pp. 327, 334–336; Wiegand *et al.* 2005, entire). Relevant to wholly aquatic species, such as the Big Sandy and Guyandotte River crayfishes, Angermeier (1995, pp. 153–157) found that fish species that were limited by physiographic range or range of waterbody sizes were also more vulnerable to extirpation or extinction, especially as suitable habitats became more fragmented.

As detailed in this final rule and in the April 7, 2015, proposed rule (80 FR 18710), both the Big Sandy crayfish and the Guyandotte River crayfish are known to exist only in the Appalachian Plateaus physiographic province and are limited to certain stream classes and habitat types within their respective river basins. Furthermore, the extant populations of each species are limited to certain subwatersheds, which are physically isolated from the others by steep topography, stream distance, human-induced inhospitable intervening habitat conditions, and/or physical barriers (*e.g.,* dams and reservoirs).

Genetic Fitness

Species that are restricted in range and population size are more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their susceptibility to inbreeding depression, and reducing the fitness of individuals (Soule 1980, pp. 157–158; Hunter 2002, pp. 97–101; Allendorf and Luikart 2007, pp. 117–146). Similarly, the random loss of adaptive genes through genetic drift may limit the ability of the Big Sandy crayfish and, especially, the Guyandotte River crayfish to respond to changes in their environment such as the chronic sedimentation and water quality effects described above or catastrophic events (Noss and Cooperrider 1994, p. 61). Small population sizes and inhibited gene flow between populations may increase the likelihood of local extirpation (Gilpin and Soulé 1986, pp. 32–34). The long-term viability of a species is founded on the conservation of numerous local populations throughout its geographic range (Harris 1984, pp. 93–104). These separate populations are essential for the species to recover and adapt to environmental change (Harris 1984, pp. 93–104; Noss and Cooperrider 1994, pp. 264–297). The populations of the Big Sandy crayfish are isolated from other existing populations and known historical habitats by inhospitable stream conditions and dams that are barriers to crayfish movement. The current population of the Guyandotte River crayfish is restricted to two disjunct stream systems that are isolated from other known historical habitats by inhospitable stream conditions or by a dam. The level of isolation and the restricted ranges seen in each species make natural repopulation of historical habitats or other new areas following previous localized extirpations virtually impossible without human intervention.

*Guyandotte River crayfish*—As discussed previously, the historical range of the Guyandotte River crayfish has been greatly reduced. Based on the Guyandotte River crayfish's original distribution and the behavior of other similar stream-dwelling crayfish, it is reasonable to surmise that, prior to the widespread habitat degradation in the basin, individuals from the various occupied sites were free to move between sites or to colonize (or recolonize) suitable vacant sites (Momot 1966, entire; Kerby *et al.* 2005, pp. 407–408). Huff Creek, where the species was last noted in 1989 (Jezerinac *et al.* 1995, p. 170), is one of the few streams in the basin that still appears to maintain habitat conducive to the species (Loughman 2013, p. 9; Loughman 2015b, pp. 14–15). However, Huff Creek is physically isolated from the extant Clear Fork and Pinnacle Creek populations by the R.D. Bailey Dam on the Guyandotte River near the town of Justice, West Virginia. This physical barrier, as well as generally long distances of often marginal habitat between potentially suitable sites, makes it unlikely that individuals from the extant Clear Fork and Pinnacle Creek populations will successfully disperse to recolonize other locations in the basin.

Also, as noted in the April 7, 2015, proposed rule (80 FR 18710) and above under *Factor A,* the persistence of Pinnacle Creek subpopulation is exceptionally vulnerable to several proximate active surface coal mines and ORV use in the Pinnacle Creek watershed. This subpopulation lacks significant redundancy (*e.g.,* the ability of a species to withstand catastrophic events) and representation (*e.g.,* the ability of a species to adapt to changing environmental conditions), and has very little resiliency (*e.g.,* the ability of the species to withstand stochastic events); therefore, this small subpopulation is at an increased risk of extirpation from natural demographic or environmental stochasticity, a catastrophic event, or even a modest increase in any existing threat at the two known stream occurrences.

*Big Sandy crayfish*—Survey work demonstrates that the geographic extent of the Big Sandy crayfish's occupied habitat, in the context of the species' historical range, is reduced (Thoma 2009b, p. 10; Thoma 2010, p. 6; Loughman 2013, pp. 7–8; Loughman 2015a, entire). Additionally, these best available data indicate that, because of widespread habitat degradation, the species is notably absent from many individual streams where its presence would otherwise be expected, and at most sites where it does still persist, it is generally found in low numbers.

