Devils Hole pupfish (*Cyprinodon diabolis*)

5-Year Review: Summary and Evaluation

Devils Hole pupfish (*Cyprinodon diabolis*) / photo: O. Feuerbacher/USFWS

U.S. Fish and Wildlife Service

Southern Nevada Fish and Wildlife Office

Las Vegas, Nevada

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I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The Devils Hole pupfish (*Cyprinodon diabolis*) is a small-bodied fish (Cyprinodontiformes: Cyprinodontidae) endemic to the Devils Hole, located within Ash Meadows, Nye Co., Nevada. The Devils Hole is the sole wild habitat for this species and designated as a geographically disjunct unit of Death Valley National Park, now surrounded by the Ash Meadows National Wildlife Refuge. This species was listed due to the extremely restricted distribution, and unique qualities of the species and habitat (Miller 1948). The small population size, inability for geographic expansion in the wild, and the ongoing threats to its single habitat contrast sharply from other listed species relative to its recovery objectives. Previous Recovery Plans (Service 1980, 1990) state the ultimate endpoint for recovering the Devils Hole pupfish is the downlisting to threatened status, coincident with the ongoing maintenance in its natural habitat, and the establishment of satellite refugia populations. The Devils Hole pupfish is intrinsically impacted by habitat extremes, including high temperature, low dissolved oxygen, fluctuating food resources, and catastrophic events (such as earthquakes), along with ongoing and existential threats of water development projects.

Methodology Used to Complete This Review:

This 5-year review was conducted by the Service's Southern Nevada Fish and Wildlife Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on May 20, 2021 (86 FR 27462). We also contacted State agencies, Federal agencies, local agencies, and species experts, to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files. This review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing.

Contact Information:

Lead Field Office:

Southern Nevada Fish and Wildlife Office, Las Vegas, Nevada

Federal Register (FR) Notice Citation Announcing Initiation of This Review:

86 FR 27462. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 76 Species in California and Nevada. Published on May 20, 2021.

Listing History:

Original Listing

Species: Devils Hole pupfish (*Cyprinodon diabolis*)

Date listed: March 11, 1967

FR Notice: 32 FR 4001

Classification: Endangered

State Listing

Devils Hole pupfish (*C. diabolis*) is listed as Endangered by the State of Nevada (NAC 503.065.2).

Associated Rulemakings:

Critical Habitat was not designated at the time of listing on March 11, 1967 or subsequently thereafter.

Review History:

Since the time of listing in 1967, the listing status of the Devils Hole pupfish has not been revisited in a previous 5-year review. However, downlisting criteria were previously reviewed in 2019 for the *Supplemental Finding for the Devils Hole Pupfish (Cyprinodon diabolis), within the Recovery Plan for the Endangered and Threatened Species of Ash Meadows, Nevada* (Service 2019). The original and revised Recovery Plans were published by the Service in 1980 and 1990.

Species' Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for Devils Hole pupfish is 5, based on a 1-18 ranking system (48 FR 43098).

Recovery Plan or Outline:

Name of Plan or Outline: *Recovery Plan for the Endangered and Threatened Species of Ash Meadows, Nevada*

Date Issued: September 28, 1990

II. REVIEW ANALYSIS

Information on the Species and its Status

Species Biology, Habitat and Life History

The Devils Hole pupfish (DHP) is a small species of *Cyprinodon* [1 in. (25 mm)] that is restricted to a single natural habitat, the submerged limestone cavern of Devils Hole, Nye County Nevada (Figure 1). Wales (1930) described the species as unique among the Death Valley pupfishes, given its lack of preorbital scales, lack of typical cross-bar color pattern in males, large eye, and the absence of pelvic fins (*reviewed in* Miller 1948).

The Devils hole pupfish is an annual species (James 1969) that predominantly grows during the spring, with little to no growth during the winter. Limited food resources are associated with lack of sunlight in cooler months, and conversely higher algal growth during the spring and summer. Resources are sufficiently limited that population size fluctuates annually during the year, but is always persistently small (Soltz and Naiman 1978). Results from stomach content analysis reveals the species feeds opportunistically on algae (*Spirogyra* and diatoms), amphipods, ostracods, and protozoans (Minckley and Deacon 1975). Spawning occurs year round at low levels and reaches its peak during the maximum photoperiod (Minckley and Deacon 1973).

