DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[FWS–R2–ES–2008–0080; 92220–1113–0000–C6]

RIN 1018—AU97

Endangered and Threatened Wildlife and Plants; Removal of the Concho Water Snake From the Federal List of Endangered and Threatened Wildlife and Removal of Designated Critical Habitat

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: The best available scientific and commercial data indicate that the Concho water snake (*Nerodia paucimaculata*), a reptile endemic to central Texas, is recovered. Therefore, under the authority of the Endangered Species Act of 1973, as amended (Act), we, the U.S. Fish and Wildlife Service (Service) remove (delist) the Concho water snake from the Federal List of Endangered and Threatened Wildlife, and accordingly, also remove its federally designated critical habitat. This determination is based on a thorough review of all available information, including new information, which indicates that the threats to this species have been eliminated or reduced to the point that the species has recovered and no longer meets the definition of threatened or endangered under the Act. We are also providing notice that the final post-delisting monitoring for the Concho water snake has been completed.

DATES: This final rule becomes effective on November 28, 2011.

ADDRESSES: The proposed rule, all comments received, the post-delisting monitoring plan, and this final rule are all available on the Internet at *http://www.regulations.gov* and *http://www.fws.gov/southwest/es/AustinTexas/.* Supporting documentation we used in preparing this final rule will be available for public inspection, by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Road, Suite 200, Austin, TX 78758; telephone 512–490–0057; facsimile 512–490–0974.

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

SUPPLEMENTARY INFORMATION:

Background

It is our intent to discuss in this final rule only those topics directly relevant to the removal of the Concho water snake from the Federal list of threatened species under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq.*). The Concho water snake is endemic to the Colorado and Concho Rivers in central Texas (Tennant 1984, p. 344; Scott *et al.* 1989, p. 373). It occurs on the Colorado River from E.V. Spence Reservoir to Colorado Bend State Park, including Ballinger Municipal Lake and O.H. Ivie Reservoir, and on the Concho River from the City of San Angelo, Texas, to its confluence with the Colorado River at O.H. Ivie Reservoir. At the time the species was listed as threatened in 1986 (51 FR 31412), there were considered to be two subspecies of *Nerodia harteri,* the Concho water snake (*N.h. paucimaculata*) and the Brazos water snake (*N.h. harteri*). Densmore *et al.* (1992, p. 66) determined the Concho water snake was a distinct species, and in 1996 we changed our reference to the species to recognize the scientific name *N. paucimaculata* (50 CFR 17.11). Some authors use the common name of Concho watersnake, based on Crother (2000, p. 67). However, this has not been universally adopted, so we continue to use Concho water snake in this rule. For more background information on the Concho water snake, refer to the proposed delisting rule published in the **Federal Register** on July 8, 2008 (73 FR 38956), the final listing rule published in the **Federal Register** on September 3, 1986 (51 FR 31412), Campbell (2003, pp. 1–4), the 2004 revised biological opinion (BO) on water operations on the Concho and Colorado Rivers (Service 2004, pp. 1–76), and the 1993 Concho Water Snake Recovery Plan available online at *http://ecos.fws.gov/docs/recovery_plan/930927b.pdf.* We note that research conducted since the recovery plan was completed in 1993 has provided new information on the species.

Previous Federal Actions

In June 1998, we received a petition from the Colorado River Municipal Water District (District) to delist the Concho water snake because our original data (regarding snake distribution and abundance and threats) for listing the snake were in error. On August 2, 1999, we published a 90-day petition finding (1999 petition finding) that the petitioner did not present substantial information indicating that delisting the species may be warranted (64 FR 41903). The petition did not contain any information addressing the threats to the species nor did it include a discussion of the three recovery criteria. As a result of the negative 90-day finding, we did not conduct a full status review at that time. However, in the process of revising the biological opinion under section 7 of the Act for the operations of the upper Colorado River dams in 2004 (Service 2004a), the Service determined there was sufficient new information available to warrant a status review of the species. This final rule constitutes the conclusion of a full status review of the Concho water snake and analyzes all of the outstanding concerns from the 1999 petition finding.

On July 8, 2008, we published a proposed rule to remove the Concho water snake from the list of threatened species (73 FR 38956). A draft of the post-delisting monitoring plan was made available for public review and comment on September 23, 2009 (74 FR 48595).

Additional background information regarding other previous Federal actions for the Concho water snake can be obtained by consulting the species' regulatory profile found at: *http://ecos.fws.gov/speciesProfile/SpeciesReport.do?spcode=C04E.*

Recovery

Section 4(f) of the Act directs us to develop and implement recovery plans for listed species unless the Director determines that such a plan will not benefit the conservation of the species. The Service completed the Concho Water Snake Recovery Plan in 1993 (Service 1993). The Concho Water Snake Recovery Plan outlines recovery criteria to assist in determining when the snake has recovered to the point that the protections afforded by the Act are no longer needed (Service 1993, p. 33). These criteria are: (1) Adequate instream flows are assured even when the species is delisted. (2) Viable populations are present in each of the three major reaches (the Colorado River above Freese Dam (forms O.H. Ivie Reservoir), Colorado River below Freese Dam, and the Concho River). Here, population is defined as all Concho water snakes in a given area, in this case, each major river reach. (3) Movement of an adequate number of Concho water snakes is assured to counteract the adverse impacts of population fragmentation. These movements should occur as long as Freese Dam is in place or until such time that the Service determines that Concho water snake populations in the three reaches are viable and ''artificial movement'' among them is not needed.

We used the recovery plan to provide guidance to the Service, State of Texas, and other partners on methods to minimize and reduce the threats to the Concho water snake and to provide criteria that could be used to help determine when the threats to the Concho water snake had been reduced so that it could be removed from the Federal List of Endangered and Threatened Wildlife.

Provisions in recovery plans are recommendations that are not binding and can be superseded by more current scientific information. There are many paths to accomplishing recovery of a species in all or a significant portion of its range. The main goal is to remove the threats to a species, which sometimes may occur without meeting all recovery criteria contained in a recovery plan. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, the Service may judge that, overall, the threats have been reduced sufficiently, and the species is robust enough, to reclassify the species from endangered to threatened or perhaps to delist the species. In other cases, recovery opportunities may be recognized that were not known at the time the recovery plan was finalized. Achievement of these opportunities may result in progress toward recovery in lieu of methods identified in the recovery plan. Likewise, we may learn information about the species that was not known at the time the recovery plan was finalized. The new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery of a species is a dynamic process requiring adaptive management. Judging the degree of recovery of a species is also an adaptive management process that may, or may not, fully follow the guidance provided in a recovery plan.

A review of the best scientific and commercial data currently available (see Summary of Factors Affecting the Species section below) indicates that all three criteria in the Concho water snake recovery plan (adequate instream flows even after delisting, viable populations in each of the three major river reaches, and movement of snakes to assure adequate genetic mixing) have been met. Further, recovery of the Concho water snake has been a dynamic process, which has been fostered by the significant amount of new data collected on the biology and ecology of the species by numerous species experts. Since the time of listing and preparation of the recovery plan, biologists have discovered that the snakes are able to persist and reproduce along the shorelines of reservoirs and that the snakes have managed to persist in all three population segments, surviving many years of drought. Including this new information, the analysis below considers the best available data in determining that the Concho water snake no longer meets the definition of a threatened or endangered species.

Summary of Comments and Recommendations

In our proposed rule (71 FR 38956), we requested comments from the public on the proposed removal of the Concho water snake from the list of threatened species during a 60-day comment period that ended on September 8, 2008. We also contacted Federal agencies, State agencies, local officials, and congressional representatives to invite comment on the proposed rule.

During the public comment period, we received no requests for a public hearing and none was held. Overall we received 23 written comments from the public. Twenty of these were similar letters that supported removal of the species from the protected list and stated that our decision to delist the Concho water snake was based on sound science. Two of these letters of support came from the Texas Department of Transportation (TxDOT) and Texas Parks and Wildlife Department (TPWD). Six of these letters were from city officials, ten were from river authorities or water districts, including the Colorado River Municipal Water District (District), and two were from private businesses. We also received one nonsubstantive comment and two substantive critical comments from professional biologists (one specifically expressed opposition to the proposal). Our responses are provided below to a summary of each substantive comment received.

Peer Review

In accordance with our policy published on July 1, 1994 (59 FR 34270), we solicited independent expert opinions from knowledgeable individuals with scientific expertise that included ecology of water snakes, conservation biology principles, and river hydrology. Out of seven individuals that agreed to provide peer review, we received six peer review comments. One peer reviewer stated support for the proposal. Three peer reviewers were noncommittal on their support, but provided many substantive comments and questions. Two peer reviewers stated opposition to the proposal and provided substantive criticism. Our responses are provided below to a summary of each substantive comment received from the peer reviewers.

Comments From Peer Reviewers

(1) Comment: It is premature to delist the Concho water snake because essential data are lacking. For example, no data are presented on population structure, demographics, trends, or genetics.

Our Response: The Act requires us to consider the best available information when making decisions on what species should be protected. Population demographic estimates have been reported for the Concho water snake (Whiting *et al.* 2008, pp. 441–442). While more quantitative analysis of population structure, trends, and genetics would be informative and useful to us in formulating this rule, we believe the data used in this final rule support our decision because it is derived from many years of monitoring collections (Thornton 1996, pp. 26–50, Forstner *et al.* 2006, p. 18) and consistent with the opinion of most experts on the Concho water snake. Reference the following sections below for descriptions of the best available information related to population structure, demographics, and genetics: *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Fragmentation; and *Application of the Recovery Plan's Criteria,* Population Viability. We find that the best available information supports the decision that the Concho water snake has recovered and no longer qualify as threatened.

Past studies of the Concho water snake were intended to monitor the populations over time using mark-recapture techniques (that is, inserting a tag in captured snakes so that individuals can be identified when they are recaptured). Although these studies by the District (summarized in District 1998) resulted in a large number of snakes collected over 10 years (9,069 unique snakes), the study did not quantify the amount of effort expended during each survey, so that reliable population estimates or trends over time could not be calculated. Whiting *et al.* (2008) utilized these data to attempt to model population trends. However, the results proved too unreliable to effectively model population trends because the dispersal rates of snakes out of the study areas were not quantified. This resulted in a potential overestimate of the death rate of snakes that were not recaptured, when they could have, in fact, simply moved out of the study area

(Whiting *et al.* 2008, p. 443). The original study was not designed to accommodate a population viability analysis and attempts to do so provided results with an unacceptable degree of uncertainty and with imprecise conclusions. As a result, the best available information on snake populations supports that the snakes have persisted over a long time period throughout the majority of their historic range and have continued to persist following habitat alterations from reservoir inundation and drought.

(2) Comment: The Concho water snake occupies an extremely small area of Texas, and one small mistake could easily cause the extinction in a significant portion (i.e., all) of its range. It is better to err on the side of caution than face the consequences of early protection removal.

Our Response: The current range of the snake is estimated to total about 280 miles (mi) (451 kilometers (km)) of river and about 40 mi (64 km) of reservoir shoreline. The best available information, including the reports of species experts (in particular Dr. James Dixon and Dr. Michael Forstner), does not indicate that the species is vulnerable to extinction. The recent studies available to us report that the species is capable of withstanding significant environmental perturbations (Dixon 2004, pp. 10–11; Forstner *et al.* 2006, pp. 16–18; Whiting *et al.* 2008, p. 343). Under our post-delisting monitoring plan, we will be monitoring the status of the species and can emergency list it if necessary (see the Post-Delisting Monitoring Plan section below).

(3) Comment: My strong conclusion is that viable populations of the Concho water snake have not been demonstrated. Documentation of persistence and reproduction is not adequate to determine population viability.

Our Response: Please see our response below to *Comment (28).* We have updated the discussion of viable population in the final rule to be more consistent with the description used in the recovery plan for the species (see *Application of the Recovery Plan's Criteria* section below).

(4) Comment: Survey results from Dixon (2004) and Forstner *et al.* (2006) failed to find snakes at some sample sites, indicating possible local extinctions and suggesting that recovery criterion 2 for viable populations has not been met and site occupancy may have decreased by 23 to 27 percent.

Our Response: Dixon made only one sampling visit to 13 sites and found Concho water snakes at all but 3 sites (Dixon 2004, pp. 4–5). Forstner *et al.* (2006, pp. 6–7, 12) surveyed several sites up to three times in 2005. They found snakes at all sites except for three sites on the Concho River, which were only sampled one time following a rainstorm event making detection difficult (Forstner *et al.* 2006, p. 12). In contrast, earlier studies (District 1998, p. 13) resulted in consistent captures of snakes at nearly all sites surveyed, however, those sites were sampled three times or more annually. Both Dixon (2004, pp. 9, 14–15) and Forstner *et al.* (2006, p. 13) explain that there are a variety of field conditions that influence the ability to capture snakes at a given time and location. Variability of sampling success is common in field investigations, and both of these reports consisted of sampling efforts too small to interpret negative capture data as local extinctions or a decline in site occupancy.

(5) Comment: I agree with the proposed rule to delist the Concho water snake, although I don't know if I believe that the Concho water snake has ''recovered'' as much as it continues to persist despite marked modifications to its habitat along the Colorado and Concho rivers. The snake is more of a habitat generalist than originally thought, and successful reproduction takes place under lower stream flows than previously indicated. The 2008 Memorandum of Understanding (MOU) between the Service and the Colorado Municipal Water District ensures adequate stream flows, although it may be strained by drought conditions. Twenty years of field studies demonstrate continued reproductive success in both the Concho and Colorado Rivers, including reservoirs. Dixon (2004) reports finding that dense vegetation and beavers failed to impede reproduction at the Freese Dam site, and he found the Elm Creek site, devoid of water for three years, still contained a reproducing population.

Our Response: We agree that the best available information supports the decision to remove the Concho water snake from the list of threatened species under the Act. We recognize that our understanding of the snake's ecology has benefitted from new information that has been collected since the listing and since the recovery plan was completed. The removal of the snake from the list of threatened species is due both to recovery actions, such as the 2008 MOU with the District, and new biological information on the species' ability to persist in habitats such as reservoirs and no change (or slight increase) in the species' known range (about 80 river miles more than known at the time of listing).

(6) Comment: The proposed rule uses an inappropriate timeframe for analysis of factors that could affect the species in the future. Factors that are not considered threats on a 20-year timeframe may threaten the species on a more meaningful timeframe of 50–100 years, which is consistent with the recovery plan.

Our Response: We agree the 20-year foreseeable future was not a sufficiently long timeframe for our analysis. We have updated the rule to evaluate the threats to the species considering longer timeframes, as available information allows. In considering the foreseeable future in the threats analysis, we generally regarded 50 to 100 years as a time frame where some reasonable predictions could be made. This range of time originated from the analysis of forecasting for water management, which is looking ahead to expected conditions in the year 2060 (TWDB 2007, p. 2), and consideration of climate change models, which typically forecast 50 to 100 years into the future (Bernstein *et al.* 2007, pp. 8–9; Jackson 2008, p. 8; Mace and Wade 2008, p. 656).

(7) Comment: Lake populations are not as robust as the river populations (low densities via low recruitment), and their mere presence is not an indicator of population health. Lake populations appear to be isolated sinks and there may not be riverine recruitment from these populations. Due to the relatively recent appearance of the lakes, the data are only isolated snapshots and more monitoring is necessary before we know the true effects of river modification on Concho water snake populations.

Our Response: Recruitment is the successful influx of new members into a population by reproduction or immigration (Lincoln *et al.* 1998, p. 257). Sinks are populations or breeding groups that do not produce enough offspring to maintain themselves without immigrants from other populations. Please see our responses to *Comments (1)* and *(28)* for related information. Dixon (2004, p. 14) states that both reservoirs (Ivie and Spence) provide prime habitat for Concho water snakes along the rocky shorelines. Whiting *et al.* (1997, p. 331) found over 300 individual snakes in Lake Spence 20 years after the reservoir was filled. Also, analysis by Whiting *et al.* (2008, pp. 439, 443) found no evidence of a difference in survival among the five subpopulations (including three riverine reaches and two reservoirs). This suggests there may be no difference in survival rates between reservoir and riverine snake populations, although the authors recognize that the data from reservoirs were not sufficient for reliable estimates of snake survival and population growth (Whiting *et al.* 2008, p. 443).

Successful use of the reservoirs by Concho water snakes is one factor we considered in this decision and provides some added assurance that the snakes are not likely to become endangered in the foreseeable future. It is not unexpected that populations of the snakes in the artificial habitat of the reservoirs may not be as robust by some measures compared with populations in the natural riverine habitat. However, we have no information that indicates the snakes in reservoirs are population sinks. We know that the snakes have been shown to persist and reproduce in Spence Reservoir for at least 35 years after construction (1969 to 2005) and in Ivie Reservoir for at least over 15 years after construction (1989 to 2005) (Forstner *et al.* 2006, p. 12). The Service finds that this is a sufficient amount of time to determine that snakes are likely to continue to persist in reservoirs in the foreseeable future.

(8) Comment: Evidence of successful reproduction from Forstner *et al.* (2006) is based on flawed analysis of mass-length relationships for female snakes. This relationship is curvilinear (represented by a curved, rather than straight, line) and, therefore, the data should have been log transformed or fit using a power function rather than a simple linear analysis. Based on this, at most only one of the four females found by Forstner *et al.* (2006) appears to have low mass suggesting a post-partum state that indicates reproduction. Also, since evidence of reproduction was found at only a single site below Freese Dam (Ivie Reservoir) by Forstner *et al.* (2006), it is premature to conclude that a viable population exists in this reach.