Because the Big Sandy crayfish is wholly aquatic and therefore limited in its ability to move from one location to another by the basin's complex hydrology, the species' overall distribution and abundance must be considered carefully when evaluating its risk of extinction. Prior to the significant habitat degradation that began in the late 1800s, the Big Sandy crayfish likely occurred in suitable stream habitat throughout its range (from the Levisa Fork/Tug Fork confluence to the headwater streams in the Russell Fork, Levisa Fork, and Tug Fork basins) (Thoma 2010, p. 6; Thoma *et al.* 2014, p. 549), and individuals were free to move between occupied sites or to colonize (or recolonize) suitable vacant sites. The current situation is quite different, with the species' occupied subwatersheds being isolated from each other, and from large areas of their unoccupied range (*e.g.,* the Johns Creek stream system), by linear distance (of downstream and upstream segments), inhospitable intervening habitat, dams, or a combination of these. Therefore, the status and risk of extirpation of each individual subpopulation must be considered in assessing the species' risk of extinction.

Based on habitat connectedness (or lack thereof), we consider there to be six existing Big Sandy crayfish subpopulations: lower Tug Fork population (Pigeon Creek), upper Tug Fork population, the Upper Levisa Fork population (Dismal Creek), the Russell Fork/Levisa Fork population (including Shelby Creek), the Pound River population, and the Cranes Nest River population (see figure 3, above). While the Pound River and Cranes Nest River are in the same subwatershed, they both flow into the Flannagan Reservoir, which is unsuitable habitat for the species (see our response to Comment 3, above). Therefore, the Big Sandy crayfish populations in these streams are not only isolated from other populations by the dam and reservoir, but also most likely isolated from each other by the inhospitable habitat in the reservoir itself (Loughman, pers. comm., December 1, 2014). Also, because the Fishtrap Dam physically isolates the upper Levisa Fork (Dismal Creek) population from the remainder of the species' range, only the Tug Fork and the Russell Fork/Levisa Fork subpopulations still maintain any possible connection.

There are two occurrences that are unlikely to represent viable subpopulations. One is an occurrence in the lower Levisa Fork mainstem near the town of Auxier, Kentucky. This site was last confirmed (a single Big Sandy crayfish was recovered) in 2009 (Thoma 2010, p. 6). This location is more than 50 km (31 mi) downstream of the nearest other occupied site. In 2009, eight other likely sites in the lower Levisa system were surveyed and found negative for the species, and in 2015, nine additional sites were surveyed and found negative in this area of the lower Levisa Fork subwatershed. Therefore, we conclude that the lower Levisa Fork system does not represent a viable subpopulation. However, because the exact site near Auxier, Kentucky, was not surveyed in 2015, and because the Big Sandy crayfish has an estimated lifespan of 7 to 10 years, and because we have no evidence that habitat conditions have changed, it is reasonable to conclude that this site may remain occupied. Secondly, in 2015, a new occurrence location was also reported in the lower Tug Fork mainstem, with two Big Sandy crayfish captured (one was described as ''malformed'') from an isolated boulder cluster (Loughman 2015a, p. 16). Because this site is 35 km (22 mi) downstream of the nearest other occupied location (Pigeon Creek) and 11 other lower Tug Fork sites were surveyed and found negative for the species, we do not consider this a viable subpopulation.

The six subpopulations differ in their resiliency. The upper Levisa Fork, Pound River, and Cranes Nest River populations generally persist in single stream reaches. While the species appears to be moderately abundant in these streams, the available CPUE data indicate that the species has declined in abundance in the Pound and Cranes Nest Rivers since 2007 (see table 3, above). The fact that they are restricted to single streams (versus a network of streams) makes them especially susceptible to catastrophic loss (*e.g.,* contaminant spill, stream dredging, or other perturbation). The lower Tug Fork population in the Pigeon Creek system also appears to be vulnerable, with the three occupied sites having a CPUE value of 1 Big Sandy crayfish per hour and relatively low stream system QHEI scores (mean 62, n = 9). The upper Tug Fork and the Russell Fork/Levisa Fork populations are perhaps more secure, with multiple streams being occupied. However, the available CPUE data indicate declines in abundance in several of these streams (see table 3, above).

This isolation, caused by habitat fragmentation, reduces the resiliency of the species by eliminating the potential movement of individuals from one subpopulation to another, or to unoccupied sites that could become habitable in the future. This inhibits gene flow in the species as a whole and will likely reduce the genetic diversity and perhaps the fitness of individuals in the remaining subpopulations. The individual subpopulations are also at an increased risk from catastrophic events such as spills or to stochastic decline.

Direct Mortality Due to Crushing

As discussed above under *Factor A,* ORV use of unpaved trails are a source of sedimentation into the aquatic habitats within the range of the Guyandotte River crayfish. In addition to this habitat degradation, there is the potential for direct crayfish mortality as a result of crushing when ORVs use stream crossings, or when they deviate from designated trails or run over slab boulders that the Guyandotte River crayfish use for shelter (Loughman 2014, pp. 30–31).