Spatial Distribution

The Devils Hole pupfish exists precariously as a relict species, harboring unique biological diversity isolated since from the pluvial (wetter) periods in geologic time. With arguably the smallest extent of habitat among vertebrate species, the DHP survives within an 8.2 ft. (2.5 m) x 60 ft. (20 m) pool. The extreme geographic isolation and evolution from other pupfishes is well documented in its morphological and genetic characters (Miller 1948, Wilcox et al. 2006).

The small fluctuating population size of this species has concerned conservation biologists for over 50 years and multiple refuge populations have been founded, nearly all of which have failed prior to 2006 (*see* Hausner 2017). The most recent refuge population is a staffed, research-focused refuge and propagation facility near Devils Hole that began in 2013, the Ash Meadows Fish Conservation Facility (AMFCF; Figure 2). The Refuge is operated by the Service to 1) investigate the spawning biology of DHP, and 2) provide a second location if conditions become unsuitable at Devils Hole. On a monthly basis, eggs of DHP are collected from egg recovery mats and transported from the wild population to the AMFCF. Significant research advances at the AMFCF have resulted in a successful sustaining population in the Refuge Tank as well as significant advances in captive propagation that were largely unsuccessful in the past (O. Feuerbacher, *pers. comm.*).

Abundance

Although the historic population size of DHP in Devils Hole is unknown, population surveys (counts) have occurred annually since 1972 and provide the best information on abundance (Figure 3). Count estimates have shown that abundance fluctuates over short time periods, correlated with seasonal changes in habitat conditions. During the late 1970s, the population increased from a perilously low number (300) subsequent to a Supreme Court decision to ensure

adequate water levels in Devils Hole, increasing to approximately 500 individuals when the water was restored. A fall count estimate of ~500 fish continued throughout the 1980s and early 1990s, until the population entered into a precipitous decline beginning around 1995. Throughout the 2000s the population has continued to be characterized by extremely low population size. In two instances, the spring counts reached all-time lows of 39 and 35 fish observed, in 2006 and 2013, respectively. The current (fall 2024) index of population size is 263 fish (*unpubl.* ICT data 2024).

The highest counts for the period of record occurred prior to 1996; counts thereafter have been considerably lower, then began increasing again over the last decade. While the reasons for this apparent decline are unknown, several hypotheses are supported by a hierarchy of evidence. These include (in no particular order) changes in the environment affecting water quality (e.g., temperature, dissolved oxygen), physical habitat availability, ecological productivity, food availability, and the loss of genetic variation through bottlenecks in population size. Hypotheses are not mutually exclusive and in some cases interdependent. The number of hypotheses, their complexity, and the potential of synergistic effects make biological interpretation of DHP population dynamics a significant challenge.

The unique biological and ecological conditions of this system make standard fish conservation approaches impractical in many respects. Comparisons to historic data suggest that the current population size is suboptimal. The mean value for the fall count was 444 during years 1980-1999, a period when the population was generally believed 'healthy', compared to a mean of 147 from 2000-2018 (mean values for the spring count were 218 and 101 for the same periods, respectively). The management agencies consider the 3-fold reduction from historic population sizes to likely reflect human-induced changes to habitat quality and quantity, although specific drivers and their relative influences remain unclear.

Management agencies have not identified an ideal population size for the DHP in Devils Hole but recognize that there is an inverse relationship between population size and risk of extinction. Increasing the population size of the DHP is particularly important to ensure the persistence of the species due to natural stochastic events such as flooding, earthquakes, and changes in carbon sources that can further reduce population size and genetic variation. Based on the limited data from historic population sizes, population dynamics and other estimates, the management agencies suggest some general guidelines for population size and extinction risk in the *Devils Hole Pupfish Strategic Plan, Phase 2* (Figure 4, Schwemm et al. 2022).

Several management actions have been implemented to increase population size in recent years. Supplemental feeding, which began in December 2006, as an attempt to mitigate the impacts of low productivity and limited food supply suggests feeding has contributed to small increases in numbers. Managers have also attempted to address deficiencies in cover and organic matter by introducing discrete packets of woody debris on the shallow shelf. These "cover packets" are used by fish, particularly smaller individuals, and biologists have documented that they provide pockets of cooler water and serve as substrates for biofilm. However, the explicit effects on population size are unknown. Supplemental feeding and cover augmentation are believed to address secondary impacts of broader ecosystem changes and are considered temporary measures until those underlying changes are identified and mitigated.