Our Response: We agree that the use of a curvilinear function analysis would have been more statistically robust in the Forstner *et al.* (2006, p. 11) report to evaluate reproductive status of females. However, this analysis was not intended to make a strong statistical argument, but simply to substantiate the field observations of females appearing to be post-partum. These adult female snakes had lower body tone in the rear third of the body indicating (in the authors' experience with this taxon and with snakes in general) that recent offspring had been released. Although access to the river reach downstream of Freese Dam (Ivie Reservoir) was limited due to private property, Forstner *et al.* (2006, p. 18) conclude that, even with limited samples, snakes were found at the two sites available in this reach documenting that the species was persisting and reproducing in this reach. This information serves to confirm the results of the earlier 10 years of monitoring studies that found large numbers of snakes in this reach, and throughout the species' current range.

(9) Comment: The simple interpretation of lambda (λ, a calculation of the finite rate of population increase) from Whiting *et al.* (2008) using the preferred stage-based model ($\lambda = 0.67$ to 0.78) is that the species is declining 22 to 33 percent per generation. This, in addition to low survivorship of neonates, is strong evidence that Concho water snake populations are not viable.

Our Response: Whiting *et al.* (2008, p. 443) explains that the modeling results of the finite rate of increase from the mark-recapture study were biased low due to the effect of dispersal of snakes out of the study areas, and this is what produced the low estimate of λ. Since dispersal rates were not measured in the study, the analysis resulted in a large standard error and imprecise conclusions with high uncertainty. Whiting *et al.* (2008, p. 443) go on to conclude that the Concho water snakes have evolved through stochastic environmental fluctuation (such as droughts, floods, and fires) and occur in high densities in riverine habitats, with low extinction risk. This finding is consistent with the conclusion by Forstner *et al.* (2006, p. 19) that the populations of the snake appear to be viable. Whiting *et al.* (2008, p. 442) suggested that low survivorship values (for both juveniles and adults—rates for neonates were not calculated) compared to other similar snakes are being offset by increased reproductive effort with higher clutch sizes (number of young produced) in Concho water snakes than other similar snakes (Greene *et al.* 1999, pp. 706–707). Also see our response to *(1) Comment* above.

(10) Comment: The documented persistence of Concho water snakes during long-term droughts, coupled with the 2008 MOU, which will maintain minimum flow releases, provide a reasonable amount of confidence that the recovery criterion for maintaining adequate flows has been met. Loss of flows no longer poses a significant threat to the Concho water snake.

Our Response: We agree. The minimum flow releases provided by the 2008 MOU, other reservoir releases for water delivery and water quality management, and natural inputs to the rivers from springs and tributary streams, combined with the snakes' ability to withstand stochastic events like droughts, make this threat no longer of sufficient magnitude to warrant the species' listing as threatened.

(11) Comment: The 2008 MOU states that the District can further reduce or even terminate flows during times of extremely low inflow. Given the fairly well documented climate change that is now occurring, which may influence the lengths of drought in the region (and hence the amount of inflow), coupled with the thought that these animals rarely live longer than 5 years, I question whether it is reasonable to leave the MOU so loosely written. Perhaps the Service might choose to be notified after some length of time has passed with no flow occurring so that an assessment can be made as to its effects on the snake populations?

Our Response: The 2008 MOU between the Service and the District does provide the District the ability to forego the minimum flow releases in the event of ''extended hydrological drought and to provide water for health and human safety needs.'' The drought measure is based on reservoir elevation (1,843.5 feet (ft) (561.9 meters (m)) above mean sea level at Spence Reservoir, and 1,504.5 ft (458.5 m) at Ivie Reservoir). These elevations represent the stage when the reservoirs are at about 12 percent of reservoir capacity. These criteria for foregoing minimum flow releases are consistent with the operations included in the 2004 Biological Opinion (Service 2004a, pp. 11–12). Since Spence Reservoir was initially filled in 1971, the water level elevation has only been below this mark during 2002 to 2004, at the end of a prolonged drought extending from 1992 to 2003 (District 2005, pp. 39–43). This reach of the Colorado River below Spence Reservoir makes up about 36 percent of all estimated available habitat within the current range of the Concho water snake (Service 2004a, p. 72). Ivie Reservoir has not been below this mark since it initially filled in 1991. Discharge in the river is well-monitored with gauges maintained by the U.S. Geological Survey (USGS), and flow data (historical and real time) are available on-line. Reservoir stage data are also available on-line on the District's webpage. Therefore, these data can be easily accessed making a notification process unnecessary. Under our post-delisting monitoring plan, we will be using existing stream gauges to monitor instream flows throughout the range of the snake. This information will be used in combination with biological monitoring data to assess the status of the species in the future (see the Post-Delisting Monitoring Plan section below).

We have revised our discussion of the effects of drought on the Concho water snake and included in the discussion a consideration of future climate change (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows, below). Also, see our response to Comment 12 below.

(12) Comment: Drought continues to be a threat because, despite the species' persistence through historic droughts, it now occurs in combination with other stressors, such as reduced availability of riffles, vegetation encroachment, and changing prey base that may compromise survival and population recovery following a drought.

Our Response: We have substantially increased our analysis in this final rule of the potential effects of declining flows due to drought, as well as other threats (see Summary of Factors Affecting the Species). We found none of these potential threats, either acting alone or in combination, have resulted in negative responses by the snake sufficient to justify the species' continued listing as threatened. Forecasting the impacts from future climatic events, such as drought, is difficult to quantify because of the large amount of uncertainty associated with climate modeling, particularly related to precipitation forecasting. However, we revised our discussion of threats related to drought and climate change in this final rule (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows below).

We do not foresee future habitat conditions deteriorating to a point where the species is likely to become endangered. Forstner *et al.* (2006, pp. 15–17) and Whiting *et al.* (2008, p. 343) explain that the snake is well adapted to extreme drought conditions. This is demonstrated in the Concho River where the snake continues to persist despite extremely low flow conditions (Dixon 2004, pp. 8–9, Forstner *et al.* 2006, p. 8). The snake has been shown to be more abundant and widespread than originally thought and capable of surviving in reservoirs (District 1998, pp. 18–29). Reservoir operations have provided continual stream flows that have sustained the habitat for the species, even during the prolonged drought extending from 1992 to 2003 (District 2005, pp. 39–43), and we expect minimum reservoir releases to continue. In addition, the snake is equipped to handle stochastic environmental fluctuations, such as low stream flow conditions resulting from drought, and has demonstrated the ability to persist in these less-than-favorable habitat conditions (Forstner *et al.* 2006, p. 17; Whiting *et al.* 2008, p. 443). Also, the threat of vegetation encroachment is no longer considered a significant threat because the snake has shown the ability to maintain populations in river reaches with substantial vegetation encroachment (Dixon 2004, p. 9). Additionally, habitat restoration efforts such as the removal of salt cedar and other brushy species and the creation of artificial instream riffle structures are aimed at improving habitat for the Concho water snake to increase their likelihood of survival during droughts and other stressors. We expect some salt cedar control efforts to continue into the foreseeable future.

(13) Comment: The importance of groundwater-surface water interactions to maintain adequate flows is stressed in the proposed rule. However, there does not appear to be a clear understanding of where groundwater pumpage for consumptive use has influenced base flows. Existing groundwater-surface water interaction models, and even simple gain and loss studies, could provide critical information regarding where the influence of groundwater pumping may influence critical flows and available habitat.

Our Response: We agree this could be important information to consider. We assume there is some influence of local and regional groundwater withdrawals on the availability of water for instream flows. However, we are not aware that such information is currently available or that to quantify this relationship within the range of the Concho water snake is possible at this time.

(14) Comment: Has the occurrence and status of riffle habitat been quantified using GIS or remote imagery in the reaches where the species is known to occur?

Our Response: We are not aware of the availability of this type of information, and the publicly available imagery is not of sufficient resolution to reliably quantify snake habitat in the river. The Service did estimate the quantity and quality of snake habitat by reach in the 2004 Biological Opinion (Service 2004a, Appendix B, pp. 70–72), and we consider it to still be reasonably accurate and the best information available . The information has been added to this final rule (see *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Quality and Quantity section below). The river reaches in question remain largely undeveloped.

(15) Comment: The suggestion that pool habitats, created by the backwater behind low-head dams, provide refuges for snakes during drought is unsubstantiated. These habitats may represent population sinks, where mortality exceeds recruitment.

Our Response: The suggestion that pools behind low-head dams act as refuge habitats comes from the expert opinion of Dr. James Dixon (Dixon 2004, p. 16). Dr. Dixon is considered a reliable source, as he has studied this species since 1991 (see Werler and Dixon 2000, pp. 209–216).

(16) Comment: The proposed rule indicates that 'an excellent first step' in reversing vegetation encroachment has been accomplished (73 FR 38962). While laudable, a 'first step' should not be construed as success in eliminating vegetation encroachment as a threat.

Our Response: Recent efforts by the District to control salt cedar are conservation actions that we expect will benefit the Concho water snake through maintaining native riparian vegetation and possibly providing additional instream flows. These actions do not completely eliminate vegetation encroachment. However, vegetation encroachment, such as has occurred on the Concho River, is not considered a significant threat since the snake has shown the ability to maintain populations in river reaches with substantial vegetation encroachment (Dixon 2004, p. 9). We have revised the discussion of vegetation encroachment within this final rule (see *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Channel Maintenance Flows section below).

(17) Comment: It seems reasonable to assume that there is likely movement between snake populations with the discovery that the snakes are living in the reservoirs, and, therefore, likely little threat from population fragmentation. Have there been studies of possible gene flow between the populations?

Our Response: We agree that fragmentation has been reduced with the new information on the persistence of the snake in reservoirs. We presume that over time, this allows snakes from the upper Colorado River reach (below Spence Reservoir) to interact with snakes from the Concho River reach by moving through Ivie Reservoir. Previous studies conducted on gene flow suggested that populations of snakes above and below Freese Dam should be more than large enough to maintain existing genetic variation based on mitochondrial DNA analysis (Sites and Densmore 1991, p. 10). We presume that is still the case. Densmore (1991, pp. 10–11) went on to say that periodic transfer of snakes should probably be implemented to mimic gene flow. More recent analysis has been initiated using modern molecular techniques to evaluate possible gene flow between populations, but data or results from these studies by Dr. Michael Forstner (2008) have not yet been reported. Forstner (2008, p. 14) does suggest that there is no evidence that Freese Dam (Ivie Reservoir) is a barrier to gene flow for either water snake in the Colorado River. However, the report notes that it may have been too short a time to detect such a change (Forstner 2008, pp. 14–15), and we do not know whether there are adequate sample sizes from this study to reliably describe gene flow levels between populations or river reaches; however, the 2008 MOU calls for the movement of snakes to provide some gene flow between river reaches.

(18) Comment: Have any mark and recapture studies been done to demonstrate the movement of snakes between fragmented habitat, e.g., from reservoir to below reservoir and to quantify dispersal of individuals within reservoirs?

Our Response: Some mark-recapture and radio telemetry studies have documented movements in Concho water snakes (Werler and Dixon 2000, p. 212). Although most snakes showed strong site fidelity, some snakes moved as far as 12 mi (19 km). No studies have documented long-range movements between populations or around a large dam. However, the 2008 MOU calls for periodic movement of snakes around the large dams. In addition, the 2008 MOU was amended in 2011 to also include the movement of five snakes from above both dams to below both dams. The 2008 MOU calls for the movement of five snakes from below Spence and Freese dams to above these dams every 3 years. This amount of transfer of snakes should be more than sufficient to maintain gene flow, as studies have shown that as few as one individual exchanged with each generation may be sufficient to maintain adequate gene flow between animal populations (Mills and Allendorf 1996, p. 1,557). Also see the discussion below under Habitat Modification from Fragmentation.

(19) Comment: What is the evidence that fish populations are viable and that cyprinids (minnows) and their habitat (*e.g.,* riffles) are of sufficient quality and quantity in all three reaches? Is the opinion of one or more scientists adequate, or is there sufficient data on the status or trends of fishes in the three reaches to support the assumption that the fish prey base for the Concho water snake is sufficient? Are there data, such as the Texas Commission on Environmental Quality's (TCEQ) Clean Rivers Program data on fishes, which could be analyzed to determine if there are any trends in fish populations worth noting? How are the fish populations that the snakes depend on for food going to fare in situations like prolonged drought?

Our Response: We have revised the discussion of forage fish availability under the section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows below to better explain why we do not find that lack of forage fish is a significant threat to the snake. We are not aware of additional fish data that could inform our decision on the Concho water snake. However, a review of the 10 years of fish surveys by the District from 1987 to 1996 showed that the snakes were opportunistic predators on a variety of fish species (Service 2004a, Appendix A, pp. 68–69). The most abundant fish available and in the snakes' diet are fish species that are adapted to harsh stream conditions (intermittent flow and poor water quality), such as red shiners (*Cyprinella lutrensis*) (Burkhead and Huge 2002, p. 1) and fathead minnows (*Pimephales vigilax*) (Sublette *et al.* 1990, pp. 162–166). Together these two fishes made up two-thirds of the diet of the Concho water snakes. We expect populations of these fish species to persist in harsh environments with intermittent water available (Burkhead and Huge 2002, p. 1; Sublette *et al.* 1990, pp. 162–166). We also expect them to quickly recolonize stream reaches from reservoirs or other refuge habitats after dewatered conditions due to drought have ended. This is based on observations of the snakes being found at sites where they were absent due to lack of water and being found again when the water returns. This occurred in 2004 at Ballinger Lake and Elm Creek (Dixon 2004, pp. 4, 11–12; Forstner *et al.* 2006, p. 15).

(20) Comment: Were nutrient concentrations in water actually evaluated in relation to algal productivity? Is the fish assemblage changing in species composition or relative abundance in response to changing nutrient conditions?

Our Response: The reference to nutrient concentrations and algal productivity was related to past concerns as a possible threat to the Concho water snake during the 1986 listing. We are not aware of data connecting increases in nutrient concentrations to algal productivity or changes in fish species composition or relative abundance within the range of the Concho water snake. There has been no subsequent indication that these threats are actually occurring or are affecting fish communities or snake populations.

(21) Comment: References in reports indicate decreased cooperation by private landowners, indicating stakeholder buy-in is inadequate, raising the possibility that harassment and persecution of snakes now and following delisting is a threat.

Our Response: We have no information that intentional harassment and persecution by landowners or recreationists are likely to affect the species on a rangewide or local population level. The reference (Forstner *et al.* 2006, p. 18) did not indicate decreased cooperation by private landowners, but that new landowners were not easily contacted due to changing ownership. We have revised the discussion to further explain this threat under *Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.*

Comments From State Agencies

(22) Comment: The TPWD accepted the District's 1998 arguments to delist the Concho water snake and did so on November 16, 2000. TPWD believes the continuing conservation efforts of the District and other interested parties will ensure the snake's place as a member of the native fauna of Texas for the foreseeable future.

Our Response: We agree with the comment by the TPWD that the Concho water snake no longer qualifies as a threatened species.

(23) Comment: Removing the Concho water snake from protection under the Act will reduce the costs and time associated with section 7 consultations with the U.S. Fish and Wildlife Service. As a result, TxDOT may now delay the letting of some projects until after the final delisting occurs.

Our Response: We understand that removing the species from the Federal list of threatened species will benefit some planned actions by eliminating the requirement for section 7 consultations for actions with a Federal nexus that may affect the Concho water snake.

Comments From the Public

(24) Comment: A comment from the District explained that they conducted field studies on the Concho water snake

from 1987 to 1996 that demonstrated the snake population was much more stable than previously thought. Later field studies in 2003 to 2007 determined the snake was in a recovered state. Additionally, the District agreed to provide stream flow discharge from two of its Colorado River reservoirs (E.V. Spence and O.H. Ivie Reservoirs), which further supports the long-term existence of the snake.

Our Response: The Service recognizes the many years of field studies that the District conducted, and the benefits of the District's partnership with the Service in signing the 2008 MOU to provide reservoir releases for the Concho water snake. The recovery of the Concho water snake and its removal from the list of threatened species are largely due to the efforts of the District to provide reservoir releases to maintain snake habitats over the past 20 years and into the future, and to collect new information documenting the biology, distribution, and abundance of the snake.

(25) Comment: The proposed delisting fails to make a convincing case that recovery of the Concho water snake is sufficient to justify its removal from threatened species protections. The proposal's arguments are vague, circular, repetitive, and sometimes contradictory. There is little supporting data or science provided. The delisting is premature and unsupported.

Our Response: We disagree with the commenter's conclusions. We have updated and clarified the text in this final rule in response to this and other comments received to better explain our analysis and conclusions. Specifically, we revised the discussion and analysis under section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.* The Service believes the removal of the snake is warranted based on the best available scientific information.

(26) Comment: The proposed rule fails to adequately address availability of, and threats to, the important riffle habitats of the Concho water snake. For example, reservoir habitats used by the snake must be equal to or greater than the amount of riverine riffle habitats lost due to effects of the reservoir construction at O.H. Ivie Reservoir. The range extension for the snake does not include information on the amount and quality of habitat and its use by snakes. There is no estimate provided of past or future loss of riffle habitat, or an assessment of the long-term success of the artificial riffles, to support that riffle habitat loss is not still a threat to the Concho water snake.

Our Response: We recognize that there has been, and will continue to be, changes in the characteristics of the riverine habitat within the range of the Concho water snake as a result of past and ongoing human activities. While there have not been any recent studies to quantify these changes, the best available data indicate that any possible loss of riffle habitat is not resulting in impacts that would likely cause the snake to become endangered. The best example is observed in the Concho River where the long-term substantial decline in minimum stream flows and the loss of flushing flood flows have reduced natural riffle habitats available (Dixon 2004, pp. 8–9). However, Concho water snakes continue to persist in relatively high numbers in this reach. For example, 20 of the 45 Concho water snakes observed or captured by Forstner *et al.* (2006, p. 8) were from the Concho River. In addition, the snake's use of other habitats, including reservoir shorelines, lessens the overall effect of decreased riffle habitat availability. We have revised our discussion in this final rule and provided a quantified estimate of habitat availability by reach throughout the range of the species (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Quality and Quantity below).