Interspecific Competition

A contributing factor to the imperilment of the habitat-specialist Big Sandy and Guyandotte River crayfishes may be increased interspecific competition brought about by habitat degradation (Loughman 2015a, pp. 42–43; Loughman 2015b, p. 36). Both the Big Sandy crayfish and the Guyandotte River crayfish are associated with faster moving water of riffles and runs with unembedded substrate, while other native species such as the spiny stream crayfish (*Orconectes cristavarius*) are typically associated with the lower velocity portions of streams and appear to be tolerant of higher levels of sedimentation. Because the lower velocity stream habitats suffer the effects of increased sedimentation and bottom embeddedness before the effects are manifested in the faster moving reaches, the native crayfish using these habitats likely migrated into the relatively less affected riffle and run habitats that are normally the niche of the Big Sandy or Guyandotte River crayfishes (Loughman 2014, pp. 32–33). In the ensuing competition between the habitat-specialist Big Sandy and Guyandotte River crayfishes and the more generalist species, the former are thought to be at a competitive disadvantage (Loughman 2015a, pp. 42–43; Loughman 2015b, p. 36). The 2015 survey data indicated generally that at degraded sites, species such as *O. cristavarius* were dominant, with the Big Sandy and Guyandotte River crayfish being absent or occurring in low numbers. However, at high-quality sites where either the Big Sandy or Guyandotte River crayfish were present, the other species were found in relatively low numbers.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) concluded that the evidence for warming of the global climate system is unequivocal (IPCC 2013, p. 3). Numerous long-term climate changes have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns, and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (IPCC 2013, p. 4). The general climate trend for North America includes increases in mean annual temperatures and precipitation and the increased likelihood of extreme weather events by the mid-21st century (IPCC 2014, pp. 1452–1456). The U.S. National Climate Assessment predicts that over the next century, the eastern United States will experience: (1) An increase in the frequency, intensity, and duration of heat waves; (2) a decrease in the frequency, intensity, and duration of cold air outbreaks; (3) an increase in the frequency of heavy precipitation events; (4) an increase in the risk of seasonal droughts; and (5) an increase in the strength of tropical storms (Melillo *et al.* 2014, pp. 374, 398–399). The U.S. Geological Survey's and individual State's climate predictions support a finding that conditions within the ranges of both the Big Sandy and Guyandotte River crayfishes are expected to undergo significant temperature and precipitation changes by 2050 (Byers and Norris 2011, pp. 19–21; Kentucky's Comprehensive Wildlife Conservation Strategy (KCWCS) 2013, pp. 12–16; Kane *et al.* 2013, pp. 11–13; Alder and Hostetler 2014, entire).

An increasingly large body of scientific research indicates climate change poses a significant threat to a variety of species and ecosystems (Thomas, *et al.* 2004, entire; Byers and Norris 2011, pp. 7–17; Kane *et al.* 2013, pp. 14–48; KCWCS 2013, pp. 17–26; IPCC 2014, Chapter 4, entire), with freshwater ecosystems being considered especially vulnerable to the direct effects of climate change, such as altered thermal regimes and altered precipitation and flow regimes (IPCC 2014, pp. 312–314; McDonnell *et al.* 2015, pp. 14–16). As climate change alters freshwater ecosystems, aquatic species will either adapt to the new conditions, migrate to waters that maintain suitable conditions, or become locally extirpated. Species with small geographical ranges or those limited in their ability to disperse because of watershed boundaries and fragmented river networks (for example by dams and impoundments) may be particularly vulnerable to climate change (Eaton and Scheller 1996, p. 1113; Ficke *et al.* 2007, p. 602; Capinha *et al.* 2013, p. 732; Trumbo *et al.* 2014, pp. 182–185; McDonnell *et al.* 2015, pp. 2, 14–18).

Perhaps the most obvious and direct effect of climate change to the Big Sandy and Guyandotte River crayfishes is an increase in average ambient air temperature, which by 2050 is predicted to rise by 1.9 to 2.8 degrees Celsius (°C) (3.4 to 5.0 degrees Fahrenheit (°F)) within the ranges of these species (Byers and Norris 2011, p. 20; Alder and Hostetler 2013, entire; KCWCS 2013, p. 13). As ambient air temperatures increase, stream water temperatures are also expected to rise, although the precise relationship between air temperature and water temperature may vary based on a variety of factors, such as groundwater inflow, riparian vegetation, or precipitation rates (Webb and Nobilis 2007, pp. 82–84; Kaushal *et al.* 2010, pp. 464–465; Trumbo *et al.* 2014, pp. 178–185; McDonnell *et al.* 2015, pp. 12–18). We are unaware of information on the specific thermal tolerances of the Big Sandy or Guyandotte River crayfishes, but note that Loughman (2015a, p. 28; 2015b, p. 35) collected the former species in June, July, and September from waters that ranged from 19.0 to 27.3 °C (66.2 to 81.1 °F) with a mean temperature of 21.7 °C (71.1 °F), and he collected the latter species in May and June from waters that ranged from 14.9 to 23.0 °C (58.8 to 73.4 °F) with a mean of 19.7 °C (67.5 °F). These data and information on the thermal preferences of other stream-dwelling crayfishes indicate that the likely preferred temperature for the Big Sandy and Guyandotte River crayfishes is around 21 to 22 °C (71 to 72 °F) (Espina *et al.* 1993, pp. 37–38; Keller and Hazlett 2010, p. 619).

