Hiko White River Springfish
(*Crenichthys baileyi grandis*)
and
White River Springfish
(*Crenichthys baileyi baileyi*)

5-Year Review:
Summary and Evaluation

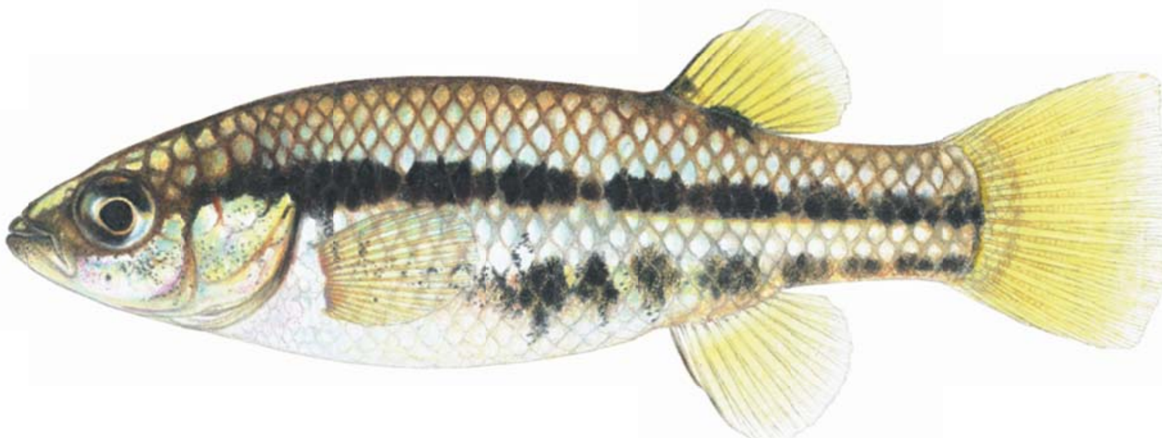

Illustration of Hiko White River springfish by Joseph R. Tomelleri

U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
Reno, Nevada

December 14, 2012

5-YEAR REVIEW
Hiko White River Springfish (*Crenichthys baileyi grandis*)
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I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (USFWS) 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:

For the purpose of this document, we will review the White River springfish (*Crenichthys baileyi baileyi*) and Hiko White River springfish (*C. b. grandis*) that occurs in the Pahranagat Valley, Lincoln County, Nevada. To avoid confusion between names, the scientific name *Crenichthys baileyi* or the generic term "springfish" will be used when referring to the species level; White River springfish will be used when referring to the subspecies *C. b. baileyi*; Hiko White River springfish will be used when referring to the subspecies *C. b. grandis*; and "Pahranagat Valley springfishes" when referring to the two subspecies together.

Crenichthys baileyi can inhabit water of high temperature (26˚- 37˚ Celsius (C), 79˚ - 99˚ Fahrenheit (F)) and low dissolved oxygen (0.7 – 3.3 O_2 parts per million (ppm)) levels (Sumner and Sargent 1940, Hubbs and Hettler 1964). They are omnivorous and opportunistic feeders though may be primarily herbivorous (Williams and Williams 1982, Hobbs 1998). Introductions of exotic species have negatively affected *C. baileyi* through competition and predation throughout its range (Deacon et al. 1964, Deacon and Minckley 1979, Courtenay et al 1985, Tuttle et al. 1990, Scoppettone 1993, NDOW 2007). Few studies have focused on the life history and biology of the White River springfish thus information presented here has often been gathered from surrogate species. For the purpose of this document, surrogate species will include information gathered at the species level (*C. baileyi*) or from other related subspecies: Preston White River springfish (*C. b. albivallis*), Moorman White River springfish (*C. b. thermophilus*), and Moapa springfish (*C. b. moapae*).

Methodology Used to Complete This Review:

This review was prepared by the Nevada Fish and Wildlife Office (NFWO), following the Region 8 guidance issued in February 2011. We used information from the 1998 Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley, survey information from experts who have been monitoring these species, and the database maintained by the Nevada Natural Heritage Program. We received no information from the public in response to our Federal Notice initiating this 5-year review. This 5-year 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. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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

On February 14, 2007, the USFWS announced initiation of the 5-year review of this taxon and the opening of a 60-day period to receive species status information from the public (72 FR 7064). We did not receive any information from this solicitation.

Listing History:

Original Listing
FR Notice: 50 FR 39123
Date of Final Listing Rule: September 27, 1985
Entity Listed: Species
Classification: Endangered

State Listing
The State of Nevada listed the *Crenichthys baileyi baileyi* and *Crenichthys baileyi grandis* as endangered, effective September 25, 1998 pursuant to Nevada Administrative Code 503.065.

Associated Rulemakings:

Critical habitat for both springfishes was designated in 1985 at the time of listing under the Act (USFWS 1985). Critical habitat for the White River springfish includes Ash Springs, its associated outflows, and surrounding land areas for a distance of 50 feet from the springs and outflows in Pahranagat Valley, Lincoln County, Nevada. Critical habitat for the Hiko White River springfish includes Crystal and Hiko springs, their associated outflows, and surrounding land areas for a distance of 50 feet from the springs and outflows in Pahranagat Valley, Lincoln County, Nevada.

Review History:

The USFWS last reviewed *C. b. grandis* and *C. b. baileyi* in 1985 when they were listed. Although we have tracked the status of threats to these species in the context of recovery plan development and biological opinions, no comprehensive status reviews (e.g., 12-month finding, 5-year review, or reclassification rule) have been completed.

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

The recovery priority number is 3C for both *C. b. grandis* and *C. b. baileyi* according to the USFWS's 2012 Recovery Data Call for the NFWO, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies that faces a "high" degree of threat for which extinction is almost certain in the immediate future because of rapid population decline and habitat destruction and has a high potential for recovery. The "C" indicates conflict with construction or other development projects or other forms of economic activity.

Recovery Plan or Outline:

> **Name of Plan or Outline:** Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley
> **Date Issued:** May 26, 1998

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act. The Pahranagat Valley springfishes occur in a limited area and no DPS has been designated. Therefore, the application to the DPS policy to the species' listings is not addressed further in this review.

Information on the Species and its Status

<u>Species Taxonomy, Biology, and Life History</u>
Crenichthys baileyi is a member of the Goodeidae family (order Cyprinodontiformes), which consists of approximately 40 freshwater fish species in 18 genera, the majority of which are known from central Mexico (Doadrio and Dominguez 2004; Webb et al. 2004). Only two genera of Goodeids, *Crenichthys* (springfish) and its closest relative *Empetrichthys* (poolfish), are known from the United States, where they are or were restricted to isolated spring systems in southern and eastern Nevada (Miller 1948; La Rivers 1994; Grant and Riddle 1995). Over the past century, springfish and poolfish taxonomy has been debated and these two genera have been aligned with several different families (reviewed by Grant and Riddle 1995). *Crenichthys* and *Empetrichthys* are now considered sister taxa within the subfamily Empetrichthyinae and the family Goodeidae, as proposed by Parenti (1981) and supported by subsequent studies (Grant and Riddle 1995; Doadrio and Dominguez 2004; also see Webb et al. 2004). In addition to their geographic separation, *Crenichthys* and *Empetrichthys* have distinct life history (e.g., egg laying) and ecological traits (e.g., endemic to spring systems) that separate them from other Goodeids (Grant and Riddle 1995; Doadrio and Dominguez 2004; Webb et al. 2004).