(27) Comment: The proposed rule fails to address the size and health of reservoir populations. Whiting *et al.* (2008) notes that the species occurs in relatively low densities in reservoirs, and they believe the snake may be more vulnerable to extinction in reservoirs. It appears unlikely that the use of reservoir habitats by Concho water snakes provides sufficient improvement in species status to support removal of threatened protection.

Our Response: The ability of Concho water snakes to survive and reproduce in reservoirs is one factor among many we considered in determining that the species is no longer threatened. There is some evidence that snake populations in the reservoirs are not as robust as those in their native riverine habitats. We would expect this given that the snake habitat in reservoirs is likely of a somewhat lower quality and in less abundance compared to natural riverine habitats. This is because the reservoirs may have less shallow flowing water over rocky substrates that support small fish that are the prey base for the snake. However, Whiting *et al.* (2008, p. 443) concluded that data are not sufficient for truly reliable estimates of snake survival and population growth in either of the two main reservoirs. Although the authors aimed to compare populations in reservoirs with those in rivers, data did not allow that analysis due to the inability to sufficiently quantify immigration rates (Whiting *et al.* 2008, p. 443). The statement by Whiting *et al.* (2008, p. 443) that Concho water snakes may be more vulnerable to local extinction in lakes was in the context that the extinction risk in natural river habitats is relatively low due to the snake's occurrence in high densities and their ability to grow fast and mature early. The ability of the species to utilize reservoirs is a positive discovery and supports the conclusion that the impacts of the reservoirs were not as great as initially predicted. Also, see our response to *(1) Comment* above.

(28) Comment: The proposed rule indicated that confirming that a species has persisted over time and continues to demonstrate reproductive success is sufficient to assume that populations are viable. Persistence and reproduction are not adequate to demonstrate population viability. The statement that the populations are ''seemingly viable'' is a tentative conclusion that is scientifically and legally unsupportable.

Our Response: Our explanation of population viability may have oversimplified the explanation by Forstner *et al.* (2006, p. 20) describing the status of Concho water snake populations. We understand that documenting persistence and reproduction is not adequate to precisely determine viability in most quantitative ecological contexts. In response to this comment, we have updated our explanation to describe that there are not adequate data for quantitative modeling for population viability analysis of this species (see *Application of the Recovery Plan's Criteria* section below). We have revised this discussion in the final rule to instead refer to the definition of viable population given in the recovery plan. The recovery plan defines viable population as one that is self-sustaining, can persist for the long-term (typically hundreds of years), and can maintain its vigor and its potential for evolutionary adaptation (Service 1993, p. 33). We have also included a more detailed summary of the results of the 10 years of snake monitoring, which concluded in 1996. These extensive data, in conjunction with updated limited survey data in 2004 and 2005, are the basis for determining that populations of Concho water snake are viable. In addition, it is important to recognize the standard under the Act is to determine if the species is likely to become endangered in the foreseeable future. Given the best available information, weighing the status of the species and the current and future threats, we have concluded that the snake is no longer likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

(29) Comment: The discussion in the proposed rule regarding effects of drought is poorly articulated and circular. The stated belief that the Concho water snake and its fish prey base can and will survive any level and duration of drought is unsupported by data or analysis in the proposal.

Our Response: We did not intend to imply that snakes can survive any level of drought, but we believe they can survive the expected drought conditions in the foreseeable future, based on historical records and considerations over the last thousand years based on tree-ring analysis (summarized in Forstner *et al.* 2006, p. 16). We are relying on the expert opinion and field experience of long-term herpetologists, explained in Forstner *et al.* (2006, pp. 15–17) and Whiting *et al.* (2008, p. 443) that the Concho water snake has evolved in a drought-prone, hydrologically dynamic system and has demonstrated the ability to withstand stochastic environmental fluctuations. This characteristic of the snake to endure periods of drought and resulting poor habitat conditions was documented for the Concho River reach and at Lake Ballinger on Elm Creek, a Colorado River tributary (Dixon 2004, pp. 9, 11–12; Forstner *et al.* 2006, p. 17; Whiting *et al.* 2008, p. 443). Due to water management and climate change, future droughts could be more severe than the historical record over the last 100 years. However, we cannot foresee that these conditions are likely to be so severe as to result in the extinction or endangerment of the snake. To make this explanation clearer, we have rewritten the discussion in this final rule (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows below).

(30) Comment: The success in abatement of threats over the 22 years since the Concho water snake was listed appears to be overstated in the proposed rule. Long-term success of artificial riffle construction to increase riverine habitat is not yet determinable. The 15 or so years since artificial riffle installation are not long-term in a hydrologic sense. It is my understanding the artificial riffles have not been assessed for several years.

Our Response: The artificial riffles constructed in 1989 produced immediate results as snakes were found there by 1991 (District 1998, pp. 13, 15). The six riffles were monitored from their creation in 1991 through 1996, and snakes were consistently found at five of the six sites (Thornton 1996, pp. 44–49). The success of the snakes in the reservoirs and in the artificial riffles resulted in less attention being given to the need to mitigate further for the habitat loss from reservoir construction. We are not aware of any recent monitoring efforts focused on the artificial riffles, but we have no reason to believe the snakes are not continuing to persist there.

(31) Comment: Other than species persistence, data and studies upon which the 2004 reduction of minimum instream flows was based are not discussed. There are also no studies documenting the results of the reductions in the required flow.

Our Response: A full explanation and analysis of effects of the 2004 reduction in required flows is documented in the Service's biological opinion provided to the U.S. Army Corps of Engineers as a conclusion to the formal section 7 interagency consultation for the change in reservoir operations (Service 2004a, pp. 1–76). The analysis included updated biological information that the snakes use more diverse riverine habitats (such as pools, in addition to riffles) and were found in the reservoirs and tributaries (Dixon 2004, pp. 9, 16; Service 2004, pp. 53–54). As a result of that consultation, we gave our biological opinion that the reduced reservoir releases described in the proposed agency action were not likely to jeopardize the continued existence of the Concho water snake and were not likely to destroy or adversely modify designated critical habitat. These same flow rates were used in the 2008 MOU. In making the delisting proposal and now the final rule, we relied heavily on the results of monitoring by Forstner *et al.* (2006, p. 1–22) in concluding that the reduced flow rates are sufficient for the snake.

(32) Comment: The 2004 Biological Opinion substantially changed the 1986 requirement for high discharge channel maintenance flows below O.H. Ivie Reservoir. That change is not discussed in the proposed rule, and would be of particular importance in understanding the basis for the habitat loss downstream of reservoirs.

Our Response: We have added information to the final rule explaining the changes in requirements for channel maintenance flows (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Channel Maintenance Flows below). The 2004 Biological Opinion and the 2008 MOU both recognize the benefits of periodic high discharges from either reservoir releases or flood runoff events to function in river channel maintenance to maintain suitable rock substrates and abate vegetation invasion of riffle habitat. Our analysis concludes that some flushing flows are likely to naturally occur, slowing the degradation of aquatic habitats. In addition, the snakes appear capable of sustaining populations in areas where instream habitats have been altered due, in part, to reducing flushing flows. In some areas, such as on the Concho River, the dominant substrate is solid bedrock and not as subject to invasion of vegetation. Cracks and breaks in the bedrock provide foraging habitat similar to riffles. Therefore, we did not find that the threats of reduced flushing flows are significant.

(33) Comment: Although the proposed rule says that the District has implemented every activity requested by the Service in previous biological opinions, the District's compliance was largely due to removal of requirements that they objected to prior to finalizing the opinion and removal of others by later amendments. The statement that the District has an excellent track record of carrying out conservation actions should be supported by information.

Our Response: The 1986 Biological Opinion was amended many times up until the major revision in 2004 due to changing conditions based on new information being collected (Service 2004a, pp. 1–3). A discussion of the District's compliance efforts under the previous biological opinions is documented in the 2004 revised biological opinion (Service 2004a, pp. 42–47). We have also added information throughout this final rule to document important areas where the District has fulfilled its requirements.

(34) Comment: There is no evidence provided that the instream flow requirements from the 2004 Biological Opinion and 2008 MOU are sufficient to ensure long-term species survival.

Our Response: We believe the flows provided in the 2008 MOU are sufficient to ensure long-term species survival. This is based on the information demonstrating that the species can survive under substantially lower flows compared to what was previously thought. These conclusions are based on the observations and reports of species experts (Dixon 2004, p. 16; Forstner *et al.* 2006, pp. 19–21; Whiting *et al.* 2008, p. 443). We have also revised the discussion of the threats from reduced instream flows in this final rule to include additional information and discussion on hydrology, climate change, and the potential response by the snake (see section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows below).

(35) Comment: The 2008 MOU was entered in good faith, but it is not legally enforceable. There is no consequence to the District for a lapse in conservation actions. The MOU is not an adequate substitute for legal protection under the Act.

Our Response: We do not consider the 2008 MOU (including the 2011 amendment) as a substitute for the legal protections under the Act. It does document the commitment that the District will continue to cooperate in maintaining instream flows downstream of the two Colorado River reservoirs. These flows are in addition to other reservoir releases for water delivery and water quality management, and natural inputs to the rivers from springs and tributary streams. Given the District's track record of compliance and completing conservation actions, we have no reason to doubt that the District will continue to carry out the actions agreed to in the 2008 MOU (including the 2011 amendment). In addition, Section 5.2 of the MOU notes the Service's ability to list the snake again under protection of the Act. This provision includes use of emergency listing procedures if warranted.

(36) Comment: Initiation of salt cedar control does nothing to guarantee threat abatement to Concho water snake habitat. Salt cedar control has a long history of variable and generally quite limited success. It will be many years before it can be determined if the recently initiated project will provide any benefit to the snake.

Our Response: Salt cedar control is one conservation action that can provide benefits to the Concho water snake through restoration of native riparian vegetation to provide natural stream-side habitat conditions and potential water savings for instream flow increases. We agree with the comment that it will take time to document the actual benefits to the snake.

(37) Comment: The proposal acknowledges that delisting recovery criteria from the recovery plan have not been met, but claims additional information has rendered those criteria partially invalid. This undermines the recovery planning process and is offensive to the many stakeholders who participate in recovery plan development. If the recovery plan is out-of-date or otherwise invalid, the Service should convene the recovery team and amend or rewrite the plan with appropriate public and stakeholder review. This will yield a firmer basis and greater support than the current process for delisting.

Our Response: The Service believes that the Concho water snake has recovered and generally met the criteria from the 1993 recovery plan. Although meeting the recovery criteria is not necessarily required for delisting, we have discussed the criteria below in this final rule section *Application of the Recovery Plan's Criteria.* The Service does not believe it is necessary to revise the recovery plan for the Concho water snake. We have found the current information is sufficient to support that the species no longer qualifies as a threatened species. Therefore, additional time and resources would not be well spent to revise the recovery plan. Also we have sought the input of the public, stakeholders, and experts, including former recovery team members, during the comment period for the proposal to remove the snake from the threatened list.

(38) Comment: While District water rights may ensure water deliveries to downstream users, they do not ensure that deliveries will occur through the natural streambed where Concho water snake exists. Such rights can be fulfilled through other means, like canals, water trades, storage, etc., that result in dewatered stream channels.

Our Response: The primary water releases for downstream water users that provide benefits to the snake occur from the required minimum flow releases from Ivie Reservoir for the Lower Colorado River Authority (LCRA). These releases are required by the District's State water right permit for Ivie Reservoir. The deliveries are made using the natural channel. Other deliveries made for water quality improvement occur between Spence and Ivie Reservoirs and also use the natural channel. We have no reason to believe that these water deliveries would not use the natural stream channel in the future. The District already uses a sophisticated system of pipelines to deliver most of their water to its customers, the majority of whom are cities upstream of the two reservoirs (District 2005, pp. 2–5). Therefore, we do not foresee the District using any other methods than the natural channel to deliver water downstream.

(39) Comment: The Service statement that the snakes may not need to be transferred between populations to prevent genetic isolation illustrates the prematurity of this proposed rule. A delisting decision should be based on something more reliable than that the species ''may not need'' this conservation action.

Our Response: We have clarified this language in this final rule (see *Application of the Recovery Plan's Criteria* section below). Section 4.1 of the 2008 MOU, as amended in 2011, states that, ''In the springtime once every 3 years, the District, in coordination with the Service, should move five male snakes (each) from below Spence and below Freese [Ivie Reservoir] dams to above these dams, and move 5 different male snakes from above both dams to below both dams. Moving snakes will be dependent upon availability of funding for the District.'' This requirement was included in the 2004 Biological Opinion (Service 2004a, p. 61). Should funding be unavailable in any particular snake-moving year, every effort will be made to move snakes in the succeeding year. Previously, movement of snakes was suggested with the Concho River population as well (Service 1986, p. 24). However, because the snakes exist in Ivie Reservoir they have access from the Colorado River to the Concho River so transferring snakes to the Concho River was determined not necessary.

(40) Comment: The reference to the uncertainties in the results from Whiting *et al.* (2008) should be clarified that the uncertainties resulted from the data being insufficient to estimate survival and trend reliably due primarily to insufficient sampling at any single study site, along with a host of variables, especially environmental variability within a site and among sites, and also because dispersal rates were not measured among sites. Therefore, study results have not been robust enough to allow either population or trend estimates with satisfactory precision.

Our Response: We have updated the text in the final rule to be consistent with this comment (see *Application of the Recovery Plan's Criteria* section below).

(41) Comment: A reliable trend estimate for the Concho water snake over a span of years seems to be lacking for the species, and there are no reasons given for why this was so. A trend analysis would be better to ascertain if the species should be delisted.

Our Response: We agree that a reliable trend analysis over time would be useful in confirming the status of the species. Despite many years of monitoring surveys over time, no reliable trend analysis has been completed due to variations in study efforts and methods and to environmental conditions (District 1998, p. 18; Service 2004a, p. 23; Forstner *et* *al.* 2006, p. 12–13; Whiting *et al.* 2008, p. 343). However, the best available information on the population status of the snake from the large numbers of snakes captured during the 10 years of monitoring (District 1998, p. 21) and confirmed in 2005 (Forstner *et al.* 2005, pp. 19–20) demonstrates that its status is sufficiently good to warrant removal from the list of threatened species. For more discussion on this issue, see *Application of the Recovery Plan's Criteria,* Viable Populatins section of this rule.

Summary of Factors Affecting the Species

Section 4 of the Act and its implementing regulations (50 CFR part 424) set forth the procedures for listing, reclassifying, or removing species from listed status. ''Species'' is defined by the Act as including any species or subspecies of fish or wildlife or plants, and any distinct vertebrate population segment of fish or wildlife that interbreeds when mature (16 U.S.C. 1532(16)). Once the ''species'' is determined, we then evaluate whether that species may be endangered or threatened because of one or more of the five factors described in section 4(a)(1) of the Act. We must consider these same five factors in delisting a species. We may delist a species according to 50 CFR 424.11(d) if the best available scientific and commercial data indicate that the species is neither endangered nor threatened for one of the following reasons: (1) The species is extinct; (2) the species has recovered and is no longer endangered or threatened (as is the case with the Concho water snake); and/or (3) the original scientific data used at the time the species was classified were in error.

A recovered species is one that no longer meets the Act's definition of threatened or endangered. The analysis for a delisting due to recovery must be based on the five factors outlined in section 4(a)(1) of the Act. This analysis must include an evaluation of threats that existed at the time of listing, those that currently exist, and those that could potentially affect the species once the protections of the Act are removed.

The Act defines ''endangered species'' as any species which is in danger of extinction throughout all or a significant portion of its range, and ''threatened species'' as any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The word ''range'' in the phrase ''significant portion of its range'' refers to the range in which the species currently exists. For the purposes of this analysis, we will evaluate whether the currently listed species, the Concho water snake, should be considered threatened or endangered throughout all of its range. Then we will consider whether there are any significant portions of the Concho water snake's range in which it is in danger of extinction or likely to become endangered within the foreseeable future (see Significant Portion of the Range Analysis section below). For the purposes of this finding, the ''foreseeable future'' is the period of time over which events or effects reasonably can be anticipated, or trends reasonably extrapolated, such that reliable predictions can be made concerning the status of the species. We considered this temporal component in the analysis in each substantive discussion under the five factors below and provide a discussion of the foreseeable future in the Conclusion of the Five-Factor Analysis section below.

Section 4(a)(1) of the Act requires that we determine whether a species is endangered or threatened based on one or more of the five following factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Our evaluation of these five factors is presented below. Following this threats analysis, we evaluate whether the Concho water snake is threatened or endangered within any significant portion of its range.

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

Habitat Description

Concho water snakes are known to occur in rivers, streams, and along the shoreline of reservoirs. These snakes are air-breathing; however, they feed almost exclusively on fish and are, therefore, found only near water sources capable of supporting at least a minimal fish population. Unlike many other species of *Nerodia,* Concho water snakes do not seem to move far from water (Werler and Dixon 2000, p. 208). During Greene's (1993, p. 96) visual and radio telemetry surveys, all snakes occurred within 33 ft (10 m) of water.