While crayfish are considered relatively tolerant to temperature fluctuations, data indicate that the upper incipient lethal temperature (the temperature at which 50 percent of the test organisms die) for stream-dwelling crayfish is about 29 to 32 °C (84 to 90 °F) (Becker *et al.* 1975, pp. 376–378; Mirenda and Dimock 1985, p. 255; Espina *et al.* 1993, p. 37); however, there may be significant variability in thermal tolerance depending on a species' geographic distribution and the size, sex, and reproductive status of individual crayfish (Becker *et al.* 1975, pp. 384–386). While important information, the upper lethal temperature limit is a poor measure by which to assess the potential for climate change to affect the Big Sandy and Guyandotte River crayfishes. Mirenda and Dimock (1985, p. 255) studied the acuminate crayfish (*Cambarus acuminatus*), a more generalist species native to the mid-Atlantic coastal plain. The authors noted that prolonged exposure (greater than 48 hours) to temperatures below that species' upper thermal limit (33 °C (91.4 °F)), but still within the zone of tolerance, could cause incapacitation or loss of condition sufficient to cause population-level effects to the species. A study of another stream species, the common crayfish (*Cambarus bartonii bartonii*), showed that its tolerance to acidic conditions decreased as temperatures approached the maximum thermal tolerance for the organism (DiStefano *et al.* 1991, pp. 1586–1589). Relatedly, drought conditions (and assumed temperature increases) in a north Georgia stream resulted in population declines and poor reproductive success in the generalist white tubercled crayfish (*Procambarus spiculifer*) (Taylor 1982, pp. 294–296). Therefore, based on the best available data, we conclude that as water temperatures increase above the Big Sandy and Guyandotte River crayfishes' assumed preferred temperature of 21 to 22 °C (71 to 72 °F) and approach the species' assumed maximum thermal threshold of 28 to 29 °C (82 to 84 °F), individual crayfish will likely suffer physiological stress, poor reproductive success, and perhaps increased mortality.

As temperature regimes within the range of the Big Sandy and Guyandotte River crayfishes begin to exceed their thermal optimum, it is likely that these species will attempt to adjust their ranges to locations that maintain favorable conditions. In general, ambient temperatures decrease with increasing elevation and/or latitude; therefore, we would expect these crayfishes to attempt to relocate to locations higher in elevation or higher in latitude (northerly direction in the northern hemisphere) (McDonnell *et al.* 2015, entire). However, because both the Big Sandy and Guyandotte River crayfishes are confined in latitude to their respective river basins, and because suitable habitats in the lower reaches of each river system are limited (primarily as a result of past environmental degradation), both species have already been largely restricted to the higher elevation streams within each river basin. Additionally, as discussed in the April 7, 2015, proposed rule (80 FR 18710, pp. 18732–18734), habitat fragmentation caused by dams and poor habitat conditions further restricts the movement of individual crayfish within their respective watersheds.

An independent assessment of the potential effects of climate change on the Big Sandy and Guyandotte River crayfishes was incorporated into an Appalachian climate change vulnerability index (Young *et al.,* 2015). This vulnerability index integrates a species' predicted exposure to climate change with three sets of factors associated with climate change sensitivity, each supported by published studies: (1) Indirect exposure to climate change, (2) species-specific sensitivity and adaptive capacity factors (including dispersal ability, temperature and precipitation sensitivity, physical habitat specificity, interspecific interactions, and genetic factors), and (3) documented response to climate change. The climate change vulnerability index ranked *Cambarus veteranus* ''highly vulnerable,'' which is defined as ''abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.'' We note that this vulnerability index was completed prior to the taxonomic split that described *C. callainus* and, therefore, assumed a single crayfish species with a geographic range that included both the Big Sandy River basin and the Upper Guyandotte River basin. It is probable that if the two species were re-evaluated separately, the reduced geographic range of each species would produce an increased climate change vulnerability score for either or both species.

The ranking of ''highly vulnerable'' for *Cambarus veteranus* produced by the vulnerability index is supported by two distribution models developed for stream crayfish in Europe. A study of the potential effects of climate change on the distribution of five relatively wide-ranging European crayfish species predicted that, by 2080, suitable accessible habitat for these species will decrease by 14 to 75 percent (Capinha *et al.* 2013, pp. 734–735). This study also indicated that the future distribution of native and nonnative crayfish species will lead to increased incidences of co-occurrence between these species with presumably negative consequences (Capinha *et al.* 2013, p. 738). Another European study evaluated the joint effects of climate change and the presence of an invasive crayfish on the distribution of another wide-ranging but endangered crayfish, the white-clawed crayfish (*Austropotamobius pallipes*) (per the International Union for Conservation of Nature ''Red List'' at *http://www.iucnredlist.org/details/2430/0*). This study predicted a range reduction for both species coupled with a decreased incidence of co-occurrence by 2050 (Gallardo and Aldridge 2013, pp. 230–231).