Crenichthys baileyi is one of two species within the genus *Crenichthys*, with the other being *C. nevadae* (Railroad Valley springfish) of Railroad Valley in central Nevada (La Rivers 1994). Originally described by Gilbert (1893) as a subspecies of *Cyprinodon macularius*, *C. baileyi* was later elevated to species status and placed within the newly created *Crenichthys* genus on the advice of Hubbs (La Rivers 1994). Williams and Wilde (1981) later recognized five subspecies of *C. baileyi* based on morphometrics, meristics (countable traits), coloration, and temporal isolation. All subspecies occur in isolated thermal springs in southern and eastern Nevada, and include: the White River springfish and Hiko White River springfish in Pahranagat Valley, Lincoln County; the Moapa White River springfish (*C. b. moapae*) to the south along the Muddy River, Clark County; the Preston White River springfish (*C. b. albivallis*) to the north in White River Valley near the towns of Preston and Lund, White Pine County; and the Moorman White River springfish (*C. b. thermophilus*) in White River Valley at Moorman Spring and Hot Creek, Nye County. The validity of the five subspecific classifications of *C. baileyi* populations has been questioned (Perkins et al. 1997) and additional research is needed to provide a more rigorous evaluation of the subspecific taxonomy of *C. baileyi*. However, Perkins et al. (1997) found a high level of genetic diversity among *C. baileyi* populations, which suggests that individual populations should be the primary ecological units for management.

Like its close relative, the Pahrump poolfish (*Empetrichthys latos*), *C. baileyi* lacks pelvic fins and the dorsal and anal fins are placed far back on the body (Hubbs and Miller 1941; La Rivers 1994; Minckley and Marsh 2009). Body coloration is typically dark olive above and silvery white below with bright silver on the cheek and opercle (Gilbert 1893; Minckley and Marsh 2009).   There are two rows of dark spots or bands along the side of the body (Gilbert 1893; Hubbs and Miller 1941; La Rivers 1994; Minckley and Marsh 2009), as opposed to the single row or band found on the Railroad Valley springfish (Hubbs and Miller 1941; La Rivers 1994).

The Hiko White River springfish is the largest of the five subspecies (adults average > 40 mm Standard Length [SL] and can exceed 65 mm SL), and breeding males display a brilliant lemon yellow color on the ventral surface of the head and body that sometimes turns into a deep orange color on the caudal fin (Williams and Wilde 1981; Minckley and Marsh 2009). The White River springfish is moderate in size compared to the other subspecies: average adult size is < 35 mm SL (Minckley and Marsh 2009) with a range of 27.2 - 38.5 mm SL based on 30 primarily female specimens; Williams and Wilde 1981).

Information is limited for the ecology, behavior, and life history of the Pahranagat Valley springfishes. However, studies have been conducted on close relatives, such as other *C. baileyi* subspecies. Based on their close relatedness, *C. baileyi* subspecies likely have similar life histories and habitat requirements (Minckley and Marsh 2009). However, it is important to keep in mind that habitat differences between sites can lead to divergence of life history traits. Additionally, many of these studies took place either in a laboratory setting or decades ago and conditions may have changed.

Given its small size, *C. baileyi* is probably short lived (three to four years; Sigler and Sigler [1987]). This species is unique among Goodeids in that it (and other members of the subfamily Empetrichthyinae [*Crenichthys* and *Empetrichthys*]) lay eggs and do not bear live young (Grant and Riddle 1995; Doadrio and Dominguez 2004; Webb et al. 2004). *Crenichthys baileyi* are broadcast spawners, releasing eggs and sperm into open water for external fertilization with no subsequent parental care. Eggs are adhesive and attach firmly to nearby vegetation (Kopec 1949).

Annual *C. baileyi* fecundity (the total number of eggs spawned by a female during a single spawning season) is not known. Most springfish females appear to spawn twice annually (Espinosa 1968; Minckley and Marsh 2009), but produce relatively few eggs per spawning event. Spawning is asynchronous (individual females will spawn at different times of the year; Deacon and Minckley 1974) and occurs over an extended period or perhaps year-round (Espinosa 1968; Sigler and Sigler 1987; Marsh and Minckley 2009). There may be a peak in spawning during the warm summer months as has been observed for *C. b. moapae* (Scoppettone et al. 1987). The period of spawning activity may be regulated by primary productivity (production of food) in the fish's habitat (Schoenherr 1981). The number of eggs deposited per spawning event and time to hatching has been reported for springfish held in aquaria. Wild *C. b. moapae* brought into captivity deposited 10-17 eggs per spawning, and these eggs hatched in 5 to 7 days (Kopec 1949). Espinosa (1968) found the number of ripe ova in *C. baileyi* specimens ranged from 3 to 13 in *C. b. moapae*, 6 to 17 in *C. b. grandis*, and 6 to 18 in *C. b. thermophilus*. Environmental conditions may also influence egg numbers in springfish.

Females generally reach sexual maturity between lengths of 24-28 mm (Espinosa 1968). However, *C. baileyi* populations in environments with exotic (i.e., non-native) aquatic species tend to have females that are smaller at first maturity (defined as the average age at which fish of a given population mature for the first time) than those living without exotics, potentially due to competition for food and overcrowding resulting in growth rate reductions (Espinosa 1968). Because reproductive potential (i.e., egg numbers) is strongly correlated with size of females, a reduction in size at first maturity may result in a reduction in overall population fecundity at sites with exotics (Espinosa 1968). Additionally, non-native species may affect *C. baileyi* mating behavior: it has been observed that White River springfish will attempt to mate with shortfin mollies (Deacon et al. 1980; Hardy 1982).

Important proximate cues for springfish spawning are not well understood, but may be related to seasonal variations in temperature, photoperiod, and light intensity. Further study is needed to understand the effects of these factors on reproductive rhythms of *C. baileyi* (Espinosa 1968). *Crenichthys baileyi* are inactive at night and active during the day; this species also tends to exhibit a bimodal pattern of activity during daylight, with activity increasing after sunrise followed by a midday depression in activity and an afternoon peak (Deacon and Wilson 1967; Hubbs et al. 1967; Wilde 1989). The primary stimulus for activity appears to be light (Deacon and Wilson 1967; Hubbs et al. 1967). Periods of activity may be related to feeding behavior (Deacon and Wilson 1967; Deacon and Minckley 1974; Wilde 1989).

Crenichthys baileyi feeds opportunistically and has an omnivorous diet that may include food items such as diatoms, algae, plant parts, detritus, and macroinvertebrates (Deacon et al 1980; Williams and Williams 1982; Wilde 1989; Hobbs 1998). Differences in diet have been observed both seasonally and between populations of *C. baileyi*, which may be contributed to differences in habitat or other factors that affect food item availability. Wilde (1989) found a preponderance of invertebrates, especially amphipods (small crustaceans), in the stomachs of *C. b. thermophilus*; and, Williams and Williams (1982) found *C. b. albivallis* to be primarily herbivorous (plant-eating). Wilde (1989) noted a shift in diet to herbivory in the winter when invertebrates were not abundant. Springfish forage along substrate and in vegetation, as evidenced by the ingestion of bottom-dwelling invertebrates, plant fragments, and detritus (USFWS 1998).