Habitat or Ecosystem

Devils Hole: The single pool is comprised of two sections with varying depth, a shallow rock shelf and a deep pool. The shallow shelf is used by fish for forage and spawning, and thus critical for the survival of the population. Specifically, the water-level above the shelf is paramount, as the entire ecosystem depends on interactions upon it. The temperature in the deep pool is stable at 33.5º C, while the shelf changes over the course of the year based on solar radiation and ambient air temperature (32.5º C – 34.5º C). Hausner et al. (2012, 2013) have shown that water temperature is regulated by mixing of convective currents between the shallow shelf and deep pool. Ambient conditions are also characterized by low and stable levels of dissolved oxygen (DO) which range from 2.5 -3.5 mg/l in the deep pool, but similarly, DO can fluctuate on the shallow shelf during photosynthesis and respiration, ranging from 1.5 mg/l – 8.0 mg/l. Based on work in hybrid DHP (Feuerbacher et al. 2015) and in other species (Shang and Wu 2004), DHP survival and reproduction could be limited during extremes of lower DO and higher temperatures. The management agencies closely monitor water quality conditions along with trends in fish abundance and habitat use during surveys.

Critical habitat has not been designated for this species.

Changes in Taxonomic Classification or Nomenclature

There have been no changes in the species taxonomic classification or nomenclature since its listing.

Genetics

The Devils Hole pupfish is part of the western pupfish clade (Cyprinodontidae: *Cyprinodon*), a group extending from the Guzmán Basin in Mexico to the Amargosa River and Death Valley regions in California and Nevada. Evolution within the group may have begun in the late Miocene or early Pliocene (Echelle 2005, 2008). Specifically, most pupfishes of the Amargosa/Death Valley regions show a pattern of genetic divergence times from in the late Pleistocene, but some species, like the Devils Hole pupfish, show greater divergence than other pupfishes, such as those immediately nearby in Ash Meadows (Echelle 2008, Sağlam et al. 2016). Genetic studies beginning with the advent of mtDNA approaches revealed genetic distinctiveness was clear, especially for the Devils Hole pupfish (Echelle et al. 2005, Echelle 2008). Later studies using fine-scale microsatellites (Wilcox et al. 2006) and later, genome-wide analyses (Martin et al. 2016, Sağlam et al. 2016) similarly show species and populations are readily distinguished by genetic characters. However, some recent interpretations of mutation rates, evolutionary change, and the age in which Devils Hole may have been first colonized contrasts between published studies (Martin et al. 2016, Sağlam et al. 2016, Martin and Hohna 2018, Sağlam et al. 2018). Genome-wide analyses are currently underway to discern genetic differences between artificial refugia populations and the wild Devils Hole and will provide insights for the genetic management of the species (Smith et al. 2024).

Management of Devils Hole pupfish

Devils Hole pupfish, and the many unique attributes of its habitat and conservation history, are renown. Therefore, the regional directors of the US Fish and Wildlife Service, the National Park

Service, and the Nevada Department of Wildlife acknowledged that they must share responsibility for the conservation of this species, and that explicit roles, responsibilities and decision-making authorities are made clear. In 2010, after fish counts were seemingly at their lowest, the parties above formed the Incident Command Team (ICT) to make collective decisions by consensus, along with a Management Oversight Team that would convene when conflicts arise within the ICT, or when higher level administrative decisions are required. These teams are each composed of one representative from each agency.

Species-specific Research and/or Grant-supported Activities

The Service currently provides funds for the conservation of Devils Hole pupfish population. Specific projects include:

- Support for the DHP recovery coordinator position, which guide the long-term strategic planning for the species (e.g., *Devils Hole Pupfish Strategic Plan Phase 2*);
- Participation in the weekly ICT meetings;
- Draft correspondence with partners on behalf of the ICT;
- Draft grant proposals and lead research activities;
- Complete biological compliance for DHP research and recovery actions under the ESA;
- Participate in population monitoring at the bi-annual fish counts and related activities;
- Providing technical assistance for habitat restoration actions conducted by the National Park Service.
- Participate and evaluate management actions as member of the Management Oversight Team (MOT);

The Service also provides funds to operate the Ash Meadows Fish Conservation Facility (AMFCF). Specific projects include:

- Provide staffing via four, full-time employees (Manager, 2x-Biologists, Maintenance);
- Maintain the only back-up population of DHP;
- Manage the monthly transfer of DHP eggs from Devils Hole to the AMFCF;
- Develop methodology to breed DHP in captivity;
- Providing education and public outreach for the conservation of DHP;

The Service provides section 6 funding to the Nevada Department of Wildlife (NDOW) for Devils Hole pupfish recovery. Specifically, the NDOW's responsibilities include:

- Participation in the weekly ICT meetings;
- Conducting population monitoring of bi-annual fish counts;
- Providing technical assistance for habitat restoration actions conducted by the National Park Service.
- Contributing to long-range strategic planning operations;

The National Park Service, via the Devils Hole Program, provides funds and personnel to conserve the Devils Hole pupfish. Specific ongoing projects include:

- Provide staffing via four, full-time employees (Manager, 2x-Biologists, Administration);

- Participation in the weekly ICT meetings;
- Conducting population monitoring of bi-annual fish counts;
- Conducting the Long-Term Ecological Monitoring of the Devils Hole ecosystem;
- Conducting specific research experiments to guide management actions;
- Conduct regular site-visits to monitor resources and inform ICT;
- Contributing to long-range strategic planning operations;
- Providing education and public outreach for the conservation of endemic species;

FIVE-FACTOR ANALYSIS

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Habitat Modification

Based on the species needs, the primary concern for Devils Hole pupfish is the loss or modification of habitat due to changes in the water level at Devils Hole. The area around Devils Hole (Ash Meadows) is a great oasis relative to surrounding landscapes of the Mohave Desert. During the late 1960s and early 1970s, large-scale agriculture resulted in numerous high-volume wells near Devils Hole (Riggs and Deacon 2002). Habitat change (and population decline) in Devils Hole (Death Valley National Monument at the time) resulted in litigation (*United States v. Cappaert, 1976*), and ultimately the curtailment of groundwater pumping. The decision required water to be maintained at 2.7 feet below a reference point to ensure the survival of the fish, irrespective of whether pumping or a combination of climate and pumping contributed to water-level (Deacon and Williams 1991). The water level showed significant, but partial recovery along with the increased abundance of DHP (Figure 3; *see also* Hausner 2017).

The litigation over Devils Hole combined with the subsequent listing of three additional fish in Ash Meadows (drawing on the same aquifer) have heightened water conservation issues in the area. Groundwater pumping regarding Devils Hole is now specifically regulated by several sequential orders of the Nevada State Engineer, each intended to provide better protection of groundwater resources. In 2008, Order 1197 prohibited new groundwater water applications in the Amargosa Desert Basin or change in the point of diversion within 25 miles of Devils Hole (NSE 2008). This order was superseded by 1197A, removing an exception for some change applications (NSE 2018). Most recently, Order 1330 supersedes previous orders to utilize a numerical groundwater flow model, the USGS Death Valley Regional Flow System model DV3, to approve or deny change applications (Halford and Jackson 2020). The Basin is closed to new applications of groundwater development. The newest order provides a case-by-case evaluation that make use of the most recent groundwater flow model. Notwithstanding these protections, both past and ongoing groundwater pumping currently impact Devils Hole (Halford and Jackson 2020).

Most concerning is that predictive models forecast declines in water levels at Devils Hole. To examine the impact from long-term development of groundwater resources, Nelson and Jackson (2020) applied the DV3 groundwater flow model to simulate scenarios of future pumping. Even at their base (least extreme) scenario that extends 2010 pumping rates out to 2120, they reported

that Devils Hole could drop by 3.2 feet. Based on the current water level in 2020 (1.7 feet below reference point), this simulation estimates that the water level in Devils Hole could fall below the court mandate level by 2078.

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

Overutilization was not known to be a factor at the time of listing and does not appear to be a threat at this time.

Factor C: Disease or Predation

Disease

Historic documentation from the Service (1980, 1990) does not reference disease as a factor affecting Devils Hole pupfish. However, as the population crashed in the 2010s, management agencies were increasing interested in understanding the role of disease on population abundance. After the all-time low fish count in 2013 (35 fish), several individuals displayed emaciation and disease conditions characteristic of food and nutrient limitation (Schwemm et al. 2022). Management agencies responded by switching the supplemental feeding to a crustacean based diet containing a more balanced fatty acid profile, administered twice weekly. Additionally, mortalities and moribund individuals are now collected and evaluated for disease in coordination with fish health professionals within the Service. Since the population has crashed to very low levels, genetic concerns due to inbreeding may also contribute to disease.