While uncertainty exists, the best available scientific data indicate that by about 2050, climate change will alter the ambient air temperature and precipitation regimes within the already limited ranges of both the Big Sandy and Guyandotte River crayfishes. Such alterations will increase the likelihood that streams will experience higher incidences of temperatures above the species' thermal optimum, perhaps approaching or exceeding their upper thermal limit. Because these species have little or no ability to migrate in response to increasing stream temperatures (or other climate change-induced perturbations), we conclude there is a likelihood that climate change will act as an ongoing stressor to each species.

Transportation Spills

There are numerous active freight rail lines in the Big Sandy and Upper Guyandotte River basins (Virginia Department of Rail and Public Transportation (VDRPT) 2013, p. 3–7; West Virginia Department of Transportation (WVDOT) 2013, p. 2–3; Kentucky Transportation Cabinet (KTC) 2015, p. 2–5). These lines were built primarily to haul locally-mined coal to outside markets, but data indicate a shift to more freight traffic through the region, crude oil shipments from Midwest shale oil fields to eastern refineries or ports, and increased rail traffic associated with shale gas development in West Virginia (VDRPT 2013, p. 5–14; WVDOT 2013, pp. 2–57–2–59; KTC 2015, pp. 2–23–2–24). Rail traffic in and through the region will likely vary in the short term as overall economic conditions fluctuate, but in the long term, rail traffic is expected to increase.

As described previously, because of the rugged topography of the region, these rail lines generally follow the mountain valleys and run immediately adjacent to streams and rivers, including those with current or historical records of Big Sandy and Guyandotte River crayfish occupation. This characteristic of the rail infrastructure increases the risk to aquatic habitats in the event of accidental spills of petroleum or other hazardous materials. Between 2003 and 2012, Virginia and West Virginia reported a Statewide average of 41 and 25 train accidents per year, respectively (VDRPT 2013, p. 3–36; WVDOT 2013, p. 2–30). We do not have fine-scale (*e.g.,* county-level) data on rail safety and note also that some categories of accidents are not required to be reported to the Federal Railroad Administration (FRA) (see *https://www.fra.dot.gov/Page/P0037*); therefore, accident risk is difficult to assess. However, several recent incidents in or near the Big Sandy River and Upper Guyandotte River basins illustrate the potential risk:

- On March 23, 2013, a derailment in Dickenson County, Virginia, left four train cars in the Russell Fork River (which is known to be occupied by the Big Sandy crayfish). One of the cars reportedly leaked propionic acid, but it was not reported whether any aquatic species were affected (Morabito 2013, entire).
- On December 27, 2013, 16 train cars derailed in McDowell County, West Virginia. At least one tank car reportedly ruptured and leaked ‘‘tar’’ into Elkhorn Creek (an upper Tug Fork tributary not known to be occupied by the Big Sandy crayfish). It was not reported whether any aquatic species were affected (Associated Press 2013, entire).
- On April 30, 2014, 15 crude oil tank cars derailed in Lynchburg, Virginia (approximately 180 km (112 mi) east of the Upper Guyandotte River and Big Sandy River basins). Three tank cars slid into the James River, and at least one car ruptured and released approximately 29,740 gallons of oil, most of which reportedly burned. It was not reported whether any aquatic species were affected (Roanoke Times 2014, entire; VADEQ 2015, entire).
- On March 5, 2015, a train locomotive struck a boulder in Dickenson County, Virginia, causing a rupture to the locomotive's fuel tank. No fuel reportedly reached the Russell Fork (Sorrell 2015, entire).
- On February 16, 2015, a train hauling crude oil derailed near Mount Carbon, West Virginia (approximately 43 km (27 mi) north of the Upper Guyandotte River basin), and 27 tank cars derailed. Approximately 378,000 gallons of crude oil were released during the incident, but it is unclear how much oil entered the Kanawha River (most of it apparently burned). It was not reported whether any aquatic species were affected (USEPA 2015, entire; FRA 2015, entire).

While the above reports do not indicate whether aquatic species were injured, a spill report from Pennsylvania did document mortality of aquatic invertebrates. On June 30, 2006, a derailment in McKeon County, Pennsylvania, resulted in three tank cars releasing 42,000 gallons of sodium hydroxide adjacent to Sinnemahoning Portage Creek. The resulting investigation determined that 63 to 98 percent of the aquatic invertebrates were estimated to be killed over 17.7 km (11.0 mi) of Sinnemahoning Portage Creek (Hartel 2006, p.18). While this report is from outside the ranges of the Big Sandy or Guyandotte River crayfishes, it is indicative of the scale of potential lethal injury that can result from transportation spills in areas where rail lines are in close proximity to streams and rivers.

Therefore, while there is uncertainty as to the likelihood or magnitude of effects of railroad accidents, based on the best available data regarding past events coupled with estimates of future rail traffic, we conclude that railroad accidents that result in the release of petroleum or other hazardous material into streams and rivers occupied by Big Sandy and Guyandotte River crayfish pose an ongoing risk to each species and that this risk is expected to stay the same or increase.