Historically, White River springfish co-occurred to varying degrees with the following native fish at Ash Springs: Pahranagat roundtail chub (*Gila robusta jordani)*; Pahranagat speckled dace (*Rhinichthys osculus velifer*); and the now-extinct Pahranagat spinedace (*Lepidomeda altivelis*) and Pahranagat desert sucker (*Catostomus clarki* ssp.) (Miller and Hubbs 1960). Hiko White River springfish historically co-occurred with the chub, speckled dace, and desert sucker at Crystal Spring (based on Hubbs' field notes, cited in Williams and Wilde 1981), and possibly co-occurred with all three species at Hiko Spring as well (Courtenay et al. 1985). Information on inter-specific interactions and habitat partitioning for these native species is generally not available. Gilbert (1893) reported that springfish were associated with speckled dace in the spring pool area of Ash Springs. However, distribution overlap with *C. baileyi* was likely limited for some of these native species due to different tolerances for water temperatures (Courtenay et al. 1985).

The fish community at Ash, Crystal, and Hiko springs has changed considerably from historic conditions due to habitat alterations and the introduction of non-native aquatic species. Today, the fish communities have shifted to predominantly non-native species, including but not limited to: mosquitofish, shortfin mollies, sailfin mollies (*P. latipinna*), convict cichlids (*A. nigrofasciatus*), carp (*Cyprinus carpio*), and tilapia species (NDOW 2012a). Interactions with these non-native species may influence life history traits of *C. baileyi*, as noted above (e.g., differences in size at first maturity in *C. baileyi* populations with and without exotics).

Additionally, non-native fish may cause a shift in habitat use by native fish (Brown and Moyle 1991 and Douglas et al. 1994, cited in Scoppettone et al. 2005).

<u>Spatial Distribution</u>

The White River springfish is endemic to thermal pools and outflows created by Ash Springs in Pahranagat Valley, Lincoln County, Nevada (Williams and Wilde 1981, Figure 1). Historically, the distribution of White River springfish in the outflow of Ash Springs was as far downstream as 8 to 11 km (5 to 7 miles [mi]) north of the town of Alamo (Miller and Hubbs 1960). Much of this outflow stream (west of US Highway 93 [US 93]) is commonly referred to as the Pahranagat Creek or Pahranagat Ditch. Williams and Wilde (1981) described the spring pool population of White River springfish as being separated from the outflow stream population by steep topography that would have prevented migration of springfish in the outflow stream into the spring pool. The outflow stream, on the other hand, may occasionally receive some Hiko White River springfish individuals that are flushed downstream from Crystal Spring to the north (also located within the creek bed) during flooding events (Williams and Wilde 1981).

The Hiko White River springfish was historically restricted to the thermal pools and outflows of Hiko and Crystal springs (Williams and Wilde 1981), two large thermal springs discharging on the valley floor of Pahranagat Valley north of the town of Alamo (Figure 1). A refuge population has been established at Blue Link Spring, Mineral County, Nevada.

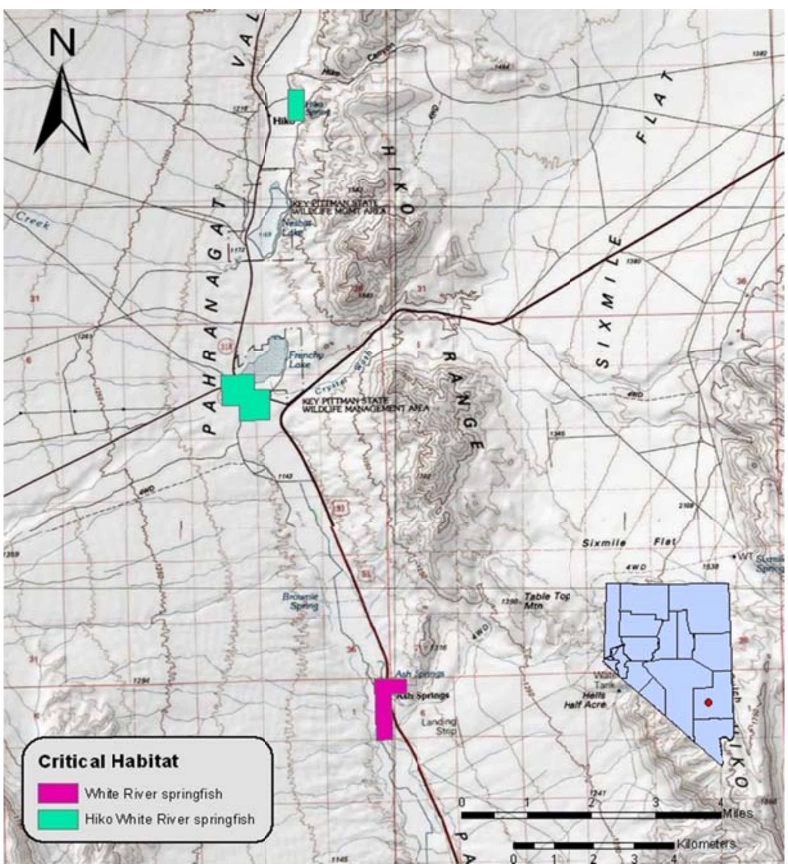

Figure 1. Map of White River springfish and Hiko White River springfish critical habitat.

Abundance

Although historical (pre-1980s) estimates of abundance for the Pahranagat Valley springfishes are generally unavailable, *C. baileyi* was described as typically common wherever found (La Rivers 1994). Recently, a variety of methods have been used to estimate abundance, including ocular observations, snorkel surveys, and mark-recapture surveys. The Nevada Department of Wildlife (NDOW) has been the primary party responsible for monitoring these fishes over the last couple of decades and their surveys are the best available information on the current population status of the Pahranagat Valley springfishes.

Ash Spring

Historical estimates of White River springfish abundance are generally unavailable. It was reported as common throughout its distribution in 1938 (Miller and Hubbs 1960). By 1959, it still appeared to be "common" in the Ash Springs pool (though in less abundance), and occurred in "moderate" numbers to several kilometers downstream (Miller and Hubbs 1960). By the early 1980s, White River springfish numbers at Ash Spring were reported to be "considerably reduced" from twenty years earlier (Courtenay et al. 1985), and it was reportedly scarce in the Ash Springs outflow (Hardy 1982, cited in Tuttle et al. 1990). Tuttle et al. (1990) estimated the number of adult White River springfish (> 25 mm TL) at Ash Springs during the mid-1980s at between 1,000 and 1,700 individuals based on snorkel surveys; almost all fish were observed in the Ash Springs pool. However, 1994 surveys using mark-recapture methods resulted in considerably higher population estimates (46,275 ± 422 springfish; NDOW 2012a).