Predation

At the time of listing, and subsequent recovery plans (Service 1980, 1990), predation was not considered as a contributing threat to Devils Hole pupfish. Still, the habitat remains free of invasive predatory fishes that typically threaten nearly all imperiled fishes of the desert Southwest. Since the population and habitat is so small, constant biosecurity measures, both for the public and scientific researchers, are strictly followed to prevent emigration into the habitat. Interestingly at the AMFCF, predaceous diving beetles, which occur only at low frequency in Devils Hole, markedly reduce survival of DHP. Ongoing monitoring and mitigation of beetles is now part of normal management activities at the AMFCF.

Factor D: Inadequacy of Existing Regulatory Mechanisms

National Environmental Policy Act (NEPA)

NEPA (42 U.S.C. 4371 *et seq*.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed, and the analysis disclosed to the public.

Clean Water Act

Under section 404, the U.S. Army Corps of Engineers (ACOE) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the ACOE criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any action with the potential to impact waters of the United States must be reviewed under the Clean Water Act, NEPA, and the Act. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts. The ACOE interprets "the waters of the United States" expansively to include not only traditional navigable waters and wetlands, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters.

Endangered Species Act (Act)

The Act is the primary Federal law providing protection for these species. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

Section 9 prohibits the taking of any federally listed endangered or threatened species. Section 3(18) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct". Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns that include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that result from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved Habitat Conservation Plan that details measures to minimize and mitigate the project's adverse impacts to listed species.

Federal Land Policy and Management Act of 1976 (FLPMA)

The Bureau of Land Management is required to incorporate Federal, State, and local input into their management decisions through Federal law. The FLPMA (Public Law 94-579, 43 U.S.C.

1701) was written "to establish public land policy; to establish guidelines for its administration; to provide for the management, protection, development and enhancement of the public lands; and for other purposes". Section 102(f) of the FLPMA states that "the Secretary [of the Interior] shall allow an opportunity for public involvement and by regulation shall establish procedures…to give Federal, State, and local governments and the public, adequate notice and opportunity to comment upon and participate in the formulation of plans and programs relating to the management of the public lands". Therefore, through management plans, the Bureau of Land Management is responsible for including input from Federal, State, and local governments and the public. Additionally, Section 102(c) of the FLPMA states that the Secretary shall "give priority to the designation and protection of areas of critical environmental concern" in the development of plans for public lands. Although the Bureau of Land Management has a multiple-use mandate under the FLPMA which allows for grazing, mining, off-road vehicle use, etc., the Bureau of Land Management also has the ability under the FLPMA to establish and implement special management areas such as Areas of Critical Environmental Concern, wilderness, research areas, etc., that can reduce or eliminate actions that adversely affect species of concern (including listed species).

The Lacey Act

The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any United States or Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

Nevada State Protection

The State of Nevada classifies the Devils Hole pupfish as an endangered species under Nevada Administrative Code §§ 503.065. State regulations providing protection for Devils Hole pupfish are described below.

Under Nevada Administrative Code §§ 503.050, 503.065, 503.067, 503.075, 503.080, 503.090, 503.103, and 503.104 (Nevada Revised Statutes §§ 501.105, 501.110, 501.181, and 503.650), a species may be designated as protected, threatened, endangered, or sensitive. The State statutes and regulations aimed at protecting wildlife and plant species, respectively, are administered by the NDOW and the Nevada Division of Forestry, under the Department of Conservation and Natural Resources. Capturing, removing, or destroying animals and plants on the State's fully protected list is prohibited for wildlife under Nevada Administrative Code §§ 503.093 and 503.094 (Nevada Revised Statues §§ 501.105 and 501.181) and for plants under Nevada Administrative Code §§ 527.250 to 527.460 (Nevada Revised Statutes §§ 527.050 and 527.300), unless a special permit has been obtained from the NDOW or Nevada Division of Forestry.