Summary of Factor E

The habitat of the Big Sandy and Guyandotte River crayfishes is highly fragmented, thereby isolating the remaining populations of each species from each other. The remaining individuals are generally found in low numbers at most locations where they still exist. The level of isolation and the restricted ranges seen in each species make natural repopulation of historical habitats or other new areas following previous localized extirpations highly improbable, or perhaps impossible, without human intervention. This reduction in redundancy and representation significantly impairs the resiliency of each species and poses a threat to their continued existence. In addition, direct mortality due to crushing may have a significant effect on the Guyandotte River crayfish. Interspecific competition from other native crayfish species that are more adapted to degraded stream conditions may also act as a contributing threat to both species, as might climate change.

*Cumulative Effects From Factors A through E*

Based on the risk factors described above, the Big Sandy crayfish and the Guyandotte River crayfish are at an increased risk of extinction primarily due to land-disturbing activities that increase erosion and sedimentation, and subsequently degrade the stream habitat required by both species (Factor A), and due to the effects of small population size (Factor E). Other contributing factors are degraded water quality and unpermitted stream dredging (Factor A). Additional likely contributing factors are competition from other crayfish, toxic spills, and climate change (Factor E). While events such as collection (Factor B) or disease and predation (Factor C) are not currently known to affect either species, any future incidences will further reduce the resiliency of the Guyandotte River and Big Sandy crayfishes.

## Determination

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on (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. Listing actions may be warranted based on any of the above factors, singly or in combination.

As discussed above, we have carefully assessed the best scientific and commercial information and data available regarding the past, present, and future threats to the Big Sandy crayfish and the Guyandotte River crayfish. The primary threat of rangewide habitat loss and degradation (Factor A) is occurring from land-disturbing activities that increase erosion and sedimentation, which degrades the stream habitat required by both species. Identified sources of ongoing erosion include active surface coal mining, commercial forestry, unstable stream channels, unpaved roads, gas and oil development, and road construction. An additional primary threat specific to the Guyandotte River crayfish is the operation of ORVs in and adjacent to Pinnacle Creek, one of only two known stream locations for the species.

Contributing threats to both species include water quality degradation (Factor A) resulting from abandoned coal mine drainage; untreated (or poorly treated) sewage discharges; road runoff; unpermitted stream dredging; and potential catastrophic spills of coal slurry, fluids associated with gas well development, or other contaminants. The effects of habitat loss have resulted in a significant range contraction for the Guyandotte River crayfish and a reduction in abundance and distribution within the fragmented range for both species, as evidenced by the results from multiple survey efforts. While the 2015 surveys did document two additional occurrences of the Big Sandy crayfish in the lower Tug Fork, those occurrences are isolated from other occurrences of the species. Occurrences of both species are correlated with higher quality habitat conditions that are fragmented by natural and human-mediated areas of lower quality habitat.

Despite the existing State wildlife laws and Federal regulations such as the CWA and SMCRA, habitat threats continue to effect these species (Factor D). Additionally, the habitat of the Big Sandy and Guyandotte River crayfishes is highly fragmented by natural and human-mediated conditions, thereby isolating the remaining populations of each species (Factor E) from each other. The remaining individuals are found in low numbers at most locations where they still exist; however, there are some occurrences of the Big Sandy crayfish in the Russell Fork with higher levels of documented individuals and catch-per-unit-effort (CPUE) results that are indicative of more robust populations. The two populations of the Guyandotte River crayfish have limited redundancy, with the Pinnacle Creek location being highly imperiled by ORV use and upstream mining operations, and significantly reduced representation. The level of isolation and the restricted range of each species make natural repopulation of historical habitats or other new areas following previous localized extirpations virtually impossible without human intervention. The reduction in redundancy and representation for each species impairs the Big Sandy crayfish's resiliency and significantly impairs the Guyandotte River crayfish's resiliency, and poses a threat to both species' continued existence. The interspecific competition (Factor E) from other native crayfish species (that are more adapted to degraded stream conditions) and climate change (Factor E) may act as additional stressors to the Big Sandy and Guyandotte River crayfishes. These Factor A and Factor E threats are rangewide and are not likely to be reduced in the future. Several of the Factor A and Factor E threats are likely to increase. For Factor A, these threats include oil and gas development and road construction, and for Factor E, these include extirpation and further isolation of populations. In combination, these ongoing and increasing threats are significant because they further restrict limited available habitat and decrease the resiliency of the Big Sandy crayfish and Guyandotte River crayfish within those habitats.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' As discussed above, we find that the Big Sandy crayfish is likely to become endangered in the foreseeable future throughout its entire range, and the Guyandotte River crayfish is in danger of extinction throughout its entire range based on the severity and immediacy of threats currently affecting these species.

For the Big Sandy crayfish, although the species still occupies sites located throughout the breadth of its historical range, the remaining sites are reduced to primarily the higher elevations within the watersheds; the remaining habitat and most populations are threatened by a variety of factors acting in combination to reduce the overall viability of the species. The risk of extinction is foreseeable because most of the remaining populations are small and isolated, and there is limited potential for recolonization.