Stream and river habitat used by the Concho water snake is primarily associated with riffles (Greene 1993, p. 96; Werler and Dixon 2000, p. 210; Forstner *et al.* 2006, p. 13) where the water is usually shallow and the current is of greater velocity than in the connecting pools. Riffles begin when an upper pool overflows at a small change in gradient and forms rapids. The stream flows over rock rubble or solid to terraced bedrock substrate through a chute channel that is usually narrower than the streambed. The riffle can extend to over 300 feet (100 m) in some locations and ends when the rapids enter the next downstream pool. Riffles are believed to be the favored habitat for foraging, with young snakes using shallow parts of riffles and adult snakes using deeper parts of riffles (Williams 1969, p. 8; Scott *et al.* 1989, pp. 380–381; Greene 1993, pp. 13, 96; Werler and Dixon 2000, p. 215; Forstner *et al.* 2006, p. 13). Juvenile snakes are closely associated with gravel shallows or riffles (Scott and Fitzgerald 1985, p. 35; Rose 1989, pp. 121–122; Scott *et al.* 1989, p. 379). This habitat is likely the best for juvenile snakes to successfully prey on small fish because the rocky shallows concentrate prey and are inaccessible to large predatory fish. The exposed rocky shoals act as thermal sinks, which maintain heat and may help keep the juvenile snakes warm and maintain a high growth rate (Scott *et al.* 1989, pp. 380–381).

Observations on the Concho and Colorado Rivers also indicated Concho water snakes were found in the shallow pools between riffles (Williams 1969, p. 8; Dixon 2004, p. 16). Dixon *et al.* (1989, p. 16) demonstrated that adult snakes used a variety of cover sites for resting, including exposed bedrock, thick herbaceous vegetation, debris piles, and crayfish burrows. Adult and maturing Concho water snakes use a wider range of habitats than do juveniles including pools with deeper, slower water (Williams 1969, p. 8; Scott *et al.* 1989, pp. 379–381; Werler and Dixon 2000, p. 211).

Range

Historically the Concho water snake was known to occur in spotty distribution in central Texas on the Colorado River below E.V. Spence Reservoir (constructed in 1969) near the City of Robert Lee, Texas, downstream to the F.M. 45 highway bridge crossing and then not again until further downstream near the City of Bend, Texas (Tinkle and Conant 1961, pp. 42–43; Williams 1969, p. 3). On the Concho River and its tributaries, Concho water snakes were historically known from Spring Creek, Dove Creek, and the South Concho River, all upstream of the Twin Buttes and O.C. Fisher Reservoirs near San Angelo, Texas, and in the Concho River downstream from San Angelo to the confluence with the

Colorado River (Marr 1944, pp. 486–487; Tinkle and Conant 1961, pp. 42–43). Prior to the Federal listing of the Concho water snake in 1986, it had been extirpated from Concho River tributaries upstream of the City of San Angelo (Flury and Maxwell 1981, p. 31), and surveys had not located snakes in lakes or reservoirs (Scott and Fitzgerald 1985, pp. 17, 34). At the time of listing, the range of the snake had been affected by O.C. Fisher, Twin Buttes, and Spence Reservoirs and one tributary creek reservoir, Ballinger Municipal Lake (on Elm Creek). A fifth reservoir, O.H. Ivie Reservoir (formerly known as Stacy), was planned for construction at the confluence of the Concho and Colorado Rivers and was expected to reduce the snake's range by more than 50 percent (Scott and Fitzgerald 1985, pp. 31, 35).

At the time of listing in 1986 the range was described as approximately 199 mi (320 km) (51 FR 31412). By 1993, Scott *et al.* (1989, pp. 382, 384), Thornton (1992, pp. 3–16), and Whiting (1993, pp. 8, 28, 117–118, 121) had found additional locations of the snake upstream and downstream and determined the Concho water snake's distribution to be approximately 233 mi (375 km) of river (Service 1993, p. 9). While the Concho water snake has been extirpated from some reaches of its historical distribution, mainly upstream of San Angelo (Flury and Maxwell 1981, p. 31), since the time of listing it has been confirmed farther downstream from Ivie Reservoir and farther upstream from Spence Reservoir (District 1998, pp. 10, 22, 26, Dixon *et al.* 1988, p. 12; 1990, pp. 50, 62–65; 1991, pp. 60–67; 1992, pp. 84, 87, 96–97; Scott *et al.* 1989, p. 384). Analysis for the 2004 revision to the 1986 Biological Opinion (BO; Service 2004a, p. 32) summarized the current known distribution of the Concho water snake as being the Colorado River from the confluence of Beals Creek (upstream of Spence Reservoir), depending on reservoir stage, to downstream of Ivie Reservoir (constructed in 1989) to Colorado Bend State Park, and on the Concho River downstream of the City of San Angelo to the confluence with the Colorado River. This is a total of about 280 mi (451 km) of river and about 40 mi (64 km) of reservoir shoreline.

The information on the current range of the snake is based largely on the monitoring studies performed by the District between 1987 and 1996 (District 1998, p.10). In addition to monitoring 3 times a year at 15 riverine sites, the District also conducted searches throughout the upper Colorado River and Concho River basins. Additional surveys taught researches that late summer and early fall were the times when the snake was most active and that snakes can often be captured in minnow traps when they are not found with searches (District 1998, pp. 16, 18). The results confirmed a larger distribution than was thought at the time of listing. For example, the snake was believed to be extirpated from the area downstream of Spence Reservoir in the Colorado River, but was found to occur there with more intensive sample efforts (District 1998, p. 22). The snake overall was found throughout its historic range, with the only exception being the small tributary streams upstream of San Angelo, where only a few snakes had been collected in the past.

To confirm the distribution of the species, Concho water snake surveys were conducted across the species' range in 2004 and 2005 (Dixon 2004; Forstner *et al.* 2006). One goal of Forstner *et al.* (2006, pp. 4–5) was to evaluate whether viable Concho water snake populations existed in all reaches of the Colorado and Concho Rivers. To do this, snake localities were surveyed ''for evidence of reproduction (one measure of sustainability).'' In all, 14 sites were sampled, and 45 Concho water snakes were collected from 11 of those sites (Forstner *et al.* 2006, pp. 9–12). Sample efforts were limited to the extent necessary to document the presence of the species and evidence of reproduction in each reach, based on the capture of either neonate snakes or post-partum females. The collection efforts were brief, and more effort would have likely increased the total number of snakes collected (Forstner *et al.* 2006, p. 11).

Persistence and reproduction were documented in the Concho River and upstream of Ivie Reservoir in the Colorado River, as well as in both Spence and Ivie Reservoirs (Forstner *et al.* 2006, pp. 12, 18). However, access downstream of Ivie Reservoir was limited by inability to contact private property owners, preventing a thorough assessment downstream of that impoundment (Dixon 2004, p. 2; Forstner *et al.* 2006, p. 18). Despite limited access downstream of Ivie Reservoir, four snakes were captured during the surveys at two sites and at least one female exhibited signs of recently giving birth. Forstner *et al.* (2006, p. 18) described these results as technically sufficient to demonstrate persistence and reproduction downstream of Ivie Reservoir 15 years after its construction. These authors conclude that, ''Even in the face of landscape scale or ecosystem wide stresses by severely reduced precipitation, increased human uses of instream flows, introduced species, and ever increasing human densities, the Concho water snake remains in the majority of the sites visited and continues to reproduce at those locations'' (Forstner *et al.* 2006, p. 18). Forstner *et al.* (2006, p. 20) state that ''self sustain[ing], seemingly viable populations in the Concho and Colorado rivers at the end of a decade of monitoring'' occur in the three reaches of the snake's range. We find that the range of the species has not declined since it was listed in 1986 and has been found to be larger, about 80 more river-mi (129 river-km), than at the time of listing. Therefore, because of its continued persistence throughout its range, the species is not threatened with endangerment due to range reduction.

Population Trends

Following listing of the Concho water snake in 1986, a 10-year monitoring study began throughout the snake's range, including several reservoirs and tributaries (District 1998, pp. 10, 22, 26). The study included mark-recapture techniques by inserting a unique tag in each captured snake of sufficient size so that individuals could be identified when they were recaptured. Over the 10 years of study, 9,069 unique Concho water snakes were captured (District 1998, p. 21). Of this total, 1,535 (17 percent) were captured in reservoirs, 1,517 (17 percent) were captured in the Concho River reach, 5,586 (62 percent) were captured in the Colorado River reach, and another 415 (5 percent) were captured in tributary streams. All of the more than 20 study sites monitored had multiple captures of snakes every year, with a variety of age classes (Thornton 1996, pp. 26–50). Sampling effort at each survey site was not quantified, and was highly variable. Therefore, an increase or decrease in numbers of snakes at a site or cluster of sites in a river reach over the 10 years of the survey does not necessarily indicate an actual increase or decrease in snakes because the effort made to find them varied from survey to survey. The high variation in sample efforts and environmental conditions prevented a thorough analysis of population trends over time or calculation of total population estimates (District 1998, p. 18).

Forstner *et al.* (2006, pp. 6–8, 18, 20) updated the past information by conducting brief field surveys in 2004 and 2005 to verify that snakes continued to be present and were reproducing in each river reach and reservoir where it had been documented in previous studies. This study, which incorporated the results by Dixon (2004), confirmed reproducing populations of Concho water snakes in each river reach and in both Ivie and Spence Reservoirs (Forstner *et al.* 2006, p. 12). Based on the snakes' persistence and reproduction throughout its range over the past 20 years, Forstner *et al.* (2006, pp. 18, 20) concluded that viable populations of Concho water snakes could be presumed to exist in all three reaches of the species' range.

Only two sample locations (below Freese Dam and at River Bend Ranch, about 25 miles (40 km) downstream of the dam) were available for access by the updated study in the reach of the Colorado River downstream of Freese Dam (Ivie Reservoir) (Dixon 2004, pp. 8, 14). This was due to the difficulties in establishing contact with private landowners in this area. However, Dixon did collect three snakes from these two sites in 2004, and one was a juvenile female (Dixon 2004, pp. 16–17). In 2005, Forstner *et al.* (2006, pp. 12, 18) collected one post-partum female below Freese Dam indicating the snake had given birth to young and confirming reproduction. Although only four snakes were captured in limited sampling efforts in 2004 and 2005 in this reach, data from the District's earlier monitoring showed large numbers of snakes in this reach (District 1998, pp. 34–38, 50). We have no reason to conclude that the snake population downstream of Freese Dam is of additional concern.

The 10 years of Concho water snake monitoring data (1987 to 1996) was reanalyzed in an attempt to evaluate population trends and quantify long-term viability (Whiting *et al.* 2008, pp. 438–439). The results, however, were inconclusive because the data were insufficient to reliably estimate survival and emigration. This was due primarily to insufficient sampling at any single study site to quantify dispersal rates, along with a host of other variables, especially different environmental conditions within a site and among sites (Whiting *et al.* 2008, p. 443). This resulted in the survival rates from the capture-recapture study being biased low and producing low estimates of annual survival with large standard errors (Whiting *et al.* 2008, p. 443). The study stated that snakes continued to persist even in drought-prone areas, some with almost total water loss, with hydrologically dynamic systems (Whiting *et al.* 2008, pp. 442–443).

In conclusion, although recent data on population trends are sparse, data showing a stable range, long-term persistence, and continuing breeding success indicate that populations have persisted and remain distributed throughout the species' range over time and do not indicate population concerns.

Habitat Quality and Quantity

At the time of listing, we believed the Concho water snakes did not exist in reservoir habitats. In fact, at the time of listing, the imminent construction of Ivie Reservoir was considered a primary threat because of the assumed habitat loss that would occur due to the reservoir. However, the magnitude of this threat did not materialize because subsequent research confirmed that Concho water snakes inhabit shallow water with minimal wave action and rocks along reservoir shorelines (Scott *et al.* 1989, pp. 379–380; Whiting 1993, p. 112). Juvenile Concho water snakes are generally found in low-gradient, loose-rock shoals adjacent to silt-free cobble. However, Concho water snakes have also been observed on steep shorelines (Whiting 1993, p. 112) and around the foundations of boat houses (Scott *et al.* 1989, p. 379).

We quantified the amount and quality of potential Concho water snake habitat and compared it by river reach and reservoir (Service 2004a, Appendix B, pp. 70–72). These data were habitat quality estimates provided by District biologist and species expert, Mr. Okla Thornton, and were digitized and summarized by the Service using a Geographic Information System. We categorized the habitat quality as high, medium, or low, and calculated the quantity of habitat based on linear meters of river bank or shoreline and summed the results by river reach and reservoir. The results were presented by five segments: (1) The Concho River segment (San Angelo to the inflow of Ivie Reservoir); (2) the Spence Reservoir segment (shoreline of the lake); (3) the upper Colorado River segment (outflow of Spence Reservoir downstream to the inflow of Ivie Reservoir) segment; (4) the Ivie Reservoir (shoreline of the lake); and (5) the lower Colorado River segment (outflow of Ivie Reservoir downstream to Colorado Bend State Park).

In total, the analysis showed over 112 mi (180 km) of snake habitat is generally available along the rivers and in the reservoirs within the species' range. The results indicated that 82 percent of overall available habitat is found in the three river reaches and 18 percent of available snake habitat is in the two reservoirs. The largest percent of ''high quality'' habitat (total of 59 mi (96 km)) was found in the upper and lower Colorado River segments (42 percent and 27 percent, respectively) (Service 2004a, p. 71). The two reservoirs combined contain 15 percent of available ''high quality'' habitats and the Concho River segment contained 16 percent (Service 2004a, p. 71). These data demonstrate that Concho water snake habitat is distributed throughout its range in both the riverine and reservoir segments.

Habitat Destruction From Reservoir Inundation

At the time we listed the Concho water snake in 1986, we believed the construction of Ivie Reservoir would result in the loss of Concho water snake habitat upstream of the dam by inundating the natural riverine rocky and riffle habitats. The site of the proposed reservoir on the Colorado River was believed to support the highest concentration of Concho water snakes (Flurry and Maxwell 1981, pp. 36, 48; 51 FR 31419). Outside of this area, the snake had been found only in isolated occurrences, which indicated an already disjunct, fragmented distribution. The snake had not been found in reservoirs or in the silted-in riverine habitat below Spence Reservoir (Scott and Fitzgerald 1985, pp. 13, 28). It also had not been found in perennial tributaries except Elm Creek near Ballinger (Scott and Fitzgerald 1985, pp. 15, 34). Thus, in 1986 we believed the inundation by Ivie Reservoir would result in a substantial loss of habitat (as much as 50 percent) for the Concho water snake by eliminating them from a substantial portion of their range.

As a result of a 1986 formal consultation conducted under section 7 of the Act with the U.S. Army Corps of Engineers on construction of Freese Dam to form Ivie Reservoir (1986 BO), the District agreed to implement a number of conservation measures under required reasonable and prudent alternatives to avoid jeopardizing the snake. These measures included, but were not limited to: Long-term monitoring of the snakes, completing life-history studies, maintaining specific flow regimes from Spence and Ivie Reservoirs, creating six artificial riffles below Spence Reservoir, and transplanting snakes between populations above and below Ivie Reservoir (Service 1986, pp. 12–24). Ivie Reservoir was constructed in 1989 and the District carried out the required measures over the following 10 years (District 1998, p. 29; Service 2004a, pp. 42–47).

As part of their long-term monitoring plan, District field biologists conducted extensive searches for the Concho water snake beginning in 1987. According to Dixon *et al.* (1988, p. 12; 1990, pp. 50, 62–65; 1991, pp. 60–67; 1992, pp. 84, 87, 96–97), snakes were documented within and above Spence Reservoir, downstream of Spence Reservoir in the artificial riffles, at Ballinger Municipal Lake, the old Ballinger Lake, and the connecting channel between the two Ballinger lakes. The snake was also documented in multiple locations on Elm Creek and two of its tributaries, Bluff Creek and Coyote Creek (Scott and Fitzgerald 1985, pp.14–15, 30; and Scott *et al.* 1989, p. 384). Snakes were regularly found in Spence, Ivie, and Lake Ballinger Reservoirs, a habitat type they were not known to occupy at the time of listing. Concho water snakes have continued to be found in reservoirs. Dixon's (2004, pp. 3–4) surveys in 2004 confirmed that snakes persist in Spence and Ivie Reservoirs. In 2004, Ballinger Lake had only a small pool of water remaining, and no snakes were found there at that time. However, after rains in 2005, Forstner *et al.* (2006, p. 12) confirmed snakes were again present and reproducing within Lake Ballinger. These observations confirm that Concho water snakes have adapted to using reservoirs as habitat.

Studies have found that rocky shorelines were the single most important component of snake habitat in reservoirs, and that changes in water surface elevation of Spence Reservoir will affect the availability of that shoreline habitat (Whiting 1993, p. 13; Whiting *et al.* 1997, pp. 333–334). Although Forstner *et al.* (2006, p. 17) refer to the lakes overall as ''very poor Concho water snake habitat,'' while Dixon (2004, p. 14) calls them ''prime habitat,'' both reports conclude that there are rocky outcrops and boulder slopes in limited areas within the reservoirs that are occupied by the snake. The snakes have remained in Spence Reservoir for nearly 40 years following its construction and for at least 15 years following construction of Ivie Reservoir. Because Concho water snakes are now known to be reproducing and persisting over time in reservoirs and their current distribution is larger than reported historically and at the time of listing, habitat loss from reservoir inundation is no longer believed to be a threat to the long-term survival of the species.

Habitat Modification From Reduced Instream Flows

a. Hydrology and Historic Instream Flows.

Even prior to the Concho water snake listing in 1986, a primary concern for the conservation of the species has been the potential impacts of habitat modification that occurs with reductions in instream river flow rates throughout its range (Scott and Fitzgerald 1985, p. 33). The source of these concerns originates from the storage and use of water for human consumption (primarily the damming and diversion of surface water for municipal uses) and the compounding effects of drought (natural rainfall levels below average). In the following discussions we analyze the sources, potential mechanisms, and possible effects arising from the threats related to the reduction of instream flows.