In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1967. Other Federal and State regulatory mechanisms may provide some discretionary protections for the species but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations continue to have limited ability to protect the species in absence of the Endangered Species Act.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

Stochastic Events

Since the species habitat is so limited, it is susceptible to catastrophic events that may adversely modify habitat conditions. Small populations have an inherent risk of extirpation due to stochastic events. Periodic earthquakes and flooding are natural events that drastically remove algae, cover and other attributes from the shallow shelf. Depending on the time of year (e.g., late fall, winter) sunlight might not allow for algal regrowth prior to winter, contributing to further resource limitations. Flooding may also deposit additional material, such as rocks and sediment, that would reduce both water volume and depth (past management actions involved the removal of material) over the shallow shelf). Finally, earthquakes have previously altered the hydrologic connections to the aquifer, causing lowered water levels that persist for months to years after the seismic event.

Vandalism

Vandalism has played a minor, but periodic role since the Federal management of Devils Hole in 1952 (*reviewed in* Brown 2017). Although the habitat is wire-fenced, locked and under video surveillance, periodic events still occur. Most incidents of vandalism have only short-term or limited effects (signage, fencing, etc.), but some have involved the illegal capture of fish, destruction of research and monitoring tools and entering the water. However, at least one recent case documented wading on the shallow shelf during peak spawning season in April 2016, disturbing the substrate where eggs and larvae occur, ultimately resulting is 12 months in jail (Bream 2016, NPS 2018). The event occurred after a recent population estimate of 115 fish (NPS 2018).

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, overall, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

The Devils Hole pupfish Recovery Plan(s) state the primary objective is to downlist from endangered status, but maintain the species as threatened status in perpetuity. Due to the habitat's extremely small size and flutuations in population size due to natural and man-made influences, the species is always vulnerable, even if pristine natural conditions exist, such as predevelopment water levels, are restored to Devils Hole.

The ideal size for a secure, self-sustaining population suitable for downlisting is not known. The highest counts on record were approximately 300 in winter and over 500 in the fall, and provide a starting point in which further evaluation is required. For example, after groundwater pumping near Devils Hole ceased, fall counts reboundned considerably during a 20 year period, but unfortunuately crashed and remained very low another 20 years. The complex interactions of changing threats show that, at least in this case, the population in Devils Hole remains vulernable despite periodically higher population sizes. At present, the average fish count for Devils Hole over the last five years is 153 (spring) and 211 (fall) and shows a gradual increase from the lowest count in 2013. The most recent counts of Devils Hole are 263 (fall 2023) and 191 (spring 2024) fish.

The primary criteria for downlisting the DHP involves bringing greater security to water levels at Devils Hole (Factor A). The concern for water conservation by state and Fedearl agencies has clearly increased over time, as evidenced by recent Orders of the Nevada State Engineer. Additionally, the Service has increased engagenmet on hydrologic negotiations with Federal agencies concerning new groundwater development. Contrastingly, Devils Hole has yet to completely recover from localized pumping 50 years later. Although the level of future recharge for the aquifer supporting Devils Hole is unknown and uncertainty for what level of groundwater curtailment may exist in the future, the modelled scenarios for the future of Devils Hole are not optimistic.

Also, secondary factors identified in the Five Factor Analysis section cause concern. Disease (Factor C) is an emergent threat which deserves more consideration. Evaluation of fish after lowest counts have idenfied individuals of poor health. More research is required to discern the ultimate, and not mutually exclusive hypotheses such as nutrition limitation and inbreeding depression, among others. Finally, periodic unusual events (Factor E) such and flooding, earthquakes, and vandalism, continue to threaten the species. These impacts vary from insignficant to substantial.

IV. SYNTHESIS

The current status of the Devils Hole pupfish has neither significantly improved nor degraded since the time of its listing. Based on population size over the period of standardized fish counts, the population has temporarily increased, decreased, and increased again since listing. Prior to the success of the AMFCF, the species narrowly avoided extinction several times (e.g., 2006 and 2013). As originally postulated, the small habitat size, unique characteristics of the species, and ongoing pressure to develop water resources in the Amargosa Desert contribute to its relative instability and insecurity.

After reviewing the best available scientific information, we conclude that Devils Hole pupfish (*Cyprinodon diabolis*) remains an endangered species. The evaluation of threats affecting the

species under the factors in 4(a)(1) of the Act and analysis of the status of the species in our 1967 listing determination remains an accurate reflection of the species' current status.

V. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Monitor compliance with Nevada Revised Statute Order 1330 (January 13, 2022), where new applications for underground water within the Amargosa Desert will be denied and change applications will be evaluated by the USGS Death Valley Regional Flow System numerical flow model. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020).