Currently, White River springfish in the Ash Springs system occur primarily in the spring pools and outflow located above (to the east of) US 93, and in limited numbers in the outflow below US 93 to the confluence with Pahranagat Creek (NDOW 2012a). The majority (~95 percent) of the fish's distribution is on private property, with the remaining 5 percent being on land administered by the Bureau of Land Management (BLM). Population counts or estimates of White River springfish have been inconsistent in methods and frequency throughout its monitoring history because of access issues related to land ownership; e.g., surveys have often been limited to the small portion of the fish's distribution that is on BLM land. In 2005, NDOW was granted permission to access private lands and survey for White River springfish throughout the Ash Springs system for the first time in about 10 years (NDOW 2010a). Visual snorkel surveys conducted in 2006 found springfish to be "abundant" and distributed throughout the BLM and private land portions of the spring and outflow (NDOW 2006). In 2010, NDOW counted 730 springfish during a snorkel survey, and documented fish concentrating near the major spring inflows (NDOW 2010a). In February 2011, 1,400 springfish were counted during an NDOW snorkel survey. During June 2012 snorkel surveys, NDOW counted 5,462 springfish (NDOW 2012d). Springfish were observed to be abundant throughout the spring outflow above US Highway 93 and rare in the outflow below the highway during all survey visits between September 2011 and June 2012 (NDOW 2012d).

Hiko and Crystal Springs

The Hiko White River springfish was historically restricted to the thermal pools and outflows of Hiko and Crystal Springs (Williams and Wilde 1981), two large thermal springs discharging on the valley floor of Pahranagat Valley north of the town of Alamo. In 1963, Hiko Spring outflow was modified for irrigation, which caused the extirpation of two other native fish species from this spring system (Courtenay et al. 1985). The introduction of largemouth bass (*Micropterus salmoides*), mosquitofish (*Gambusia affinis*), and shortfin mollies (*Poecilia mexicana*) into Hiko Spring shortly thereafter (1964-1965) was followed by a decrease in springfish abundance and the extirpation of the species from this site by 1967 (Deacon 1979; Minckley and Deacon 1968; Williams and Wilde 1981; Courtenay et al. 1985). Descendants of springfish collected from Crystal Spring (70 individuals) were transplanted into Hiko Spring in 1984 (USFWS 1998), and the population increased and then remained fairly stable until the year 2000. During this period, the estimated population size reached a high of over 8,000 springfish in 1986 and only occasionally fell below 4,000 fish (NDOW 2011a). However, the Hiko Spring population has decreased substantially since 2000, coinciding with the appearance of red swamp crayfish (*Procambarus clarkii*) in the system (NDOW 2011a). The estimated springfish population at Hiko Spring has been between about 300 and 1,000 fish from 2006 onward.

Early estimates of Hiko White River springfish population size at Crystal Spring are not available, but the species was described as abundant in the spring pools and common in the outflows during the 1960s (Courtenay et al. 1985). Following the introduction of convict cichlids (*Amatitlania nigrofasciatus*) and shortfin mollies in the 1970s (Williams and Wilde 1981; Courtenay and Deacon 1982), there was a steep decline in the Hiko White River springfish population at this site (Courtenay et al. 1985). Population size estimates based on mark-recapture methods in 1986 and 1987 were less than 300 individuals, and springfish were restricted to the headwater pools (Tuttle et al. 1990). Surveys conducted by NDOW since 2004 indicate that the species continues to persist at this site, but at low numbers (typically, population estimates are <1,000 individuals in the north and south spring pools combined) (NDOW 2011b). While a variety of methods have been used to describe and estimate abundance of Hiko White River springfish over the years, NDOW has recently conducted mark-recapture surveys using the Peterson Method with a 95 percent confidence interval recommended by Ricker (1975) to estimate population size. Population estimates for Hiko White River springfish at Hiko and Crystal springs during recent survey years are as follows (taken from NDOW 2010b-c, 2011a-b; 2012 b-c; high estimates reported when multiple surveys occurred within a given year):

2010 Population Estimates:

- Hiko Spring: 236 springfish with a 95% confidence interval of 156 to 357 fish.
- Crystal Spring:
    - North Pool: 228 springfish with a 95% confidence interval of 156 to 334 fish.
    - South Pool: 490 springfish with a 95% confidence interval of 252 to 681 fish.

2011 Population Estimates:

- Hiko Spring: 247 springfish with a 95% confidence interval of 147 to 448 fish.
- Crystal Spring:
    - North Pool: 111 springfish with a 95% confidence interval of 69 to 191 fish.
    - South Pool: 720 springfish with a 95% confidence interval of 280 to 1,873 fish.

2012 Population Estimates:

- Hiko Spring: 379 springfish with a 95% confidence interval of 243 to 626 fish.
- Crystal Spring:
  - North Pool: 63 springfish with a 95% confidence interval of 28 to 252 fish.
  - South Pool: 407 springfish with a 95% confidence interval of 273 to 605 fish.

<u>Blue Link Spring</u>

In 1984, a refuge population of Hiko White River springfish was established at Blue Link Spring in Mineral County, Nevada, because of threats to the Hiko and Crystal springs populations (USFWS 1998). This site is on land administered by BLM. A total of 264 fish from Hiko Spring were transplanted to this site, and a population was quickly established and within three years was estimated at over 11,000 fish. In 1990, the population crashed and was believed lost when thermal spring outflows into the reservoir decreased (due to valve failure or vandalism) and the water cooled considerably (NDOW 2011c). Following repair of the spring box water supply valves, an additional 150 fish from Hiko Spring were transplanted to Blue Link Spring in 1991 (USFWS 1998; NDOW 2011c). The population at this site has since recovered (USFWS 1998). A visual estimate during a July 2011 survey put the population at about 4,000 fish (NDOW 2011c).

<u>Habitat or Ecosystem</u>

<u>Pahranagat Valley</u>

Pahranagat Valley is approximately 65 kilometers (40 miles) long and 11 kilometers (7 miles) wide (USFWS 1998). Its northern boundary is the constricted section of the valley about 16 kilometers (10 miles) north of Hiko, Nevada, and its southern boundary is a similarly constricted point in the valley immediately south of Maynard Lake, which has been dry since 1940 (U.S. Department of Agriculture 1940). Pahranagat Valley extends over approximately 142,449 hectares (352,000 acres), and includes 4,850 hectares (12,000 acres) of private lands, 538 hectares (1,330 acres) of State land, 2,180 hectares (5,400 acres) of USFWS land, and 134,882 hectares (333,300 acres) of public lands administered by the BLM.

<u>Ash Springs</u>

Ash Springs is the southernmost, largest, and warmest of the three major spring systems found in Pahranagat Valley. Ash Springs consists of at least seven springs which originate from a contact between alluvium and bedrock (Garside and Shilling 1979). The springs have a common outflow stream, which has been impounded by construction of US 93 and now forms a large, deep convoluted pool (USFWS 1998). Depths in the pool are controlled by a control gate located adjacent to US 93, which is used to manage outflows used for irrigation. The spring pool provides good stream flow when this gate is open. Below the highway, the outflow stream flows southwest to join the outflow stream from Crystal Spring. From this point on, the stream is referred to as the Pahranagat Creek.