Beginning in eastern New Mexico, the upper Colorado River watershed, including the Concho River drainage, is semi-arid with average annual rainfall ranging from 15 to 35 inches (in) (38 to 89 centimeters (cm)) (TWDB 2007, p. 132). The area has a warm and windy climate that produces average annual gross lake surface evaporation of 65 to 80 in (165 to 203 cm) (TWDB 2007, p. 133). The water that produces river flows where the Concho water snake occurs originates exclusively from rainfall precipitation. This occurs through either direct surface runoff or natural groundwater storage of rainfall and then later discharge to surface flows through spring flows or seepage out of stream banks. The Colorado River generally increases in flow rate downstream, depending on rainfall, aquifer conditions, and water releases from reservoirs.

Since the early 1900s the upper Colorado River watershed (including the Concho River) has been modified to accommodate human water demands, primarily for agricultural irrigation (about 80 percent of all water used), municipal, and industrial uses. The construction of numerous reservoirs for surface water storage significantly affects the hydrology in every part of the river system and all of the snake's range. Most of the surface water storage in reservoirs is for municipal use, while groundwater pumping serves most agricultural irrigation needs. To assess the changes in stream flow conditions over time that have already occurred, we reviewed the flow data derived from stream flow gauges within the snake's range.

The USGS operates many stream gauges that monitor stream flow conditions within the range of the Concho water snake. Asquith and Heitmuller (2008, pp. 1–10) analyzed streamflow data in Texas using statistical tools to evaluate trends over time in low-flow discharge rates. A review of seven mainstem stream gauges within the range of the Concho water snake found statistically significant declining trends in mean streamflow over the period of record at six of these seven stream gauges. They also found significant declining trends in harmonic mean streamflow for the period of record at four of the seven gauges (Asquith and Heitmuller 2008, pp. 810–813, 846–853). The period of record encompassed by analysis of these gauges ranged from 39 to 100 years of data, ending in water year 2007. The ''harmonic mean streamflow'' is a statistic derived from daily mean streamflow and is commonly used as a design streamflow for contaminant load allocations by Texas Commission on Environmental Quality (TCEQ) to address the effects of dilution to protect human health and other aquatic life forms. It is a useful statistic for evaluation of low-flow conditions to explain hydrologic changes resulting from streamflow regulation, climate change, or land-use practices (Asquith and Heitmuller 2008, p. 2). Other abbreviated analyses of stream flows have also indicated substantial historical declines (Service 2004a, pp. 35–38; Forstner *et al.* 2006, pp. 13–16). Although annual precipitation in this region varies substantially from year to year (TWDB 2007, p. 135), an assessment of statewide annual average trends of precipitation and temperature across Texas suggested no significant changes over more than the last 100 years (TWDB 2007, pp. 299–300). This suggests that human-induced changes in land and water uses over the past 50 to 100 years have resulted in lesser overall flows in the rivers of the upper Colorado River watershed.

Asquith and Heitmuller (2008, p. 8) also analyzed the percent of days where the stream gauges recorded zero flow in the river. These data are important as they would be indicative of extreme environmental conditions that could cause stress to the snake or its fish prey base. For the period of record at these gauges, the results ranged from 0.1 percent of days with zero flow at the stream gauge near San Angelo on the Concho River to 9.3 percent at the stream gauge measuring outflow from Spence Reservoir. The outflow of Spence Reservoir had many no-flow days in the period of time prior to the listing of the snake when the District routinely did not release water from the reservoir. Over the 10 years from 1998 to 2007, the percent of zero-flow days ranged from none at two gauges on the Colorado River to 25.8 percent at the gauge on the Concho River at Paint Rock (Asquith and Heitmuller 2008, pp. 810–813, 846–853). These data demonstrate that there have been considerable periods of time in recent history where there has been no flow in the river where the snakes occur. Asquith *et al.* (2007b, pp. 469–473, 493–494) also summarized the percentage of zero-stream-flow days by month at USGS gauges and found the highest proportion of zero-stream-flow days at the seven gauges on the Colorado River within the snake's range occur during the months of July and August. For example, the stream gauge near Ballinger (located on the Colorado River between Spence and Ivie Reservoirs) had 5.1 percent of zero mean daily flow for all days from 1908 through 2003. Of the zero-flow days, over 15 percent occurred in each of the months of July and August, which was more than any other months (Asquith *et al.* 2007b, pp. 473). This may be a critical period in the life history of the snake because it is generally this time of year when female snakes give birth to young snakes (Werler and Dixon 2000, p. 216).

b. Future Instream Flows

To consider the expected water availability conditions in the foreseeable future within the upper Colorado River watershed, we reviewed the 2007 Texas State Water Plan. This planning document was developed from information provided by local regional water planning groups and it was approved by the Texas Water Development Board. It represents the best available information to use in forecasting the likely future water availability and use in Texas in the year 2060 (TWDB 2007, pp. 1–10). The range of the Concho water snake occurs in the Texas Water Planning Region F. Although this Region is somewhat larger than the upper Colorado River watershed, it is a reasonable area for us to consider for future water conditions in the range of the Concho water snake. The Region encompasses the entire upper Colorado River watershed and projections for the larger area would not be expected to differ greatly from the portion within the upper Colorado River watershed that comprises Concho watersnake habitat.

The projections from this water plan indicate that the overall human water use in Region F is expected to increase only slightly in the next 50 years. The human population is predicted to grow about 17 percent in the next 50 years, from 620,000 people in 2010 to 724,000 in 2060 (TWDB 2007, p. 43). Over the same time, the total water use in the region is expected to increase by only about 2 percent, from 807,453 acre-feet used in 2010 to 825,581 acre-feet in 2060 (TWDB 2007, p. 43). Agricultural irrigation demands are expected to decrease by 5 percent and make up 551,774 acre-feet in 2060, while municipal water demands are projected to increase 11 percent over the same period, to 135,597 acre-feet in 2060 (TWDB 2007, p. 44). Based on these projections, we do not foresee the threat of losses of instream flow substantially increasing beyond their current level in the next 50 years. However, the forecasting of future water conditions within this area has high uncertainty, largely due to the unpredictable climatic conditions (TWDB 2007, p. 297–299). The region is particularly susceptible to extreme drought, where precipitation is below average for extended periods of time (10 years or more), as the region experienced during the late 1990s and early 2000s (TWDB 2006, 1–60, 1–67). Droughts will certainly continue to occur and produce additional challenges to the water system of the upper Colorado River watershed.

An additional source of uncertainty for future instream flows is the potential effects of global climate change on water availability in this region. According to the Intergovernmental Panel on Climate Change, ''Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level'' (IPCC 2007, p. 1). Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007, p. 1). It is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007, p. 1). Data suggest that heat waves are occurring more often over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007, p. 1).

The IPCC (2007, p. 6) predicts that changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century. For the next two decades a warming of about 0.2 °C (0.4 °F) per decade is projected (IPCC 2007, p. 6). Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007, p. 6). Various emissions scenarios suggest that, by the end of the 21st century, average global temperatures are expected to increase 0.6 °C to 4.0 °C (1.1 °F to 7.2 °F) with the greatest warming expected over land (IPCC 2007, p. 6–8).

Localized projections suggest the Southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007, p. 8), with warming in southwestern States greatest in the summer. The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency, resulting in high intensity and variability of precipitation that increases flooding events and long periods of drought (IPCC 2007, p. 8). Modeling efforts evaluating climate change in this region of Texas have only recently been initiated (CH2M HILL 2008; Jackson 2008; Mace and Wade 2008; TWDB 2008). As with many areas of North America, this area (central and western Texas) is projected to experience an overall warming trend in the range of 2.5–3.9 °C (4.5–6 °F) over the next 50 to 200 years (IPCC 2007, p. 9; CH2M HILL 2008, p. 6–3; Mace and Wade 2008, p. 656). The IPCC (2007, p. 8) states there is high confidence that semi-arid areas, like the western United States, will suffer a decrease in water resources by mid-century due to climate change. Although more local precipitation models vary substantially, with some even predicting increased annual precipitation, a consensus is emerging that evaporation rates in central and western Texas are likely to increase significantly (Jackson 2008, p. 21; CH2M HILL 2008, p. 7–30, 7–31). Many models are also predicting that seasonal variability in flow rates is likely to increase with more precipitation occurring in the wet seasons and more extended dry periods (CH2M HILL 2008, p. 7–30; Jackson 2008, p. 19; Mace and Wade 2008, p. 656).

An evaluation of the hydrological impacts of climate change on the annual runoff and its seasonality in the upper Colorado River watershed was conducted by CH2M HILL (2008). Four modeling scenarios (chosen to represent a range of possible future climatic conditions) were each run under a 2050 and 2080 time scenario producing annual runoff estimates at 6 sites in this watershed. For the 2050 scenarios, the results from all 4 scenarios predicted declines in annual runoff at all 6 gauges ranging from 11 to 44 percent. Annual runoff at the stream gauge on the Colorado River at Ballinger, for example, was predicted to decline by 19 to 38 percent (CH2M HILL 2008, pp. A–1–A–4). For the 2080 scenarios, one model predicted increases in annual runoff ranging from 41 to 90 percent. The other three 2080 scenarios predicted declines in annual runoff ranging from 9 to 65 percent at 6 gauges. Annual runoff at the stream gauge at Ballinger was predicted to decline by 25 to 40 percent (CH2M HILL 2008, pp. A–1–A–4). However, the modeling efforts from this study focus on annual averages and do not account for the flooding events or long periods of drought. It is these specific extreme events that are important for maintaining habitat for the snake, and they cannot be reliably based on historic patterns upon which this study was predicated.

In addition, all climate change modeling has inherently large uncertainties due to the incorporation of many variables that are difficult, if not impossible, to accurately predict (CH2M HILL 2008, p. ES–1; Jackson 2008, p. 20). As an example, the Texas State Water Plan considered future global climate change to be a challenge for water availability forecasting in 2060. However, the uncertainties associated with climate change were very large in comparison with other uncertainties, such as those associated with population growth and water demand. As a result, the State did not believe that climate change concerns warranted specific planning measures at the time (TWDB 2007, p. 299). However, expected future warming from climate change could significantly increase potential evaporation rates in the region, in combination with expected reduced precipitation and extended droughts in western Texas.

c. Maintenance of Instream Flows

Efforts to minimize the potential impacts of reduced instream flows by securing minimum flow releases from the Colorado River reservoirs began with the 1986 BO. It included measures for the District to maintain certain flow conditions downstream of both Spence and Ivie Reservoirs (Service 1986, pp. 14–19) for the benefit of the snake and its habitat. These two reaches represent an estimated 57 percent of all snake habitat available and 69 percent of available high-quality habitat (Service 2004a, p. 70). These minimum reservoir releases were maintained by the District until 2004 (Service 2004a, pp. 43, 45) when the Service revised the 1986 BO and reduced the required flow rates from both reservoirs (Service 2004a, pp. 11–13). The analysis in the 2004 BO included updated biological information that the snakes use more diverse riverine habitats (such as pools, in addition to riffles) and were found in the reservoirs and tributaries (Dixon 2004, pp. 9, 16; Service 2004a, pp. 53–54). As a result of that consultation we gave our biological opinion that the reduced reservoir releases described in the proposed agency action were not likely to jeopardize the continued existence of the Concho water snake and were not likely to destroy or adversely modify designated critical habitat.

The Service determined that lower minimum flow rates were sufficient to maintain the habitat and populations of the Concho water snake (Service 2004a, pp. 53–54). The District will, to the extent there is inflow into Spence Reservoir, maintain a minimum flow in the Colorado River downstream of not less than 4.0 cubic feet per second (cfs) (0.11 cubic meters per second (cms)) during April through September and 1.5 cfs (0.04 cms) during October through March. To the extent there is inflow into Ivie Reservoir, the District will maintain a minimum flow in the Colorado River downstream of Ivie Reservoir of not less than 8.0 cfs (0.23 cms) during the months of April through September and 2.5 cfs (0.07 cms) during the months of October through March (Service 2004, pp. 11–12). The expectation for the District to implement the 2008 MOU and the expected extent of low-flow conditions are addressed in detail in discussions below.

When the Concho water snake is delisted, the minimum flow requirements required by the 2004 BO will no longer apply. However, the purpose of the 2008 MOU is for the District to provide assurance that minimum reservoir releases will continue in perpetuity, consistent with the 2004 Biological Opinion (BO, Service 2004a, pp. 11–12). The releases are the same as those required in the 2004 BO, and the District has agreed to maintain these flows, to the extent there is inflow, when the Concho water snake is removed from the Federal list of threatened species. The 2008 MOU acknowledges the Service's ability to add the Concho water snake back to the list of protected wildlife, even under emergency listing provisions, if future conditions warrant.

We have confidence that the District will implement the MOU in good faith after the Concho water snake is removed from the threatened list. The District has implemented every activity requested by the Service in previous biological opinions beginning in 1986 (Service 2004a, p. 42–47). The minimum flows required in the 2004 BO have been implemented by the District, and those flow requirements were duplicated in the 2008 MOU. The District has an excellent track record of carrying out conservation actions to benefit the Concho water snake (Freese and Nichols 2006, pp. 6.1–6.13). In addition, the post-delisting monitoring plan for the Concho water snake includes monitoring of instream flows to monitor stream conditions and verify that flows called for in the 2008 MOU are being realized.

The District has maintained flows from both Spence and Ivie Reservoirs. This is demonstrated by measures of the daily median flow at two gauges downstream of the reservoirs. Daily median flows (*i.e.,* the number where half the recorded flows are higher and half are lower within a given day of records) provide a better assessment for this purpose than the daily mean flow, which would be skewed higher due to very short-term high-flow flood events. Daily median flows (calculated for each calendar day from the mean daily discharges for the time period referenced) in the reach of the Colorado River below Spence Reservoir (as measured at the USGS gauge near Ballinger since Spence Reservoir was constructed, 1969–2007) exceeded 4.0 cfs (0.11 cms) in the summer (April through September) all but 12 days out of a total of 183 days. During the winter (October through March), daily median flows always exceeded 1.5 cfs (0.04 cms). Daily median flows in the reach of the Colorado River below Ivie Reservoir (as measured at the USGS gauge at Winchell since Ivie Reservoir was constructed, 1990–2007) exceeded 8.0 cfs (0.23 cms) in the summer (April through September) all but 15 days out of a total of 183 days. During the winter (October through March), daily median flows always exceeded 2.5 cfs (0.07 cms). Based on these past actions, we believe that the District will continue to maintain instream flows in the foreseeable future.

The 2008 MOU allows the District to reduce or discontinue minimum flow releases below either reservoir based on inflow or when water storage in that reservoir falls below about 12 percent of capacity. Since Spence Reservoir was initially filled in 1971, the water level elevation has only been below this mark during the period from 2002 to 2004, at the end of a prolonged drought from 1992 to 2003 (District 2005, pp. 39–43). Ivie Reservoir has not been below this mark since it initially filled in 1991 (District 2008, pp. 1–2). Based on the historic record and the foreseeable future of about 50 years, we would expect these conditions to occur infrequently. Using data from Spence Reservoir where this storage level has occurred, it has happened less than 10 percent of the time since 1971 (3 years out of 37 years of operation).

We also anticipate that small amounts of water and minimal stream flows will still be present at most times of the year in the gaining reaches of the Colorado River and below Spence and Ivie Reservoirs due to dam leakage and seepage, contributing inflow from creeks and sub drainages, and discharges from springs where shallow groundwater interfaces with the stream (Dixon 2004, p. 9). The gaining nature of the river reach downstream of Spence Reservoir is particularly evident as both the annual mean flow and harmonic mean streamflow increased between the stream gauge measuring outflow of the reservoir and the gauge at Ballinger, some 50 mi (80 km) downstream (Asquith and Heitmuller 2008, pp. 810–813). This gaining stream trend is greatly controlled by ambient weather conditions. For example, during periods of long-term drought (more than 10 years), the tributaries and springs will cease flowing or have significantly lower flow. However, during average rainfall periods, these sources of water help to restore and maintain more stable instream flows in the main rivers (Service 2004a, p. 50). Additionally, even when releases from dams have ceased, normal seepage from a dam occurs and provides for the formation of pools (large and small) that can provide habitat for the Concho water snake and the fish it preys upon for varying periods of time. When dam releases are resumed, the pools (located upstream of low-head dams and up and downstream from spring areas) that may have served as refuge habitat are reconnected by flowing water (Dixon 2004, p. 16).

Texas water law requirements also result in maintenance of some instream flow. Texas observes traditional appropriative water rights, which is also known as the ''first in time, first in right'' rule (see Texas Water Code § 11.027). The State's water policy requires the TCEQ to set, to the extent practicable, minimum instream flows to protect the State's water quality when issuing water rights permits (see Texas Water Code § 11.0235(c)). Furthermore, Texas water law prohibits the owner of stored water from interfering with water rights holders downstream or releasing water that will degrade the water flowing through the stream or stored downstream (Texas Water Code § 297.93). The District's 1985 water rights permit associated with Ivie Reservoir (TCEQ 1985, Permit #3676, p. 4) requires the District to maintain minimum flows below Ivie Reservoir of 8 cfs (0.23 cms) from April through September and 2.5 cfs (0.07 cms) from October through March (consistent with flows called for in the 2008 MOU). Flows are often also provided downstream of both Spence and Ivie Reservoirs to ensure water quality and provide for downstream water rights. Releases from Spence Reservoir are periodically made to improve the quality of water entering Ivie Reservoir. Spence Reservoir is known to be high in dissolved solids and chlorides (District 2005, pp. 24–27), so if flows into Spence Reservoir are low, water quality in the reservoir can become degraded unless high volumes of water are released. Therefore, long-term low-flow releases or no releases from Spence and Ivie Reservoirs are rare unless an emergency situation occurs.

d. Response of Species to Reduced Instream Flows

We considered the potential impacts on the Concho water snake of reduction of instream flows from water management actions. We also considered the effects of short-term large-magnitude instream flow declines resulting from droughts that are expected to occur in some frequency over the next 50 years in the foreseeable future. In summary, we found that the best available information from numerous ecological studies by snake experts supports the conclusion that the species is well adapted to endure the occasional conditions of extreme low flows or periodic cessation of flows.