For the Guyandotte River crayfish, the species has been reduced to two locations, and its habitat and population are threatened by a variety of factors acting in combination to create an imminent risk of extirpation of one of the locations, thereby reducing the overall viability of the species. The risk of extinction is high because the two populations are severely reduced and isolated, and have essentially no potential to be recolonized following extirpation.

Therefore, on the basis of the best available scientific and commercial information, we are listing the Big Sandy crayfish as a threatened species and the Guyandotte River crayfish as an endangered species in accordance with sections 3(6), 3(20), and 4(a)(1) of the Act. For the Guyandotte River crayfish, all of these factors combined lead us to conclude that the danger of extinction is high and immediate, thus warranting a determination as an endangered species rather than a threatened species. In contrast, for the Big Sandy crayfish, all of these factors combined lead us to conclude that the danger of extinction is foreseeable rather than immediate, thus warranting a determination as a threatened species.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. Because we have determined that the Big Sandy crayfish and the Guyandotte River crayfish are threatened and endangered, respectively, throughout all of their ranges, no portion of their ranges can be ''significant'' for purposes of the definitions of ''endangered species'' and ''threatened species.'' See the Final Policy on Interpretation of the Phrase ''Significant Portion of Its Range'' in the Endangered Species Act's Definitions of ''Endangered Species'' and ''Threatened Species'' (79 FR 37578; July 1, 2014).

**Available Conservation Measures**

Listing a species as endangered or threatened under the Act increases recognition by Federal, State, Tribal and local agencies; private organizations; and individuals that the species requires additional conservation measures. These measures include recovery actions, requirements for Federal protection, and prohibitions against certain practices. The Act encourages cooperation with the States and other countries and calls for recovery actions to be carried out for listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

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

Recovery planning includes the development of a recovery outline shortly after a species is listed and preparation of a draft and a final recovery plan. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. Revisions of the plan may be done to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan also identifies recovery criteria for review of when a species may be ready for downlisting or delisting, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (composed of species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our Web site (*http://www.fws.gov/endangered*), or from the Northeast Regional Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribes, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (*e.g.,* restoration of native vegetation, removal of sedimentation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because they may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands. We also recognize that for some species, measures needed to help achieve recovery may include some that are of a type, scope, or scale that is independent of land ownership status and beyond the control of cooperating landowners.

Following publication of this final listing rule, additional funding for recovery actions will be available from a variety of sources, including Federal budgets; State programs; and cost share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the States of Kentucky, Virginia, and West Virginia will be eligible for Federal funds to implement management actions that promote the protection or recovery of the Big Sandy crayfish, and the State of West Virginia will be eligible for Federal funds to implement management actions that promote the protection or recovery of the Guyandotte River crayfish. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants.*

Please let us know if you are interested in participating in recovery efforts for the Big Sandy crayfish or the Guyandotte River crayfish. Additionally, we invite you to submit any new information on these species whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

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

Federal agency actions within the species' habitat that may require consultation as described in the preceding paragraph include land management agencies such as the U.S. Forest Service or the Bureau of Land Management. Or a Federal agency may have regulatory oversight, such as the U.S. Army Corps of Engineers when a section 404 CWA permit is issued; the Office of Surface Mining, Reclamation, and Enforcement when a coal mining permit is issued or overseen; or the Federal Highway Administration when they assist with the funding or construction and maintenance of roads, bridges, or highways.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to endangered and threatened wildlife. The prohibitions of section 9(a)(1) of the Act, codified at 50 CFR 17.21 for endangered wildlife and 50 CFR 17.31 for threatened wildlife, make it illegal for any person subject to the jurisdiction of the United States to take (which includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these) endangered or threatened wildlife within the United States or on the high seas. In addition, it is unlawful to import; export; deliver, receive, carry, transport, or ship in interstate or foreign commerce in the course of commercial activity; or sell or offer for sale in interstate or foreign commerce any listed species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to employees of the Service, the National Marine Fisheries Service, other Federal land management agencies, and State conservation agencies.

Under section 4(d) of the Act, the Service has discretion to issue regulations that we find necessary and advisable to provide for the conservation of threatened species. As discussed in the previous paragraph, the general prohibitions and exceptions that apply to threatened wildlife will apply to the Big Sandy crayfish upon the effective date of this final rule (see **DATES**). However, we may revise these general prohibitions and exceptions as they apply to the Big Sandy crayfish by promulgating a species-specific rule under section 4(d) of the Act detailing the prohibitions and exceptions that are necessary and advisable for the conservation of the species. Therefore, we are investigating what specific prohibitions and exceptions to those prohibitions may be necessary and advisable for the Big Sandy crayfish's conservation and intend to publish, as appropriate, a proposed 4(d) rule for public review and comment in the future. Activities we are considering for potential exemption under a 4(d) rule include, but are not necessarily limited to, exceptions for (1) specific habitat restoration activities that will benefit the Big Sandy crayfish, and (2) sustainable forestry practices that primarily occur directly adjacent to, or upslope from, streams occupied or likely to be occupied by the Big Sandy crayfish and that are implemented according to well-defined and enforceable best management practices (*e.g.,* Sustainable Forestry Initiative or Forest Stewardship Council) or other such approved guidelines.