Based on intermittent measurements collected by the U.S. Geological Survey (USGS), the mean annual discharge of Ash Springs is approximately 18.2 cubic feet per second (cfs) (2004 – 2012). Over this period of record, discharge measurements ranged from 14.5 to 21.8 cfs at Ash Springs (USGS 2012). Temperature measurements range from approximately 31 to 36°C (88 to 97°F)

(Hubbs and Hettler 1964; Garside and Schilling 1979; Courtenay et al. 1985; Tuttle et al. 1990; BIO-WEST 2007). Dissolved oxygen concentrations at Ash Springs ranged from 1.8 to 5.1 mg/l (ppm) seasonally during a study by Tuttle et al. (1990); BIO-WEST (2007) recently recorded dissolved oxygen concentrations of 1.71 mg/l (or ppm) at the source of Ash Spring.

The Ash Springs pool occupies a surface area less than 2 acres in size, and is approximately 0.4 km (0.2 mi) long and 0.5 to 2.0 m (1.6 to 6.6 ft) deep (Tuttle et al. 1990). The bottom consists of sand and silt with locally dense submergent vegetation and algal mats. A thick canopy of willow (*Salix* sp.) and ash trees (*Fraxinus* sp.) border the eastern bank while the west side is more sparsely vegetated with willow, ash, and grasses.

Golden et al. (2007) performed biological surveys of the BLM managed portion of Ash Springs. Aquatic vegetation documented included: creeping primrose-willow (*Ludwigia repens*), duckweed (*Spirodela* sp.), and horsehair algae (*Chlorophyceae* sp.). Emergent vegetation included: Olney's three square bulrush (*Schoenoplectus americanus*), saltgrass (*Distichlis spicata*), spikerush (*Eleocharis* sp.), and Yerba mansa (*Anemopsis californica*). Shrubs or trees around Ash Springs include salt cedar (*Tamarix* spp., BLM 1989 and observations by USFWS biologists), cottonwood (*Populus* sp.) and green ash (*Fraxinus pennsylvanica*). Surveys that included the private portion of Ash Springs described the most abundant aquatic plants to include spiny naiad (*Najas marina*), filamentous alga, muskweed, and red ludwigia (*Ludwigia repens*), which was lower in abundance than the previous two (NDOW 2007a).

Ash Springs currently supports many aquatic invasive species, including western mosquitofish, shorfin molly, convict cichlid, and bullfrogs (*Lithobates catesbeianus*) (BIO-WEST 2007; NDOW 2010a). Red swamp crayfish have been documented in low numbers west of US 93 but not east in Ash Springs pool (NDOW 2012a). These non-native species are thought to negatively impact the White River springfish.

<u>Crystal Springs</u>

Crystal Springs is the second largest of the three major spring systems found in Pahranagat Valley. It consists of at least two springs; one flows from an orifice in limestone bedrock and the other from a contact between alluvium and bedrock (Garside and Shilling 1979). This spring system is on private land and has been extensively modified for agricultural use (Courtenay et al. 1985). It consists of two impounded headwater pools with outflows that are diverted for agriculture (Tuttle et al. 1990). These pools have abundant aquatic vegetation and a silty bottom (Tuttle et al. 1990). Pool water level is controlled by a gate that directs flow into one of two outflows. The smaller outflow, created to provide water for nearby agriculture, conveys water intermittently, and thus offers little habitat for the Hiko White River springfish. The main outflow (the historical headwaters of Pahranagat Creek) continues for approximately 900 m (0.6 mile) before flowing into a concrete irrigation channel, with five diversion boxes and seven outlet concrete channels (four to the east and three to the west). The main outflow channel is characterized by dense aquatic vegetation and silt substrate (Tuttle et al. 1990), but the riparian corridor along the main concrete channel is minimal. Farther downstream, the water flows back into an earthen channel. Portions of this channel have previously been trenched, but most areas appear to have been undisturbed for several years. Flow in this channel is periodically interrupted by agricultural diversions; however, these diversions do not commonly cause flow to cease entirely. The last portion of the Crystal Springs outflow is an earthen ditch extending 5.8 km (3.6 mi) and averaging 1 meter (3.3 ft) in width. This portion connects to Ash Springs outflow; however, for much of the year only the upper 4.8 km (3.0 mi) of the ditch contains water.

Based on intermittent measurements collected by USGS, the mean annual discharge from Crystal Springs is approximately 12.2 cfs (2004 – 2012). Over this period of record, discharge measurements ranged from 10.2 to 13.6 cfs (USGS 2012). Water temperature averages about 26 to 28^{o}C (79 to 82^{o}F) in the spring pools (Hubbs and Hettler 1964; Courtenay et al. 1985; Tuttle et al. 1990; BIO-WEST 2007). Temperatures were warmer during the earlier part of the century, but the spring has cooled by several degrees in recent years (USFWS 1998). The dissolved oxygen levels in Crystal Springs ranges from 1.3 to 6.4 mg/l (1.3 to 6.4 ppm) depending on the season (Tuttle et al. 1990). The main channel of the outflow has a much greater dissolved oxygen concentration (6.5 to 15.7 m/l or ppm) than the created irrigation ditch (3.6 to 5.9 m/l or ppm) (Tuttle et al. 1990). BIO-WEST recorded low dissolved concentrations of 1.02 mg/l (1.02 ppm) at the source of Crystal Spring in 2005.

Golden et al. (2007) performed biological surveys at Crystal Spring in 2005. Aquatic vegetation documented included creeping primrose-willow, watercress (*Nasturtium officinale*), and horsehair algae. Emergent vegetation included Baltic rush (*Juncus articus*), broadleaf cattail (*Typha latifolia*), saltgrass, spikerush, and Yerba mansa. Trees near the spring included Fremont cottonwood (Populus fremontii), willow (*Salix* sp), and the non-native salt cedar (*Tamarix* spp.).

Crystal Springs currently supports many aquatic invasive species, including red swamp crayfish, western mosquitofish, shortfin mollies, convict cichlids, and bullfrogs (BIO-WEST 2007; NDOW 2012c). These non-native species negatively impact the Hiko White River springfish population.

<u>Hiko Spring</u>

Hiko Spring is the northernmost, smallest, and coolest of the three major spring systems found in Pahranagat Valley. The water issues from a contact between alluvium and dolomite (Garside and Schilling 1979). This spring system is located on private land and has been extensively modified from historical condition. The outflow stream from Hiko Spring was probably first redirected and impounded in 1865 to provide water for the silver stamp mills in the area, and secondarily to create Nesbitt and Frenchy Lakes (Courtenay et al. 1985), two lakes that are now part of NDOW's Key Pittman Wildlife Management Area. Today, the water from Hiko Spring is used primarily for agricultural and municipal purposes. Previously diverted into concrete ditches, the entire outflow stream is now captured in underground pipes, which transport the water to nearby agricultural lands. The only surface water remaining is an impoundment at the spring source and a small marsh created by seepage from the spring pool.