There are no specific studies that have evaluated the effects of declining instream flows on the snake's habitat or populations. However, we can assume that the linear extent of dewatered riverine habitats during extended drought periods could be quite large and the length of time without flows could extend for several months or more (Service 2004a, p. 51). These habitat modifications could impact the snake by decreasing reproductive success during the summer months, reducing the snake's fish prey base, or reducing over-winter survival during their hibernation period.

Recent monitoring studies have provided observations that suggest Concho water snakes have the ability to survive extreme low-flow periods. For example, Elm Creek had experienced a number of extended no-flow periods over several years prior to 2004 and then flooded in August 2004. A review of the flow data from the USGS stream gauge on Elm Creek near Ballinger found 44 percent of all days between January 2000 and July 2004 recorded no discharge. In September 2004, Dixon (2004, p. 11) noted Concho water snakes inhabited the site. Dixon (2004, p. 12) surmised that snakes either moved from the mouth of Elm Creek at the Colorado River (a distance of 4.6 mi (7.4 km)), or existed in deep pools somewhere within a returnable distance to the site. Another example of snake persistence during dry times was the drying of Ballinger Lake in 2004 and confirmation of reproductive snakes in the lake in 2005 following rains (Dixon 2004, p. 4; Forstner *et al.* 2006, p. 15; Whiting *et al.* 2008, p. 443).

The best demonstration of the Concho water snake's endurance of low-flow conditions is found in the Concho River. Two large dams on the Concho River just upstream of the City of San Angelo capture essentially the entire upper Concho River watershed. There have never been minimum flows purposely provided for the snake in the Concho River. This has resulted in extreme low flows in the downstream reaches. We presume the low flows are maintained from small gains from groundwater discharge or return flows (Dixon 2004, pp. 8–9). Since 1916, the annual mean streamflow at the flow gauge at Paint Rock on the Concho River has declined from 136 cfs (3.85 cms) for the 92-year period of record down to 24.8 cfs (0.7 cms) for the recent 10 years from 1998 through 2007. The harmonic mean streamflow at this gauge has declined from 1.0 cfs (0.03 cms) for the period of record to 0.3 cfs (0.01 cms) for the recent 10 years (Asquith and Heitmuller 2008, pp. 849–850). Over the same time periods the gauge has recorded zero flow for 8 percent of the days for the period of record and 25 percent of the days from the recent 10 years (Asquith and Heitmuller 2008, pp. 849–850). These flow data represent extreme low-flow conditions resulting from long-term human water use and recent short-term drought and have been accompanied by degradation of habitat by silting in of the stream and encroachment of vegetation (Dixon 2004, pp. 8–9). Despite this apparent long-term habitat modification, the snake continues to persist in this reach, and Forstner *et al.* (2006, p. 8) found the highest numbers of Concho water snakes (20 of all 45 snakes captured or observed during their brief surveys) in this reach of the Concho River.

The mechanism for persistence in these conditions of long periods of drought, according to Dixon (2004, p. 9), is the ability of the snakes to use pools of water that form upstream of low-head dams (small private dams, a few feet tall, that create pools upstream and riffle-like areas downstream). Within both the Concho and Colorado Rivers, these pools can extend two-thirds of a mile (1 km) or more up river (depending on dam height). The riffles and pools that lie upstream of these low-head dams may not completely dry up because of small springs and creeks nearby. These pools act as refuges for juvenile and adult Concho water snakes when measurable flow ceases (Dixon

2004, p. 9). Concho water snakes have been located in pools behind low-head dams along the Colorado River, and Dixon (2004, p. 9) states that it is reasonable to expect the small pools behind low-head dams on the Concho River to act in the same way. Also, even during drought, water continues to flow over bedrock in some areas, and snakes have been observed foraging for fish in the diminished flow. The extent of solid bedrock in some of the riffle systems tends to maintain the nature of the riffle and does not allow vegetation to root and collect debris and silt (Dixon 2004, p. 9).

Another way the snakes may endure drying conditions is to use deep burrows for over-winter hibernacula (shelters for hibernating snakes). Greene (1993, pp. 89, 94) found Concho water snake hibernacula within 19.7 ft (6 m) of water with a mean depth of 1.7 ft (0.52 m). Hibernacula types included crayfish burrows, rock ledges, debris piles, and cracks in concrete of low water crossings for adults and loose embankments of rock and soil for juveniles. Dixon (2006, p. 2) stated that during droughts the snakes were possibly in the crayfish burrows, since they may retain moisture longer.

Lack of forage fishes available for prey by the snakes is another reason that drought and resulting decreasing flows could impact Concho water snakes. Fish are the principal food of the Concho water snake (Williams 1969, pp. 9–10; Dixon *et al.* 1988, p. 16; 1989, p. 8; 1990, p. 36; 1992, p. 6; Thornton 1990, p. 14; Greene *et al.* 1994, p. 167). At the time of listing, we believed that declining flows, inundation, pollution, and other habitat threats would have adverse impacts on riffle-dwelling fish (51 FR 31419). However, the snakes are not species-specific and have been shown to take advantage of whatever small-bodied species is most abundant. A review of the 10 years of fish surveys by the District from 1987 to 1996 showed that the snakes were opportunistic predators on a variety of fish species (Thorton 1992, pp. 16–34; Service 2004a, pp. 68–69). The most abundant fish available and in the snake diet are fish species that are adapted to harsh stream conditions (intermittent flow and poor water quality), such as red shiners (Burkhead and Huge 2002, p. 1) and fathead minnows (Sublette *et al.* 1990, pp. 162–166). Together these two fishes made up two-thirds of the diet of the Concho water snakes. Because of their ability to withstand harsh stream conditions, we expect these fish species to persist in the harshest environments, and they can recolonize stream reaches after dewatered conditions end. In addition, information indicates the snake is able to survive in captivity for up to 12 months with a reduced food supply (Dixon 2006, p. 2). This suggests that the snakes can endure a short-term absence of food resources when forage fish are scarce. The periodic loss of stream flows due to drought will impact fish availability in the river, but the snakes are adaptable to prey upon whatever fish species survives the low flows or survive without food for short periods.

e. Summary of Habitat Modification From Reduced Instream Flows

In conclusion, we expect extreme low-flow and drying river conditions to occur only rarely within most of the range of the snake. However, when extreme drought (10 years or more of below-average annual precipitation) does occur, the snake is adapted to withstand harsh conditions. Species experts are confident that the Concho water snake has evolved and adapted for thousands of years through many documented extreme droughts (Forstner *et al.* 2006, pp. 17–19). Forstner *et al.* (2006, pp. 16, 20) indicate that, despite the inevitable impacts and future stressors on this taxon by anthropogenic and natural cycles, the snake has persisted in an environment for the past several millennia that has seen ''frighteningly intense periods of drought.'' The Concho water snake has survived historically under extreme drought and low-flow conditions (Forstner *et al.* 2006, p. 22). Climate change could alter the overall water availability and seasonality of flows in the range of the snake, but the uncertainties associated with forecasting the effects of climate change and where they will occur are so great, relative to the threats of population growth and water demand, that the State did not believe that it warranted planning efforts. Because of the high uncertainty on the effects of climate change, we cannot reliably predict if river conditions in the foreseeable future will be significantly worse than historical conditions. Thus, we find that the threat of habitat modification from the reduction of instream flows caused by reservoir operations and drought is not likely to endanger the Concho water snake in the foreseeable future.

Habitat Modification From Reduced Channel Maintenance Flows

At the time of listing, we were concerned that the construction of Ivie Reservoir would prevent floodwater scouring by large flows that serve to maintain natural river conditions. Channel scouring occurs when flood waters transport silt and fine materials downstream and displace encroaching vegetation from the river channel. In other words, large flood events serve to physically displace vegetation growing in the silt and sand along the banks within the stream channel. These channel maintenance flows are important to remove the fine substrates and vegetation and maintain the riffles, gravel bars, and rocky stream bank habitats often used by the snakes as foraging habitat. Without such flooding, riffle habitat is modified as the rocky streambed becomes covered with silt and vegetation becomes established and armors the stream bank. Riffle habitat creates sites for reproduction and habitat for small fish that young snakes prey upon. Although in some reaches, such as some sites on the Concho River, the dominant substrate is solid bedrock, and the cracks and breaks in the rock serve the same purpose as riffles as a place for snakes to feed (Dixon 2004, p. 9).

Asquith *et al.* (2007a, pp. 469–473, 491–494) analyzed trends over time for the annual maximum streamflow and found statistically significant declining trends in flow during the period of record at six of the seven gauges on the Concho and Colorado Rivers within the range of the Concho water snake. Also, review of the hydrograph of the daily stream flow data for the period of record at these seven stream gauges shows a decline in the frequency and duration of high-flow events (Asquith and Heitmuller 2008, pp. 810–813, 846–853).

However, some high flows continue to occur naturally even during recent drought periods. For example, over the 10 years from 1999 to 2008 the USGS stream gauge on the Colorado River near Ballinger, downstream of Spence Reservoir, recorded streamflow events of over 1,000 cfs (28 cms) in 6 of the 10 years and had a peak flow of over 9,500 cfs (270 cms) in June of 2000 (USGS 2008). For the same time period at the gauge at Winchell, downstream of Ivie Reservoir, 9 years had flow events exceeding 1,000 cfs (28 cms) with a peak flow of 16,500 cfs (470 cms) in July 2002 (USGS 2008). The gauge at Paint Rock, on the Concho River, also had streamflow events exceeding 1,000 cfs (28 cms) for 9 of the 10 years with a peak flow of over 5,000 cfs (140 cms) in November 2004 (USGS 2008). In addition, the 2008 MOU with the District calls for periodic high rates of discharges to manage water quality in the reservoirs. These releases could be coupled with flood runoff events and may function as channel maintenance flows. We have no reliable means to reasonably forecast the frequency and occurrence of future high flows in the river. However, some global climate change models are indicating a possible future trend of more precipitation occurring during wet seasons (Mace and Wade 2008, p. 656), although there is substantial uncertainty with future predictions. If this occurs over the next 50 years, it could increase the number and magnitude of high discharge events that would serve as channel maintenance flows in the range of the Concho water snake.

One consequence of reduced flushing flows is the increase in abundance of salt cedar (*Tamarisk* sp.), a nonnative species of tree that was introduced to the United States in the 1800s from southern Europe or the eastern Mediterranean region (DiTomaso 1998, p. 326). In the watersheds of Spence and Ivie Reservoirs, these plants are abundant and have been reported to have affected water quality and quantity because they consume large volumes of water and then transport salts from the water to the surfaces of their leaves. When the leaves are dropped in the fall, the salt is concentrated at the soil surface (DiTomaso 1998, p. 334; Freese and Nichols 2006, p. 5.5). The lack of flushing flows in the rivers allows these invasive plants to become established in the fine substrates along the banks and eventually reduce the amount of gravel and rocky stream substrates.

In an effort to increase water yield and reduce salt concentrations in Spence and Ivie Reservoirs, the District, in cooperation with the Texas Cooperative Extension Service, the Texas Department of Agriculture, the U.S. Department of Agriculture-Agricultural Research Service, and the Texas State Soil and Water Conservation Board (TSSWCB), has initiated a salt cedar control project in the Upper Colorado River Basin. The program includes spraying an herbicide to eradicate mass concentrations of salt cedar and then using a leaf beetle for biological control of new plant growth (Freese and Nichols 2006, p. 6.4). According to Freese and Nichols (2006, pp. 6.5–6.6), this project ''is an excellent first step in the recovery of the Upper Colorado River Basin back to many of its [pre-infestation] functions, including native riparian habitat for wildlife and improved habitat for fish and other aquatic organisms,'' and is ''one of the most crucial options for improving water quality and quantity.'' We have no information that the herbicide to be used (Arsenal) poses a direct poisoning threat to the Concho water snake and a previous section 7 consultation found only beneficial effects to the species (Service 2004b, p. 39).

Additionally, control programs for invasive brush species, such as juniper (*Juniperus* sp.) and mesquite (*Prosopis* sp.), are also being implemented in the Concho and Upper Colorado River Basins to increase water quantity (TSSWCB 2004, pp. 2–3; Freese and Nichols 2006, p. 6.6). The TSSWCB is focusing above O.C. Fisher and Twin Buttes Reservoirs upstream of San Angelo on the Concho River and over 175,000 acres (70,820 hectares) of invasive brush have been treated in these watersheds (TSSWCB 2004, pp. 2–3). The removal and control of salt cedar and other invasive brush from the riparian reaches of the Colorado and Concho Rivers helps augment existing stream discharge and also reduces buildup of dissolved solids (salts) in the soils of the riparian zone (Service 2004a, p. 56). Additionally, this removal encourages reformation of riffle areas, increases stream flow, and reduces sediment deposition, which improves instream habitat for the Concho water snake and other aquatic species (Freese and Nichols 2006, p. 6.6).

While both Dixon (2004, pp. 8–9) and Forstner *et al.* (2006, pp. 12, 15) document degradation of riffles from siltation, there are still numerous riffles throughout the range continuing to support Concho water snakes (Dixon 2004, pp. 5–8). In their recent survey of the Concho water snake and its habitat, Forstner *et al.* (2006, pp. 14, 16) found that the lack of flushing flows has allowed silt to settle and cover many of the riffles at historically occupied sites and that several sites have changed from riffles to slow-flowing sandy sections of river. Sand and silt fill in graveled cobble substrate and provide areas for growth of salt cedar and other vegetation, which further eliminates the rocky-bottomed riffle areas required by Concho water snakes (51 FR 31419; Scott and Fitzgerald 1985, p. 13; Forstner *et al.* 2006, p. 15). These changes are particularly evident at sites on the Concho River (Dixon 2004, p. 9). However, despite some riffle habitat loss and the presence of other system stressors, Forstner *et al.* (2006, p. 18) noted that the Concho water snake persisted and continued to reproduce at the majority of the sites they visited. In fact, the Concho River, where degradation has been most evident, contained the largest number of Concho water snakes captured by Forstner *et al.* (2006, p. 8).

Dixon (2004, p. 9) indicated that changes in the Concho River where the lack of flushing flow has allowed the accumulation of vegetation and debris likely caused the adult and juvenile snakes to retreat to refuge habitats in nearby pools and to areas where water flows over bedrock. Although some changes have occurred in the riverine habitat as a result of the loss of channel maintenance flows over time, the snakes appear to be adaptable to using other habitats and maintaining populations despite these changes. Therefore, we find that the threats associated with habitat modification from the reduction of frequency and magnitude of high-discharge channel-maintenance flows are not likely to endanger the Concho water snake in the foreseeable future.

Habitat Modification From Fragmentation

At the time of listing, we believed construction of Ivie Reservoir (Freese Dam) would likely segment Concho water snakes into three separate populations and thereby reduce genetic exchange (Scott and Fitzgerald 1985, p. 34). Prior to the snake's listing in 1986, no researchers had documented Concho water snakes traveling over land to circumvent the barriers caused by large dams, and snakes had not been located in reservoirs. Due to this separation, a reasonable and prudent measure in the 1986 BO was to transfer snakes annually between the river reaches separated by the dam. In 1995, four male snakes were moved from below Ivie Reservoir to river habitats above the Reservoir (District 199, p. 1). In 2006, five adult male snakes and one adult female snake were captured below Ivie Reservoir and released in the Concho River upstream of Ivie Reservoir (District 2006, pp. 1–2). Also in 2006, three male snakes and one female snake were transferred from the Concho River to Spence Reservoir (District 2006, pp. 3–4).

Because we now know Ivie Reservoir, which receives flow from both the Concho and Colorado Rivers, is occupied by the snake, we believe it is reasonable to surmise that snakes are capable of genetic interchange between the Concho and Colorado Rivers via the reservoir's shoreline. The District (1998, p. 14) summarized Concho water snake habitat within Ivie Reservoir and found that although the habitat is not linearly consistent, it does occur throughout the reservoir. Concho water snakes have been documented in mark-recapture studies to move up to 12 mi (19 km) (Werler and Dixon 2000, p. 212). Based on the occupancy of reservoirs by the snakes and the ability to move large distances, we have a high level of confidence that gene flow occurs between these river reaches.

In 2005 surveys, Forstner *et al.* 2006 (pp. 10–13, 18) found that Concho water snakes were reproducing in the Concho and Colorado Rivers above Ivie Reservoir and in the Colorado River below it; they concluded that the populations in those three river reaches were self sustaining and seemingly viable (Forstner *et al.* 2006, pp. 16–18, 20). The 2008 MOU, as amended in 2011 and described above, Article 4.1 also provides that, in the springtime at 3-year intervals, the District, in coordination with the Service, should move five male snakes from below Spence and Freese dams to above these dams and move five different male snakes from above to below both dams. Moving snakes will be dependent upon availability of funding for the District. If the District is unable to carry out the snake movements, the Service will work with TPWD or other partners to ensure it occurs. We believe this movement will benefit the snake by enhancing genetic exchange between the three river reaches. The periodic movement of five snakes is believed to be sufficient to mimic natural gene flow (Sites and Densmore 1991, pp. 10–11) and reduce potential effects of genetic isolation among separated populations. This level of exchange exceeds the rule-of-thumb minimum of one individual exchanged with each generation (Mills and Allendorf 1996, p. 1,557). Should funding be unavailable in any particular snake-moving year, every effort will be made to move snakes in the succeeding year.