We may issue permits to carry out otherwise prohibited activities involving endangered or threatened wildlife under certain circumstances. Regulations governing permits for endangered species are codified at 50 CFR 17.22 and for threatened species at 50 CFR 17.32. With regard to endangered wildlife, a permit may be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities. There are also certain statutory exemptions from the prohibitions, which are found in sections 9 and 10 of the Act.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a listing on proposed and ongoing activities within the ranges of species we are listing. Based on the best available information, the following actions are unlikely to result in a violation of section 9, if these activities are carried out in accordance with existing regulations and permit requirements; this list is not comprehensive:

- Normal agricultural practices, such as herbicide and pesticide use, that are carried out in accordance with any existing regulations, permit and label requirements, and best management practices.

Based on the best available information, the following activities may potentially result in a violation of section 9 the Act; this list is not comprehensive:

(1) Unauthorized operation of motorized equipment in stream habitats such that the operation compacts the stream bottom habitat (*e.g.,* driving or riding an ORV in the stream), resulting in killing or injuring a Big Sandy crayfish or Guyandotte River crayfish.

(2) Unlawful destruction or alteration of the habitat of the Big Sandy crayfish or Guyandotte River crayfish (*e.g.,* unpermitted instream dredging, impoundment, water diversion or withdrawal, channelization, discharge of fill material) that impairs essential behaviors such as breeding, feeding, or sheltering, or that results in killing or injuring a Big Sandy crayfish or Guyandotte River crayfish.

(3) Unauthorized discharges or dumping of toxic chemicals or other pollutants into waters supporting the Big Sandy crayfish or Guyandotte River crayfish that kills or injures individuals, or otherwise impairs essential life-sustaining behaviors such as breeding, feeding, or finding shelter.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the appropriate office:

- Kentucky Ecological Services Field Office, 330 West Broadway, Suite 265, Frankfort, KY 40601; telephone (502) 695–0468; facsimile (502) 695–1024.
- Southwest Virginia Ecological Services Field Office, 330 Cummings Street, Abingdon, VA 24210; telephone (276) 623–1233; facsimile (276) 623–1185.
- West Virginia Field Office, 694 Beverly Pike, Elkins, WV 26241; telephone (304) 636–6586; facsimile (304) 636–7824.

## Required Determinations

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

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

### *Government-to-Government Relationship With Tribes*

In accordance with the President's memorandum of April 29, 1994 (Government-to-Government Relations with Native American Tribal Governments; 59 FR 22951), Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments), and the Department of the Interior's manual at 512 DM 2, we readily acknowledge our responsibility to communicate meaningfully with recognized Federal Tribes on a government-to-government basis. In accordance with Secretarial Order 3206 of June 5, 1997 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act), we readily acknowledge our responsibilities to work directly with tribes in developing programs for healthy ecosystems, to acknowledge that tribal lands are not subject to the same controls as Federal public lands, to remain sensitive to Indian culture, and to make information available to tribes.

We are not aware of any Big Sandy crayfish or Guyandotte River crayfish populations on tribal lands.

## References Cited

A complete list of references cited in this rulemaking is available on the Internet at *http://www.regulations.gov* and upon request from the Northeast Regional Office (see **FOR FURTHER INFORMATION CONTACT**).

## Authors

The primary authors of this rule are the staff members of the Northeast Regional Office.

## List of Subjects in 50 CFR Part 17

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

## Regulation Promulgation

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

## PART 17—ENDANGERED AND THREATENED WILDLIFE AND PLANTS

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

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

■ 2. Amend § 17.11(h) by adding entries for ''Crayfish, Big Sandy'' and ''Crayfish, Guyandotte River'' to the List of Endangered and Threatened Wildlife in alphabetical order under CRUSTACEANS to read as set forth below:

**§ 17.11 Endangered and threatened wildlife.**

* * * * *

(h) * * *

| Species | | Historic range | Vertebrate population where endangered or threatened | Status | When listed | Critical habitat | Special rules |
|---|---|---|---|---|---|---|---|
| Common name | Scientific name | | | | | | |
| * | * | * | * | * | * | * | |
| CRUSTACEANS. | | | | | | | |
| * | * | * | * | * | * | * | |
| Crayfish, Big Sandy .......... | *Cambarus callainus* .......... | U.S.A. (KY, VA, WV) ........ | Entire .................. | T ....... | 864 ...... | NA ...... | NA |
| * | * | * | * | * | * | * | |
| Crayfish, Guyandotte River | *Cambarus veteranus* ........ | U.S.A. (WV) ..................... | Entire .................. | E ....... | 865 ...... | NA ...... | NA |
| * | * | * | * | * | * | * | |

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Dated: March 28, 2016.

**James W. Kurth,**

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

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