Based on intermittent measurements collected by USGS, the mean annual discharge from Hiko Spring is approximately 5.5 cfs (1982 – 1998). Over this period of record, discharge measurements ranged from 4.0 to 7.2 cfs (USGS 2012). Hiko Spring maintains a temperature of approximately 26^{o}C (79^{o}F) (Hubbs and Hettler 1964; Courtenay et al. 1985; BIO-WEST 2007), although a maximum temperature of 32^{o}C (90^{o}F) was recorded in 1934 (USFWS 1998).

Dissolved oxygen concentrations at Hiko Spring were recorded at 3.0 mg/l (or ppm) by Hubbs and Hettler (1964) and 3.6 mg/l (or ppm) by BIO-WEST (2007).

Golden et al. (2007) performed biological surveys at Crystal Spring in 2006. Aquatic vegetation documented included horsehair algae, and emergent vegetation included broadleaf cattail, Bermuda grass (*Cynodon dactylon*), spikerush, Olney's three square bulrush, scratchgrass (*Muhlenbergia asperifolia*), sedge (*Carex* sp.), and Yerba mansa. Trees near the spring included several species of willow.

Hiko Spring currently supports many aquatic invasive species, including red swamp crayfish, western mosquitofish, shortfin mollies, convict cichlids, and bullfrogs (BIO-WEST 2007; NDOW 2012b).

<u>Blue Link Spring</u>

A refuge population of the Hiko White River springfish was established at Blue Link Spring in Mineral County, Nevada. It is located approximately 11.6 miles east-southeast of U.S. Highway 95 from Sodaville (NDOW 2005). The spring and adjacent lands, consisting of 4.7 ha (11.6 ac), were withdrawn from mineral entry by the BLM in 1984 (58 FR 31655). Blue Link Spring is an artificial artesian well that was the result of a mining test drilling site that hit water (NDOW 2005). A berm was built to impound the water (likely for livestock use) and dynamite was used to create a deep area (NDOW 2005).

During a site visit, it was noted that 10 longhorn cattle were using the springpool and that heavy ungulate use was present along springpool edges. No cattails or bullrush were observed at this time (NDOW 2011d). A 0.5-inch PVC pipe was installed in 2010to feed water into the springpool (NDOW 2011d). Past maintenance practices by the BLM and NDOW have included removal of vegetation from the pond (USFWS 2004).

<u>Changes in Taxonomic Classification or Nomenclature</u>

There have been no changes in taxonomic classification or nomenclature of the Pahranagat Valley springfishes, but some scientists have concluded that taxonomic changes are warranted. During the past century the taxonomy of *Crenichthys* has been controversial (Grant and Riddle 1995). *Crenichthys baileyi* is a member of the Family Goodeidae and one of two genera within this family that are oviparous (Wourms 1981). The hypothesis that *Chrenichthys* belonged in the family Goodeidae was presented by Parenti (1981) and supported in studies by Grant and Riddle (1995).

Williams and Wilde (1981) provide the most recent subspecific taxonomic classification and nomenclature change for *C. baileyi*, in which 5 subspecies were recognized. The 5 subspecies of *C. baileyi* are *C. b. baileyi* (White River springfish), *C. b. grandis* (Hiko White River springfish), *C. b. moapae* (Moapa White River springfish), *C. b. albivallis* (Preston White River springfish) and *C. b. thermophilus* (Mormon White River springfish). The validity of the five subspecific classifications of *C. baileyi* populations based on morphometric, meristic, population color differences, and temporal isolation (Williams and Wilde 1981, Perkins et al. 1997) has been questioned (Rosenfeld 1991, Perkins et al. 1997).

Disjunct populations exhibiting morphological clines may occur as a result of environmental modifications coupled with adaptive genetic changes (Barlow 1961). In an analysis of electrophoretic data, Rosenfeld (1991) found almost no divergence in five subspecies of *C. baileyi*. Perkins et al. (1997) concluded that the five subspecies of *C. baileyi* should be grouped into two subspecies because fixed allelic differences, genetic differences, and genetic data concordance to hydrographic history. The two subspecies would be *C. b. moapae* and *C. b. baileyi* which would include the currently recognized subspecies *C. b. albivallis*, *C. b. baileyi*, *C. b. grandis*, and *C. b. thermophilus*.

It has been recognized that assessments of subspecific status may need to be reevaluated periodically (Haig et al. 2006). Further research is needed to provide a more rigorous evaluation of the subspecies taxonomic status of *C. baileyi*. Studies of the subspecific status should consider ecological, geographic, life-history, morphological, and genetic data (Fallon 2007). Fallon (2007) recommended using multiple markers from nuclear and mitochondrial genomes.

Genetics

Genetic variation of *C. baileyi* is currently recognized as expressing itself through the tolerance of varying temperature and dissolved oxygen levels as well as variation in subtle meristic and morphological variation between the five recognized subspecies of *C. baileyi* (Hubbs and Hettler 1964, Williams and Wilde 1981). Environmental variables, sometimes only one, can change several morphologic characteristics regardless of genotype (Hubbs 1970). The separation of environmental and genetic factors poses taxonomic problems (Tåning 1952 as cited in Hubbs 1970). *Crenichthys baileyi* inhabiting the outflow creek below Ash Springs exhibit integration of color and meristic characters with *C. b. grandis* (Williams and Wilde 1981). Integration may occur because *C. b. grandis* can be flushed from Crystal Springs during flood events into lower stretches of the Pahranagat River channel (Williams and Wilde 1981). The genetic purity *C. b. baileyi* in the headpool of Ash Springs is maintained by precipitous topography (Williams and Wilde 1981). Minckley and Marsh (2009) present a dichotomous key for distinguishing five allotopic subspecies separated by Williams and Wilde (1981):

1a. Head shorter, average < 28% SL; narrow, bony interorbital width < 13% SL;
Preston Big, Preston Town, Preston #3, Arnoldsen, Cold, Indian, and
Lund Town springs, White Pine County ……………………………….…. *C. b. albivalis*

1b. Head longer, average 29% SL or more, and broader, bony interorbital
width usually 13.5% SL, or more ……………………………………………………. 2

2a (1b) Median fins more posterior, resulting in shorter distance from anal origin
to caudal basin, <33% SL; snout length variable, av. > 8.5% SL; Mormon, Hot Creek,
and Moon River springs, Nye County ……………………………….…… *C. b. thermophilus*

2b. Median fins more anterior, resulting in longer distance from anal origin to
caudal basin, >33% SL; snout shorter, av. < 8.5% SL ……………………..…………….. 3

3a (2b) Average adult SL > 40 mm; breeding males with ventral surface of head
And body lemon yellow, sometimes extended as deep orange into caudal fin;
Hiko and Crystal springs, Lincoln County ……………………………………… *C. b. grandis*

3b. Average adult SL <35 mm; pigmentation of breeding males not as above …… 4

4a (3b). Anal rays ~12; caudal rays 17; lateral line scales < 28;
Ash Spring, Lincoln County …………………………………….………..…… *C. b. baileyi*

4b. Anal rays ~13; caudal rays av. 17.5 or more; lateral line scales >28;
Headsprings of Moapa River, Clark County ……………………………...… *C. b. moapae*.