Based on the available information, we do not believe the species is likely to become endangered in the foreseeable future due to genetic isolation or habitat fragmentation.

Habitat Modification From Pollution and Water Quality Degradation

At the time of listing, we believed buildup of algae in riffle areas reduced oxygen and nutrients available to populations of fish, the Concho water snake's primary food (51 FR 31419). We were also concerned that the inflow of nutrients into the Concho River in the San Angelo area, along with reduced dilution capability associated with lower flows, created large concentrations of algae in portions of the river (51 FR 31419). A summary of the 1987–1996 fish surveys in the Colorado and Concho rivers, included in the Service's 2004 BO (Service 2004a, Appendix A, pp. 68–69), suggested that fish populations have persisted despite the presence of algae. Also, no impacts to snakes have been observed or documented as a result of water quality conditions during the ongoing drought (Service 2004a, p. 52). We have no further indication that algae buildup has occurred or has impacted the snake or its prey base. Therefore, we no longer consider algal growth and nutrient enrichment to be significant threats to the snake's survival.

The Texas State Legislature implemented the Texas Clean Rivers program in 1991. The District has actively participated in the program since that time and monitors surface water quality in the upper Colorado River basin, which includes the distribution of the Concho water snake above Freese Dam (District 2005, p. 28). The LCRA has the responsibility for water quality monitoring below Freese Dam. Both of these entities have participated in the Clean Rivers Program since 1991 and have provided a proactive response for ensuring a high level of surface water quality in the Colorado River and its main stem reservoirs (LCRA *et al.* 2007, pp. 3–4). These programs (including routine chemical and biological monitoring, environmental education, oil field clean up, superfund site cleanup, and well plugging) are ongoing and designed to ensure water quality integrity for all aquatic resources, including the Concho water snake and fish, its primary food source, in the upper basin (LCRA *et al.* 2007, pp. 13–15, 22, 28, 33–34). As water quality problems (biological or chemical) are detected, swift responses by the District and LCRA to affect corrective actions through State of Texas regulatory agencies (TCEQ and the Texas Railroad Commission) are completed (Service 2004a, pp. 52–53).

Additional water quality protections for Concho water snakes in riverine and reservoir habitats will continue indirectly under the Clean Water Act (CWA). According to the U.S. Environmental Protection Agency (2006, p. 1), the CWA establishes basic structures for regulating discharges of pollutants into United States waters, protecting water quality for species dependent on rivers and streams for their survival. Discharges are controlled through permits issued by TCEQ; within the range of the Concho water snake, these permits are mainly to small towns. With human population growth in the region forecasted at relatively small rates (estimated 17 percent increase) over the next 50 years (TWDB 2007, p. 43), we do not predict any significant increase in this threat in the foreseeable future.

Based on the lack of information documenting effects of pollution or water quality degradation on snake populations and the ongoing efforts of water agencies to monitor and maintain healthy water quality, we find that the pollution and water quality degradation is not a significant threat to the Concho water snake.

Summary of Factor A Threats

The Concho water snake was listed in 1986 largely due to threats to its habitat from the potential for habitat modification resulting from the construction and operation of reservoirs within its range. Since the listing, the snake has been shown to be more abundant and widespread than originally thought and capable of surviving in reservoirs (District 1998, pp. 18–29). Reservoir operations have provided continual stream flows that have sustained the habitat for the species, even during an extreme drought, and we expect minimum reservoir releases to continue into the foreseeable future. In addition, the snake has been shown to be equipped to handle stochastic environmental fluctuations, such as low stream-flow conditions, and has demonstrated the ability to persist even when habitat conditions appear to be less than favorable (from reservoir inundation, low river flows, or silting in of riffles) (Forstner *et al.* 2006, pp. 13–18; Whiting *et al.* 2008, p. 443). Additionally, habitat restoration efforts such as the removal of salt cedar and other brushy species and the creation of artificial instream riffle structures are aimed at improving habitat for the Concho water snake and other aquatic species. Other potential threats to snake habitat from reduced flushing flows, fragmentation, and pollution and water quality degradation have not been found to occur at the level anticipated when the species was listed in 1986, and no impacts to the Concho water snakes have been documented.

Therefore, we believe that destruction, modification, or curtailment of the Concho water snake habitat or range due to habitat loss, altered instream flows and floodwater scouring, drought, vegetation encroachment, fragmentation, and pollution no longer threaten the Concho water snake with becoming endangered in the foreseeable future of about 50 years.

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

At the time of listing, Concho water snakes were known to sometimes be captured or killed by recreationists (51 FR 31420). The effect of this activity on Concho water snake populations was and still is believed to be minimal. However, instances of Concho and Brazos (a closely related species occurring in an adjacent drainage) water snakes being killed have been reported in both populated and unpopulated areas (Werler and Dixon 2000, p. 215). For example, Brazos water snakes have been crushed under stones at the water's edge by people walking on the banks and snakes have been shot by small caliber firearms. Concho water snakes may be confused with poisonous species of snakes. Fishermen have commented on their success in removing the ''water moccasins'' from the river (Forstner *et al.* 2006, pp. 18–19). At one of the historically most productive localities for Brazos water snakes, Forstner *et al.* (2006, p. 18) found no snakes in two years of searching. They noted dozens to hundreds of campers at the site each year. According to Dixon (2004, p. 2), there is not as much recreation occurring on the Concho and Colorado rivers, where the Concho water snake occurs, as there is on the Brazos River. The vast majority of the range of the Concho water snake occurs in remote, rural locations with very limited human access or use of the river. This fact suggests there is limited opportunity for direct mortality by humans. Even in areas with high recreational use, such as Paint Rock Park (a city park on the Concho River) the snake was still collected there in relatively large numbers in 2005 (Forstner *et al.* 2006, p. 8). We are unaware of any plans to increase recreational opportunities on the Colorado and Concho Rivers. Therefore, we believe that impacts from recreationists will continue to be minimal in the foreseeable future in the areas occupied by Concho water snakes.

While some limited killing of snakes is likely still occurring, there is no indication that any possible mortalities are affecting the species population levels, either rangewide or locally. Werler and Dixon (2000, p. 215) stated that malicious destruction of Concho water snakes ''probably does not constitute a major cause of mortality.'' We also have no reason to believe that this threat is likely to increase in the future.

Therefore, we find that mortality from this factor is not likely to cause the species to become threatened or endangered in the foreseeable future.

C. Disease or Predation

At the time of listing, no problems of disease or predation on Concho water snakes were known to exist (51 FR 31420). While currently no disease problems are known, predators on Concho water snakes have been identified. As is true for most snakes, predation by other wildlife is considered a major natural source of mortality for Concho water snakes (Werler and Dixon 2000, p. 215). Predators documented to prey on Concho water snakes include kingsnakes (*Lampropeltis getula*), coachwhip snakes (*Masticophis flagellum*), racers (*Coluber constrictor*), raccoons (*Procyon lotor*), and great blue herons (*Ardea herodias*) (Williams 1969, p. 15; Dixon *et al.* 1988, p. 18; Greene 1993, p. 102). Raptors such as hawks (*Buteo* spp.) and falcons (*Falco* spp.) are also known to prey upon snakes (Steenhof and Kochert 1988, p. 42). Predatory fish include bass (*Micropterus salmoides*) and channel catfish (*Ictaclurus punctatus*) (McGrew 1963, pp. 178–179; Jordan and Arrington 2001, p. 158). However, all of these predators are native to this region, Concho water snakes evolved tolerating predation by these species, and we have no information indicating that the natural levels of predation are likely to increase.

Therefore, we find that impacts from predation by other wildlife are not likely to cause the Concho water snake to become threatened or endangered in the foreseeable future.

D. The Inadequacy of Existing Regulatory Mechanisms

The Concho water snake was listed as endangered by the State of Texas in 1984. In 2000, it was removed from the State's list of threatened species (TPWD 2000, p.3) because TPWD no longer considered it likely to become endangered based on the information provided by the District (District 1998); therefore, it will not protect Concho water snakes if we delist the species. However, the lack of protection of the Concho water snake by the State is not considered a threat because TPWD regulations only prohibit the taking, possession, transportation, or sale of designated animal species without the issuance of a permit. There is no protection by State law for the habitat of state-listed species. Since the Concho water snake is not threatened due to taking, possession, or sale of individuals, the lack of State protections does not affect the status of the species.

The Texas Clean Rivers program, the Clean Water Act, and other Texas water law requirements, all discussed earlier under Factor A, provide some benefits to protect the habitat of the Concho water snake. These programs, in conjunction, with natural stream inflows and minimum flows from dam operations, indirectly conserve riverine habitats for the species.

As a result, inadequacy of existing regulatory mechanisms does not constitute a threat to the Concho water snake such that it is likely to become endangered in the foreseeable future.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

We are unaware of any other natural or manmade factors affecting the continued existence of the Concho water snake at this time.

Conclusion of the Five-Factor Analysis

Foreseeable Future

In considering the foreseeable future in the threats analysis for the Concho water snake, we generally regarded about 50 years as a timeframe where some reasonable predictions could be made. This range of time originated from the analysis of forecasting for water management, which is looking ahead to expected conditions in the year 2060 (TWDB 2007, p. 2), and consideration of climate change models, which typically forecast 50 to 100 years into the future; however, there was too much uncertainty with the 100-year timeframe to serve as a reasonable foreseeable future (Jackson 2008, p. 8; Mace and Wade 2008, p. 656). Since habitat modification from changing stream flows as a result of water availability and management is the primary threat of concern, this timeframe is appropriate for our analysis. This is also a reasonable timeframe for analysis considering the biology of the Concho water snake. The snakes become sexually mature at 2 or 3 years old and reproduce annually (Werner and Dixon 2000, p. 216), with a likely lifespan rarely exceeding 5 years (Mueller 1999, p. iii; Greene *et al.* 1999, p. 707). A 50-year timeframe would encompass about 10 lifespans and multiple generations for the species. Considering multiple generations is important for any possible changes over time in rates of reproductive success and recruitment (growth to adulthood). This timeframe also captures the future stochastic hydrologic conditions (particularly droughts of 10 years or more and floods) and the expected responses by a short-lived, fast-growing species such as the Concho water snake.

Application of the Recovery Plan's Criteria

The recovery plan provides important guidance on the direction and strategy for recovery, and indicates when a rulemaking process may be initiated; the determination to remove a species from the Federal List of Endangered and Threatened Wildlife is ultimately based on an analysis of whether a species is no longer endangered or threatened. The following discussion provides a brief review of the recovery criteria and goals as they relate to evaluating the status of the species.

Recovery Criterion 1: Adequate Instream Flows

The 1993 Recovery Plan called for assurance of adequate instream flows to maintain both the quantity and quality of Concho water snake habitat so that occupied habitat would continue to support viable populations of the species (Service 1993, p. 33). At the time the recovery plan was completed, adequate instream flow rates were based on the constituent elements identified in the 1989 critical habitat designation (54 FR 27382) and the reasonable and prudent alternatives identified in the 1986 BO for the construction of Ivie Reservoir. However, as the following new information became available, our understanding of the instream flow requirements necessary to support viable population of the Concho water snake has changed substantially. The topics summarized here are discussed at length above in section *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Habitat Modification from Reduced Instream Flows.

First, lower flow rates have supported reproductive snake populations despite extended droughts. The revised lower flow rates were found adequate to support riverine habitat for the snake (Service 2004a, pp. 50–52). This was based on new information from numerous studies funded by the District in the 1990s that greatly added to our knowledge of the biology of the snake and its habitat (District 1998, pp. 18–29). Additional monitoring of the snake indicated that the population was sustained by the lower flows required in the 2004 BO (Forstner *et al.* 2006, pp. 13–18). While riverine habitat is important for the conservation of the snake, the need to maintain continuous flows at levels previously required were determined to no longer be necessary to provide adequate habitat for snakes. The flows described in the Recovery Plan and the specific flows included in the 1989 critical habitat designation were based on the best scientific information at that time. However, subsequent information provided by species experts Forstner, Dixon, and Thornton indicates that the snake will survive, reproduce, and maintain population viability with less stream flow.

Second, information on the snake's habitat indicates they are more of a generalist (Dixon 2004, pp. 8–9) occurring in reservoirs and pools in rivers and do not depend on the previously accepted narrow habitat requirements restricted to riffles in rivers (Dixon 2004, 14–16). In addition to riverine habitat, the snake is known to use areas above and below low-head dams, pools created by the dams, man-made lakes, naturally occurring pools in the river, and tributaries, as Concho water snake has been found in Elm Creek and two of its tributaries.

Third, adequate flow to maintain the snake's habitat and the snake population is provided by a variety of sources in addition to the minimum flows agreed to in the 2004 BO (Service 2004a, p. 11–12), and subsequently agreed to in the 2008 MOU. We expect minimal stream flows will be present at most times of the year in the gaining reaches of the Colorado River from contributing inflow from creeks and subdrainages, and discharges from springs where shallow groundwater interfaces with the stream (Dixon 2004, p. 9). Low flows are also present below Spence and Ivie Reservoirs due to dam leakage and seepage even when no releases are being made (Dixon 2004, p. 9). In addition, Texas water law requirements also result in maintenance of some instream flow, particularly in the river reach below Ivie Reservoir where the District's water right permit requires minimum flows of 8 cfs (0.23 cms) from April through September and 2.5 cfs (0.07 cms) from October through March. Finally, dam releases from Spence Reservoir are periodically made to improve the quality of water (by diluting the salt content) entering Ivie Reservoir. All of these sources help maintain instream flows that provided habitat to the Concho water snake.

Recovery Criterion 2: Viable Populations

The Recovery Plan (Service 1993, p.33) also called for maintaining viable populations of the snake in each of the three major reaches. The Recovery Plan defines viable population as one that is self-sustaining, can persist for the long-term (typically hundreds of years), and can maintain its vigor and its potential for evolutionary adaptation (Service 1993, p. 33).

As previously described (see *A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* Range and Population Trends), monitoring studies from 1987 through 1996 confirmed a larger and more consistent distribution of the Concho water snake throughout its range, including several reservoirs and tributaries (District 1998, pp. 10, 22, 26). In addition, over the 10 years of study, 9,069 Concho water snakes were captured (excluding recaptures) (District 1998, p. 21). Of this total, 1,535 (17 percent) were captured in reservoirs, 1,517 (17 percent) were captured in the Concho River reach, 5,586 (62 percent) were captured in the Colorado River reach, and another 415 (5 percent) were captured in tributary streams. Although the results varied by year and location, each of the more than 20 sites monitored throughout the study had multiple captures of snakes, usually with a variety of age classes (Thornton 1996, pp. 26–50).

Unfortunately, the high variation in sample efforts and environmental conditions prevented a thorough analysis of population trends over time or calculation of total population estimates (District 1998, p. 18). In other words, in order to measure the changes in abundance over time the study would have had to include a quantification of the amount of effort expended during each survey. Such data would have allowed a standardization of results over time to evaluate potential trends in population abundance of the snake. The researchers decided there was too much variation in the environmental conditions and resulting catch rates to produce such estimates and did not report the amount of effort expended during the surveys, making a trend analysis inappropriate.

Forstner *et al.* (2006, pp. 6–8, 18, 20) reviewed the past population data collected on the snake (District 1998, p. 18–26), as well as conducted field surveys in 2004 and 2005 to document that snakes continued to be present and were reproducing in each river reach and reservoir where they occurred in previous studies. The study, which incorporated the results by Dixon (2004), confirmed reproducing populations of Concho water snakes in each river reach and in both Ivie and Spence Reservoirs (Forstner *et al.* 2006, p. 12). Based on the snakes' persistence and continued reproduction throughout its range over the past 20 years, Forstner *et al.* (2006, pp. 18, 20) concluded that viable populations of Concho water snakes could be presumed to exist in all three reaches of the species' range.

There was some concern by peer reviewers of the proposed rule regarding the population of the snake in the reach of the Colorado River downstream of Freese Dam (Ivie Reservoir) where only two sample locations (below Freese Dam and at River Bend Ranch, about 25 miles (40 km) downstream of the dam) (Dixon 2004, pp. 8, 14) were sampled due to the difficulties in establishing contact with private landowners in this reach. Dixon collected three snakes from these two sites in 2004, and one was a juvenile female (Dixon 2004, pp. 16–17). In 2005, Forstner *et al.* (2006, pp. 12, 18) reports collection of one post-partum female below Freese Dam indicating the snake had given birth to young, confirming reproduction. Although only four snakes were captured in limited sampling efforts in 2004 and 2005 in this reach, data from the District's earlier monitoring showed healthy populations in this reach (District 1998, pp. 34–38, 50). We have no reason to conclude that the snake population downstream of Freese Dam is of additional concern.

A reanalysis of Concho water snake monitoring data collected from 1987 to 1996 attempted to evaluate the population dynamics of the species and quantitatively assess the long-term viability (Whiting *et al.* 2008, pp. 438–439). The results, however, were inconclusive because the data were insufficient to reliably estimate survival and emigration. This was due primarily to insufficient sampling at any single study site, along with a host of variables, especially different environmental conditions within a site and among sites, and also because dispersal rates were not measured among sites (Whiting *et al.* 2008, p. 443). This situation resulted in the survival rates from the capture-recapture study being biased low and producing low estimates of annual survival with large standard errors (Whiting *et al.* 2008, p. 443). However, Whiting also stated that snakes continued to persist even in drought-prone areas, some with almost total water loss, with hydrologically dynamic systems (Whiting *et al.* 2008, pp. 442–443). Although we lack recent data on population size and viability, we have used data on current range, long-term persistence, and verification of recent breeding success as indicators that the current populations meet the definition of a viable population.