2. Collaborate with the Ash Meadows NWR to implement the *Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009* (Service 2009) and also the *Draft Ash Meadows Natural Resource Management Plan* in review (Service*, in review*); and

3. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time.

Field Supervisor, Fish and Wildlife Service

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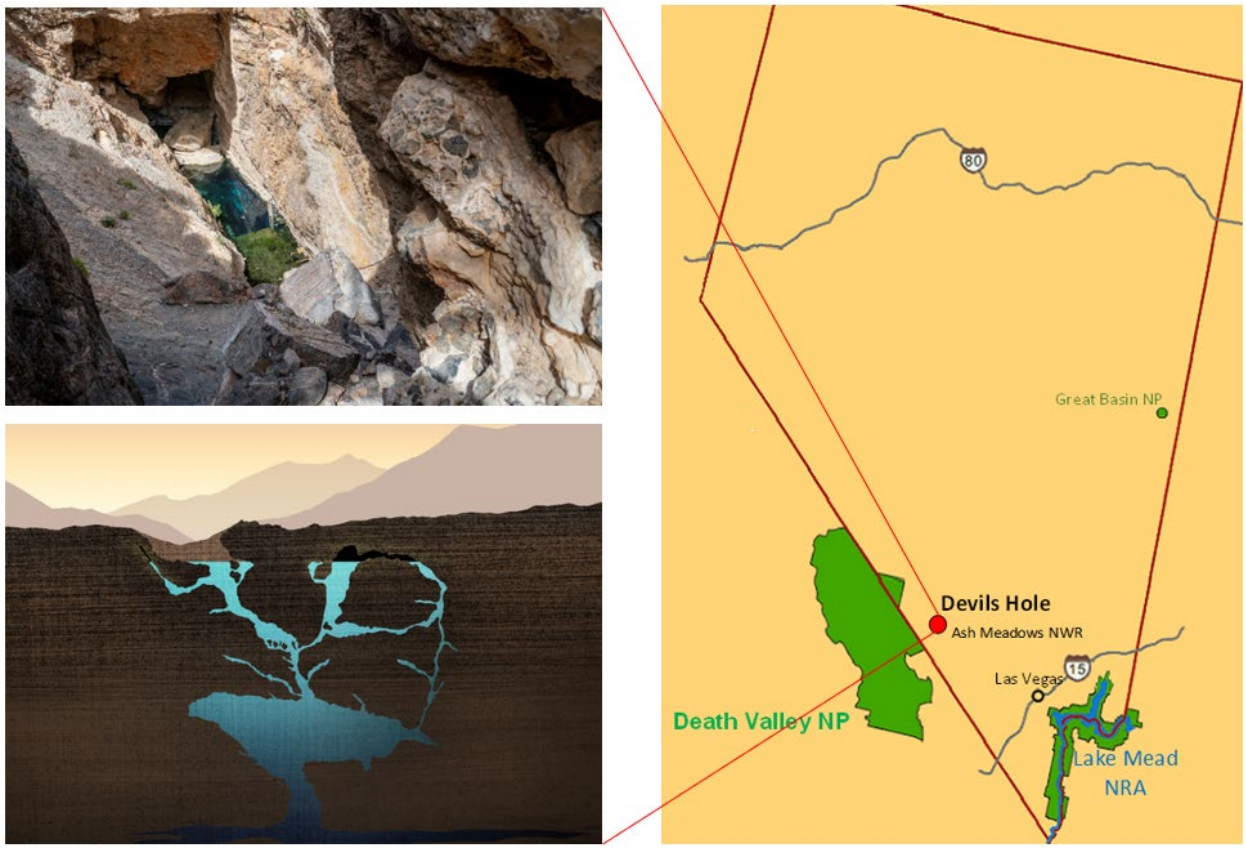

Figure 1. Area map of Devils Hole, Nye County, Nevada (*right*). Images (*left*) show habitat viewed from above (photo: Kim Stringfellow) and the profile view of Devils Hole (image credit: National Park Service).

Figure 1. Ash Meadows Fish Conservation Facility. Eggs of Devils Hole pupfish are collected via egg recovery mats (*upper right*) and raised in aquaria (*lower right*), before being transferred to the main Refuge Tank (*left*). Photo credits: USFWS.