<u>Species-specific Research and/or Grant-supported Activities</u>

The USFWS provides section 6 funding to the NDOW for Pahranagat Valley native fishes. Specifically, NDOW is tasked with:

- Coordinating the Pahranagat Valley Recovery Implementation Team (RIT).
- Conducting population monitoring and status assessment efforts for listed endangered and species of special concern fishes in Pahranagat Valley, Lincoln County and Blue Link Spring refugium, Mineral County.
- Conducting non-native species control and eradication efforts.
- Implementing the Programmatic Safe Harbor Agreement for Pahranagat Valley through identification of private land conservation opportunities and enrollment of landowners.
- Implementing specific aquatic habitat restoration and species enhancement activities on private and public land sites as opportunities are available.

New research conducted since the listing in 1985 and finalization of the recovery plan in 1998:

- Rosenfeld. 1991. Study of subspecific designations of *C. baileyi* using electrophoretic data.
- Perkins et al. 1997. Populations of *C. baileyi* based on 21 polymomorphic allozyme loci.
- Doadrio and Domíınguez. 2004. Phylogenetic relationships within the fish family Goodeidae based on cytochrome *b* sequence data.
- Webb et al. 2004. Molecular phylogeny of the livebearing Goodeidae (Cyprinodontiformes).

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

Although historical usage of Ash, Hiko, and Crystal springs is not fully understood, habitat manipulation for agricultural purposes has been a longstanding practice (USFWS 1985; Courtney et al. 1985). The first manipulation of these springs for agriculture occurred before European settlement of Pahranagat Valley by the Pahranagat Indians (Courtney et al. 1985). The largest irrigation ditch dug by the Pahranagat Indians was created to capture the outflow of Crystal Springs, and measured 2.4 meter wide, 1.8 m deep, and several kilometers long (Thompson and West 1881, in Courtney *et al.* 1985). More recent manipulations have occurred following the settlement of Pahranagat Valley in 1865. Spring modifications, including the impoundment, diversion, and piping of spring outflows for agricultural uses, and the elimination or reduction of aquatic vegetation has resulted in a loss of available habitat for the Pahranagat Valley springfishes and invertebrate food sources (USFWS 1985).

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

Overutilization for commercial, recreational, scientific, or educational purposes was not known to be a factor in the 1985 final listing rule (50 FR 39123). Overutilization for any purpose is not a threat at this time.

FACTOR C: Disease or Predation

<u>Disease</u>
Disease or parasites introduced from exotic aquaria fishes may reduce viability or cause mortality in the Pahranagat Valley springfishes (USFWS 1985). Parasites such as tapeworms (*Bothriocephalus acheilognathi*), nematodes (*Contracaecum* spp.), and anchor worms (*Lernaea* spp.) can occur in native fish populations as a result of nonnative fish introductions (Deacon and Minckley 1974, as cited in USFWS 1998). These parasites are not known to occur naturally within native fish populations in Pahranagat Valley (USFWS 1985), and likely result in negative impacts to the Pahranagat Valley springfishes. Heavy infestations may cause reduced longevity, reduced fecundity, and even cause direct mortality (USFWS 1998).

<u>Predation</u>
Non-native fish and other aquatic species have been implicated in the decline or extirpation of *C. baileyi* populations. As mentioned above, the original population of Hiko White River springfish was extirpated from Hiko Spring and its outflow stream following the introduction of non-native fish, and the *C. baileyi* population at Crystal Spring declined precipitously following introduction of non-native species in that system. Non-native species known to occur in Ash, Crystal, and (or) Hiko springs and outflows include: shortfin mollies, sailfin mollies, mosquitofish, convict cichlids, carp, bullfrogs, and red swamp crayfish (NDOW 2010a). In 2010, tilapia (an African cichlid) was first documented in Pahranagat Valley from the Ash Springs outflow near the confluence with Pahranagat Creek (NDOW 2012a). The potential for tilapia to become established in springfish habitat is a concern: the occurrence and increase in abundance of tilapia in the Muddy River of southern Nevada coincided with a decline in endemic fishes of that system (Scoppettone et al. 1998).

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The State of Nevada classifies the Hiko White River springfish as endangered under Nevada Administrative Code 503.065. Its habitat on Federal or private land was not protected by State law when it was listed under the Act (USFWS 1985). Federal and State regulations providing protection for Hiko White River springfish 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 (NDF), 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 NDF.

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 (Corps or USACE) 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 Corps's 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 Corps 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. However, recent Supreme Court rulings have called this practice into question. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving "isolated" wetlands. Currently, Corps regulatory oversight of such wetlands (e.g., vernal pools) is in doubt because of their "isolated" nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency (USEPA) have released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, isolated wetland habitat (USEPA and USACE 2007). The overall effect of the new permit guidelines on loss of isolated wetlands, such as vernal pool habitat, is not known at this time.

Endangered Species Act (Act)

The Act is the primary Federal law providing protection for these species. The USFWS's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the USFWS has analyzed the potential effects of Federal projects under section

7(a)(2), which requires Federal agencies to consult with the USFWS 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." USFWS 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 USFWS 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 which 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 results 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 USFWS 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 USFWS-approved Habitat Conservation Plan (HCP) that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional HCPs in some areas now provide an additional layer of regulatory protection for covered species, and many of these HCPs are coordinated with California's related Natural Community Conservation Planning program.

<u>Federal Land Policy and Management Act of 1976 (FLPMA)</u>
BLM 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, BLM 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 BLM has a multiple-use mandate under the FLPMA which allows for grazing, mining, and off-road vehicle use, BLM 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.

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

Competition with Nonnative Species

Exotic species have reduced the population of Hiko White River springfish through competition for food and/or space, and by direct predation (Deacon 1979; Courtenay et al. 1985; USFWS 1985). The more omnivorous feeding habits of convict cichlid may make them more competitive for food with White River springfish then shortfin mollies, which tend to be more herbivorous (Tuttle et al. 1990). In experimental conditions, White River springfish exhibited reduced growth when sympatric with convict cichlid likely as a result of aggression, even with cover present (Tippie et al. 1991). Lethal aggression has been documented when convict cichlid are guarding a nest (Tippie et al. 1991). Introduced crayfish species can have a wide trophic plasticity and may cause indirect community effects as a result of trophic cascading (Gherardi 2007). The potential competitive interactions between nonnative species and Pahranagat Valley springfishes have not been studied.

Introduction of Nonnative Aquaria Fish

Release of new nonnative aquatic species continues to be a concern at Crystal and Hiko springs. The warm water of these spring systems is conducive to many aquaria fish that are sold in southern Nevada. The location of these springs in proximity to road systems, combined with their popularity for recreational use, makes them susceptible to unwanted releases of aquaria fish. A recent survey conducted by the NDOW at Crystal Spring (north pool) resulted in the removal of a single nonnative fish from the family Osphronemidae (NDOW 2011). Our concerns as they relate to nonnative aquaria fish introductions are dependent on the species of fish and how they will interact with the springfishes (*e.g.*, competition for resources, introduction of diseases or parasites, and predation). Although nonnative fish introductions have occurred at Hiko and Crystal spring in the past, it is tough to quantify the level of future threat as introductions are generally isolated events.