Recovery Criterion 3: Movement of Snakes

The Recovery Plan also provided for the movement of Concho water snakes (Service 1993, p. 33) to counteract adverse impacts of population fragmentation and prescribed the movement of four snakes (two of each sex) every 5 years in a specific pattern above and below Ivie Reservoir and between the Concho River reach and the Colorado River reach downstream of Spence Reservoir. The 2004 BO discussed population fragmentation (Service 2004a, p. 52) and found that the specific requirement for snake movements would best be served by moving five male snakes from downstream to upstream of both the dams at Spence and Ivie Reservoirs once every 3 years. The 2008 MOU, as amended in 2010, now calls for the same movements of snakes and also includes movement of snakes from above to below both dams by the District even after the species is delisted. Since snakes are now known to occur in Ivie Reservoir, there is no longer a need to move snakes between the Concho River reach and the Colorado River reach downstream of Spence Reservoir, as those reaches are naturally connected. We added the requirement to move snakes above Spence Reservoir so that the population in Spence Reservoir can maintain genetic mixing with the riverine snakes downstream. We determined that moving only male snakes was sufficient to accomplish the objective of genetic exchange because a male will fertilize multiple females, providing opportunities for maintaining genetic diversity. We increased the frequency of snake transfers from 5 years called for in the recovery plan to an interval of 3 years to decrease the likelihood of population fragmentation. The Service believes that these movements are more than sufficient to maintain genetic heterogeneity between the separated populations (Service 2004a, p. 52) because research has shown that as few as one individual exchanged with each generation is sufficient to maintain adequate gene flow between animal populations (Mills and Allendorf 1996, p. 1,557). Also see the discussion above under Habitat Modification From Fragmentation.

Conclusion

As required by the Act, we considered all potential threats under the 5 factors to assess whether the Concho water snake is threatened or endangered throughout its range. We found that the best available information indicates that the Concho water snake is no longer threatened with becoming endangered throughout all of its range due to recovery accomplishments and new information on the ecology of the species. Concho water snakes can survive lower flows than previously thought necessary for their survival. Natural inflows and downstream senior water rights, in concert with assurances from the 2008 MOU, will maintain adequate instream flows and reduce the impacts of uncontrollable extreme drought periods. Populations of reproducing Concho water snakes are persisting in all 3 reaches of the species' range. The snake is capable of living and reproducing in reservoirs and persisting during droughts and in apparently degraded habitats. Considering these findings, evaluated in the five-factor analysis above, and that the three Recovery Plan Criteria have either been met outright, determined here to no longer be appropriate, or conditions are insured to meet the intent of each of the criteria, we have determined that none of the existing or potential threats, either alone or in combination with others, are likely to cause the Concho water snake to become in danger of extinction throughout all of its range within the foreseeable future of about 50 years.

Significant Portion of the Range Analysis

Having determined that the Concho water snake is not endangered or threatened throughout all its range, we must next consider whether there are any significant portions of the range where the Concho water snake is in danger of extinction or is likely to become endangered in the foreseeable future.

The Act defines ''endangered species'' as any species which is ''in danger of extinction throughout all or a significant portion of its range,'' and ''threatened species'' as any species which is ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The definition of ''species'' is also relevant to this discussion. The Act defines the term ''species'' as follows: ''The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature.'' The phrase ''significant portion of its range'' (SPR) is not defined by the statute, and we have never addressed in our regulations: (1) The consequences of a determination that a species is either endangered or likely to become so throughout a significant portion of its range, but not throughout all of its range; or (2) what qualifies a portion of a range as ''significant.''

Two recent district court decisions have addressed whether the SPR language allows the Service to list or protect less than all members of a defined ''species'': *Defenders of Wildlife* v. *Salazar,* 729 F. Supp. 2d 1207 (D. Mont. 2010), concerning the Service's delisting of the Northern Rocky Mountain gray wolf (74 FR 15123, Apr. 12, 2009); and *WildEarth Guardians* v. *Salazar,* 2010 U.S. Dist. LEXIS 105253 (D. Ariz. Sept. 30, 2010), concerning the Service's 2008 finding on a petition to list the Gunnison's prairie dog (73 FR 6660, Feb. 5, 2008). The Service had asserted in both of these determinations that it had authority, in effect, to protect only some members of a ''species,'' as defined by the Act (*i.e.,* species, subspecies, or DPS), under the Act. Both courts ruled that the determinations were arbitrary and capricious on the grounds that this approach violated the plain and unambiguous language of the Act. The courts concluded that reading the SPR language to allow protecting only a portion of a species' range is inconsistent with the Act's definition of ''species.'' The courts concluded that, once a determination is made that a species (i.e., species, subspecies, or DPS) meets the definition of ''endangered species'' or ''threatened species,'' it must be placed on the list in its entirety and the Act's protections applied consistently to all members of that species (subject to modification of protections through special rules under sections 4(d) and 10(j) of the Act).

Consistent with that interpretation, and for the purposes of this finding, we interpret the phrase ''significant portion of its range'' in the Act's definitions of ''endangered species'' and ''threatened species'' to provide an independent basis for listing; thus there are two situations (or factual bases) under which a species would qualify for listing: a species may be endangered or threatened throughout all of its range; or a species may be endangered or threatened in only a significant portion of its range. If a species is in danger of extinction throughout an SPR, it, the species, is an ''endangered species.'' The same analysis applies to ''threatened species.'' Therefore, the consequence of finding that a species is endangered or threatened in only a significant portion of its range is that the entire species shall be listed as endangered or threatened, respectively, and the Act's protections shall be applied across the species' entire range.

We conclude, for the purposes of this finding, that interpreting the SPR phrase as providing an independent basis for listing is the best interpretation of the Act because it is consistent with the purposes and the plain meaning of the key definitions of the Act; it does not conflict with established past agency practice (*i.e.,* prior to the 2007 Solicitor's Opinion), as no consistent, long-term agency practice has been established; and it is consistent with the judicial opinions that have most closely examined this issue. Having concluded that the phrase ''significant portion of its range'' provides an independent basis for listing and protecting the entire species, we next turn to the meaning of ''significant'' to determine the threshold for when such an independent basis for listing exists.

Although there are potentially many ways to determine whether a portion of a species' range is ''significant,'' we conclude, for the purposes of this finding, that the significance of the portion of the range should be determined based on its biological contribution to the conservation of the species. For this reason, we describe the threshold for ''significant'' in terms of an increase in the risk of extinction for the species. We conclude that a biologically based definition of ''significant'' best conforms to the purposes of the Act, is consistent with judicial interpretations, and best ensures species' conservation. Thus, for the purposes of this finding, a portion of the range of a species is ''significant'' if its contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction.

We evaluate biological significance based on the principles of conservation biology using the concepts of redundancy, resiliency, and representation. Resiliency describes the characteristics of a species that allow it to recover from periodic disturbance. Redundancy (having multiple populations distributed across the landscape) may be needed to provide a margin of safety for the species to withstand catastrophic events. Representation (the range of variation found in a species) ensures that the species' adaptive capabilities are conserved. Redundancy, resiliency, and representation are not independent of each other, and some characteristic of a species or area may contribute to all three. For example, distribution across a wide variety of habitats is an indicator of representation, but it may also indicate a broad geographic distribution contributing to redundancy (decreasing the chance that any one event affects the entire species), and the likelihood that some habitat types are less susceptible to certain threats, contributing to resiliency (the ability of the species to recover from disturbance). None of these concepts is intended to be mutually exclusive, and a portion of a species' range may be determined to be ''significant'' due to its contributions under any one of these concepts.

For the purposes of this finding, we determine if a portion's biological contribution is so important that the portion qualifies as ''significant'' by asking whether, without that portion, the representation, redundancy, or resiliency of the species would be so impaired that the species would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction (i.e., would be ''endangered''). Conversely, we would not consider the portion of the range at issue to be ''significant'' if there is sufficient resiliency, redundancy, and representation elsewhere in the species' range that the species would not be in danger of extinction throughout its range if the population in that portion of the range in question became extirpated (extinct locally).

We recognize that this definition of ''significant'' establishes a threshold that is relatively high. On the one hand, given that the consequences of finding a species to be endangered or threatened in an SPR would be listing the species throughout its entire range, it is important to use a threshold for ''significant'' that is robust. It would not be meaningful or appropriate to establish a very low threshold whereby a portion of the range can be considered ''significant'' even if only a negligible increase in extinction risk would result from its loss. Because nearly any portion of a species' range can be said to contribute some increment to a species' viability, use of such a low threshold would require us to impose restrictions and expend conservation resources disproportionately to conservation benefit: listing would be rangewide, even if only a portion of the range of minor conservation importance to the species is imperiled. On the other hand, it would be inappropriate to establish a threshold for ''significant'' that is too high. This would be the case if the standard were, for example, that a portion of the range can be considered ''significant'' only if threats in that portion result in the entire species' being currently endangered or threatened. Such a high bar would not give the SPR phrase independent meaning, as the Ninth Circuit held in *Defenders of Wildlife* v. *Norton,* 258 F.3d 1136 (9th Cir. 2001).

The definition of ''significant'' used in this finding carefully balances these concerns. By setting a relatively high threshold, we minimize the degree to which restrictions will be imposed or resources expended that do not contribute substantially to species conservation. But we have not set the threshold so high that the phrase ''in a significant portion of its range'' loses independent meaning. Specifically, we have not set the threshold as high as it was under the interpretation presented by the Service in the *Defenders* litigation. Under that interpretation, the portion of the range would have to be so important that current imperilment there would mean that the species would be currently imperiled everywhere. Under the definition of ''significant'' used in this finding, the portion of the range need not rise to such an exceptionally high level of biological significance. (We recognize that if the species is imperiled in a portion that rises to that level of biological significance, then we should conclude that the species is in fact imperiled throughout all of its range, and that we would not need to rely on the SPR language for such a listing). Rather, under this interpretation we ask whether the species would be endangered everywhere without that portion, *i.e.,* if that portion were completely extirpated. In other words, the portion of the range need not be so important that even being in danger of extinction in that portion would be sufficient to cause the remainder of the range to be endangered; rather, the complete extirpation (in a hypothetical future) of the species in that portion would be required to cause the remainder of the range to be endangered.

The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that have no reasonable potential to be significant and threatened or endangered. To identify only those portions that warrant further consideration, we determine whether there is substantial information indicating that: (1) The portions may be ''significant,'' and (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. Depending on the biology of the species, its range, and the threats it faces, it might be more efficient for us to address the significance question first or the status question first. Thus, if we determine that a portion of the range is not ''significant,'' we do not need to determine whether the species is endangered or threatened there; if we determine that the species is not endangered or threatened in a portion of its range, we do not need to determine if that portion is ''significant.'' In practice, a key part of the portion status analysis is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats applies only to portions of the species' range that clearly would not meet the biologically based definition of ''significant'', such portions will not warrant further consideration.

Based on our review of the best available information concerning the distribution of the species and the potential threats, we have determined that the Concho water snake does not warrant further consideration to determine if there is a significant portion of the range that is threatened or endangered. Through the five-factor analysis we found no areas where one or more threats are geographically concentrated. The range of the snake can readily be divided into three portions, based on the presence of large dams: (1) The Concho River segment (San Angelo to the inflow of Ivie Reservoir); (2) the upper Colorado River segment (Spence Reservoir and the Colorado River outflow downstream to Ivie Reservoir); and (3) the lower Colorado River segment (outflow of Ivie Reservoir downstream to Colorado Bend State Park). Generally, all of the potential threats to the species that were evaluated in the Summary of Factors Affecting the Species section above occur at similarly low levels in each of the three segments. However, there are some differences in flow regimes that were described in the Habitat Modification from Reduced Instream Flows section above and are considered here.

The Concho River segment has undergone the most dramatic flow reduction due to upstream dams and water diversion for human use. The result has been extended periods of very low discharges throughout much of the reach (Asquith and Heitmuller 2008, pp. 849–850). Despite the habitat alterations, the snake continues to persist in this reach and Forstner *et al.* (2006, p. 8) found the highest numbers of Concho water snakes (20 of all 45 snakes captured or observed during their brief surveys in 2004 and 2005) in this reach of the Concho River. Dixon (2004, p. 9) explains that the snakes endure these conditions by using low-flow areas over bedrock substrate for foraging and also using the pools that form behind low-head dams as habitat. Therefore, we find that the potential threats from low flows, or any other threats, in this portion of its range do not warrant continued listing of the snake.

Both the upper and lower Colorado River segments have also undergone hydrologic changes and decreases in stream flows from reservoir construction and operation (Asquith *et al.* 2008, pp. 810–813; 850–853). However, river flows have been maintained due to natural drainage inflows and minimum reservoir releases (Service 2004, pp. 35–38). Water has been released from Spence Reservoir for the benefit of the Concho water snake under the requirements of biological opinions and as part of the 2008 MOU. In addition, releases from Ivie Reservoir are required to fulfill requirements for downstream users, consistent with the flows called for in the 2008 MOU, which will continue to be implemented even if the snake is delisted. As evaluated under Summary of Factors Affecting the Species section above, we find that these flow reductions, or any other threats, in either of these segments are not threatening the species. Because the low level of threats to the species is essentially uniform throughout its range, no portion warrants further consideration to determine if they are significant.

Therefore, we find the Concho water snake is no longer threatened with becoming endangered throughout all or a significant portion of its range within the foreseeable future. We believe the Concho water snake no longer requires the protection of the Act, and, therefore, we are removing it from the Federal List of Endangered and Threatened Wildlife.

Effects of the Rule

This final rule revises 50 CFR 17.11(h) to remove the Concho water snake from the Federal List of Endangered and Threatened Wildlife. Promulgation of this final rule will affect protection afforded the Concho water snake under the Act. Taking, interstate commerce, import, and export of Concho water snakes are no longer prohibited under the Act. Federal agencies are no longer required to consult with us under section 7 of the Act to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the species' continued existence. This final rule also revises 50 CFR 17.95(c) to remove the critical habitat designation.

Post-Delisting Monitoring Plan

Section 4(g)(1) of the Act requires us, in cooperation with the States, to implement a monitoring program for not less than 5 years for all species that have been recovered and delisted (50 CFR 17.11, 17.12). The purpose of this post-delisting monitoring (PDM) is to verify that the species remains secure from risk of extinction after it has been removed from the protections of the Act. The PDM is designed to detect the failure of any delisted species to sustain itself without the protective measures provided by the Act. If, at any time during the monitoring period, data indicate that protective status under the Act should be reinstated, we can initiate listing procedures, including, if appropriate, emergency listing under section 4(b)(7) of the Act. Section 4(g) of the Act explicitly requires cooperation with the States in development and implementation of PDM programs, but we remain responsible for compliance with section 4(g) and, therefore, must remain actively engaged in all phases of

PDM. We also seek active participation of other entities that are expected to assume responsibilities for the species' conservation, post-delisting.

The Service has developed a PDM plan in cooperation with the District and TPWD. We published a notice of availability of the draft plan in the **Federal Register** on September 23, 2009, (74 FR 48595) to solicit public comments and peer review on the plan. No public comments on the PDM plan were received. Comments from six peer reviewers were considered and incorporated into the final PDM plan as appropriate. The final PDM plan and any future revisions will be posted on our Endangered Species Program's national web page (*http://endangered.fws.gov*) and on the Austin Ecological Services Field Office web page (*http://www.fws.gov/southwest/es/AustinTexas/*).

PDM for Concho water snakes will consist of two monitoring components: biological (to monitor the status of the snake) and hydrological (to monitor instream flow conditions). Over a 14-year period, surveys to measure the presence, reproduction, and abundance of snakes will be conducted annually in the fall for 13 consecutive years at 9 core biological sample sites across the snake's range. In addition, more intense biological surveys will be conducted during the spring and fall of 3 years spread over the monitoring period at 18 sample sites. Evaluation of stream conditions will consist of analysis of hydrologic data collected at eight existing stream gauges from across the snake's range, which will verify that flows called for in the 2008 MOU are being realized. Quantitative and qualitative monitoring triggers for additional conservation actions are based on documented changes to the snake's range-wide distribution; observed presence and abundance at sample sites; and successful reproduction. Triggers are also established based on instream flow conditions within the snake's habitat. If monitoring results in concern regarding the snake's status or increasing threats, possible responses may include an extended or intensified monitoring effort, additional research (such as modeling metapopulation dynamics or assessing the status of the fish prey base), enhancement of riverine or shoreline habitats, or an increased effort to improve habitat connectivity by additional translocation of snakes between reaches. If future information collected from the PDM, or any other reliable source, indicates an increased likelihood that the species may become endangered with extinction, the Service will initiate a status review of the Concho water snake and determine if relisting the species is warranted.

Paperwork Reduction Act

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

National Environmental Policy Act

We have determined that an Environmental Assessment or an Environmental Impact Statement, as defined under the authority of the National Environmental Policy Act of 1969, need not be prepared in connection with regulations adopted pursuant to section 4 of the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of all references cited herein is available upon request from the U.S. Fish and Wildlife Service, Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT** above).

Authors

The primary authors of this document are staff located at the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT** above).

List of Subjects in 50 CFR Part 17

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

Regulation Promulgation

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

PART 17—[AMENDED]

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

Authority: 16 U.S.C. 1361–1407; 16 U.S.C. 1531–1544; 16 U.S.C. 4201–4245; Pub. L. 99–625, 100 Stat. 3500; unless otherwise noted.

§ 17.11 [Amended]

■ 2. Amend § 17.11(h) by removing the entry ''Snake, Concho water'' under ''REPTILES'' from the List of Endangered and Threatened Wildlife.

§ 17.95 [Amended]

■ 3. Amend § 17. 95(c) by removing the critical habitat entry for ''Concho Water Snake (*Nerodia harteri paucimaculata).''*

Dated: October 7, 2011.

Gregory E. Siekaniec,

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

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