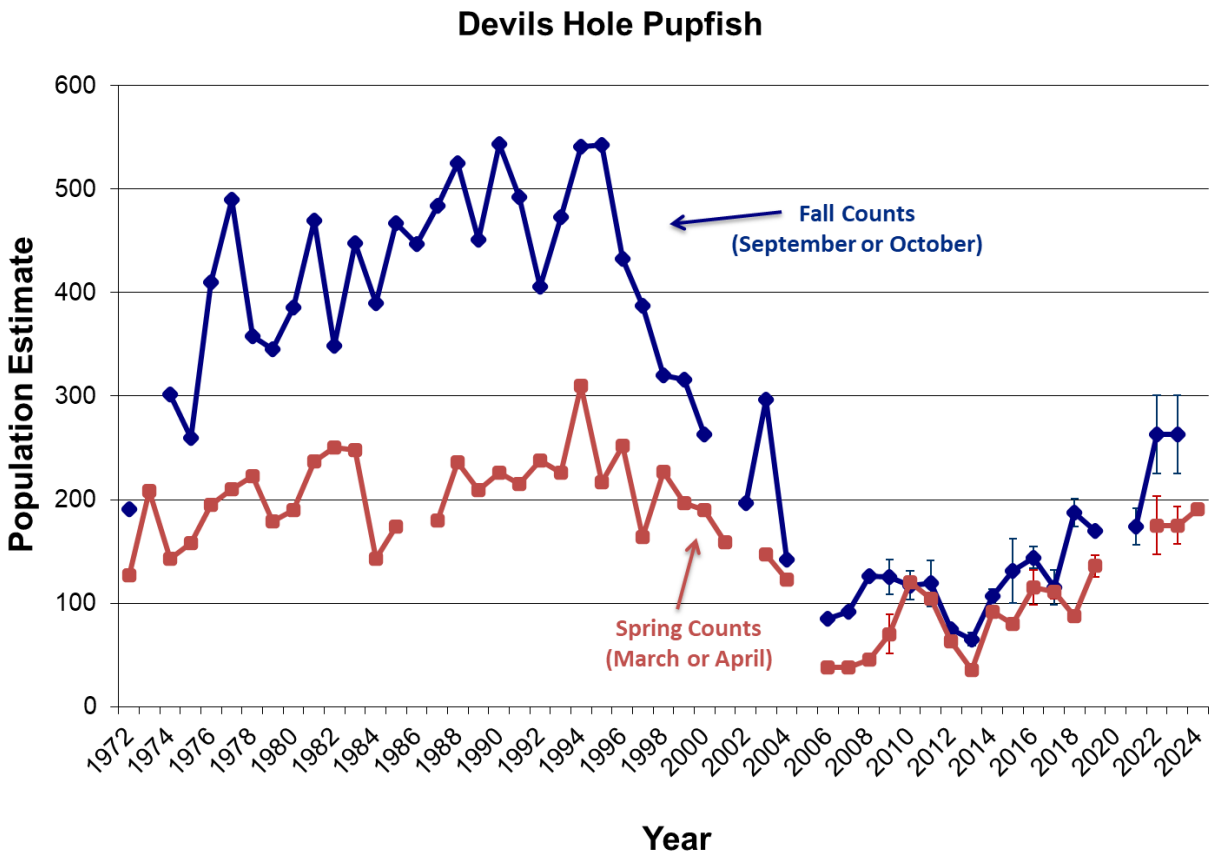

Figure 2. Wild population abundance of the Devils Hole pupfish estimated at spring and fall counts at Devils Hole (ICT records, 2024).

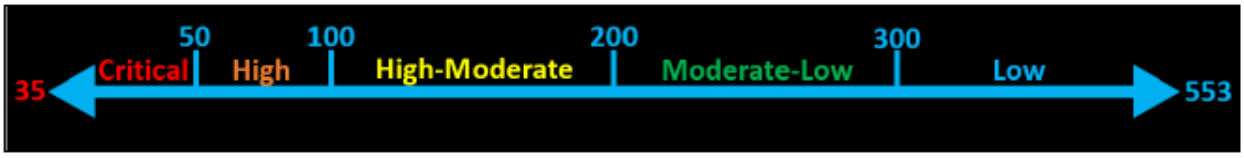

Figure 4. Conceptual depiction extinction risk for the Devils Hole pupfish in Devils Hole, relative to counts, developed by the ICT. Estimates of 553 and 35 are high and low counts for the period of record (1972–2024). Diagram reproduced from the *Devils Hole Pupfish Strategic Plan, Phase 2* (Schwemm et al. 2022).