Groundwater Development

Groundwater development is a new concern that has the potential to negatively impact spring discharge in Pahranagat Valley at Ash, Crystal, and Hiko springs. The USFWS recently provided a biological opinion to BLM for the Southern Nevada Water Authority proposed groundwater development project (USFWS 2012; BLM 2012). This opinion analyzed project construction, operation, and maintenance through the year 2125, 75 years after full project build out (USFWS 2012; BLM 2012). With relation to Pahranagat Valley, the USFWS concluded that pumping in Dry and Delamr valleys (and potentially Cave Valley) may affect spring discharge in Pahranagat Valley during the course of the project (USFWS 2012).

Further, the USFWS determined that the central carbonate-rock province model which predicted minimal to negligible effects to Ash, Crystal, and Hiko springs, likely underestimates the amount that spring flow could be reduced (USFWS 2012; BLM 2012). Due to the uncertainties related to the likelihood and magnitude of drawdown related effects to spring flow, we cannot accurately predict how the Pahranagat Valley springfish will be affected. Given these uncertainties we cannot rule out the possibility of significant impacts to the Pahranagat Valley springfish from future groundwater pumping.

Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a; and Solomon et al. 2007). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is “very likely” (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a; Solomon et al. 2007). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl et al. 2007; Ganguly et al. 2009; Prinn et al. 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a; Meehl et al. 2007; Ganguly et al. 2009; Prinn et al. 2011).

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a; see also Glick et al. 2011). There is no single method for conducting such analyses that applies to all situations (Glick et al. 2011). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Spring systems in Nevada are supplied mainly through aquifers, which are fed by snowmelt and precipitation in mountainous areas (Abele 2011). Groundwater recharge is spatially and temporally variable and largely occurs through a process called net infiltration. Net infiltration is a term used to describe the zone of surface evapotranspiration (Flint et al. 2001, in Flint et al. 2004). It can be affected by air temperature, precipitation, root zone, soil properties, and bedrock permeability (Flint et al. 2004). Climate change is expected to alter temperature and precipitation. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. Our concern with this threat is linked to the extent to which climate change may affect groundwater recharge/discharge and thus alter the habitat in Hiko and Crystal Springs.

<u>Recreational Usage of Spring Habitat</u>
All but a small portion of critical habitat at Ash Springs is on private land; the remainder (approximately 0.1 acre; USFWS 1985) is on land managed by the BLM's Ely District and Caliente Field offices as a recreational site, where swimming/bathing is a common activity. This is an area of high disturbance and NDOW noted turbidity and trash flowing from this high use area on multiple occasions during recent surveys for White River springfish (NDOW 2012). Water quality has been an issue over the years due to the high use of this system for recreation and other activities (BLM 1989). The BLM Resource Management Plan for the Ely District (BLM 2008) provides management actions and guidance for protecting Ash Springs and the springfish. BLM is developing an Ash Springs Recreation Area Management Plan to provide a framework for management direction that addresses issues such as riparian vegetation loss and bank erosion resulting from recreation use (UFWS 2008b).

III. RECOVERY CRITERIA

Recovery plans provide guidance to the USFWS, 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, over all, 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 recovery plan established equivalent delisting criteria for the Pahranagat Valley springfishes:

> 1) a self-sustaining population (comprising three or more age-classes, a stable or increasing population size, and documented reproduction and recruitment) is present in the spring pool of Hiko and Crystal Springs (Hiko White River springfish) or Ash Spring (White River springfish) for three generations (or a minimum of six consecutive years); and
>
> 2) impacts to the species and its habitats have been reduced or modified to a point where they no longer represent a threat of extinction or irreversible population decline.

Criteria 2 addresses three of the five listing factors (or threats) described in section 4(a)(1) of the Act, (A) the present or threatened destruction, modification, or curtailment of its habitat or range, (C) disease or predation, and (E) other natural or manmade factors affecting its continued existence. The listing factors (B) over-utilization for commercial, recreational, scientific or educational purposes and (D) the inadequacy of existing regulatory mechanisms are not relevant. Difficulty accessing privately owned areas has prevented progress towards implementing and monitoring recovery actions. Limited age class data has been collected during monitoring and prevents a complete evaluation of populations with regards to this delisting criterion.

In September 2008, the USFWS and NDOW entered a programmatic Safe Harbor Agreement (PSHA) under which private landowners can enroll through Cooperative Agreements (USFWS 2008a). The PSHA may assist with developing and implementing recovery actions. The purpose of the agreement is to promote the enhancement of survival and recovery as well as conservation of federally listed species in Pahranagat Valley which includes *C. b. baileyi* (USFWS 2008a).

IV. SYNTHESIS

<u>Hiko White River springfish</u>

The current population abundance numbers provided by NDOW show the population persisting at Ash, Hiko, and Crystal springs but at low numbers. A refuge for the species located at Blue Link Spring continues to show high population numbers. Habitat manipulation and predation/competition with nonnative species continue to be the major threats. Uncertainties regarding groundwater withdrawal and climate change may pose future threats to the species.

Efforts to remove nonnative species are being carried out by NDOW. These efforts have shown to only partially remove the nonnative populations for a limited amount of time. A PSHA was developed and signed by the USFWS and NDOW; to date, no landowners have participated and signed the PSHA. There is no criteria to downlist the Hiko White River springfish and negligible progress has been made towards the delisting criteria. Although the USFWS and NDOW continue to work towards delisting goals, further progress needs to be made towards addressing the delisting criteria. Therefore, Hiko White River springfish still meets the definition of endangered, and we recommend no status change at this time.

White River springfish

Monitoring of White River springfish has been sporadic, most recently qualitative, and appears to be stable but remains at depressed levels based on earlier historical accounts. Potential threats from habitat development on private lands seem to have lessened but remains possible. Uncertainties regarding groundwater withdrawal and climate change may pose future threats to the species. Recreational use of Ash Springs pools on public land threatens habitat by affecting bank stability, shoreline vegetation, and water quality. Predation and competition continue to be the greatest threat. Based on the information available, White River springfish remains at risk of extinction because of its restricted range, depressed population, and ongoing threats and it is recommended that White River springfish remain listed as endangered, and we recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X_ No Change

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

- Continue working with private landowners to foster positive working relationships and develop conservation agreements that facilitate recovery actions. Since the spring pool habitat of Crystal and Hiko springs are on private property, agreements must be in place to conduct habitat improvement projects. Habitat improvement projects may include projects that dry or divert water (to eradicate nonnatives), nonnative vegetation removal/treatment, and agricultural use modifications amongst others.
- Develop a detailed and standardized protocol for population monitoring efforts.
- Reassess nonnative species control and eradication methods. Develop a plan and/or protocol for exotic species removal that articulates strategies, rationales, and assumptions for various alternatives. Regularly analyze the effectiveness of removal efforts and adapt

to new methods as they are identified. Study and document interactions between all aquatic species within the system (*e.g.*, habitat overlap, predation/aggression).

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Hiko White River Springfish (*Crenichthys baileyi grandis*)
White River Springfish (*Crenichthys baileyi baileyi*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number: no change.

Review Conducted By: James Harter, Nevada Fish and Wildlife Office

Date Submitted to the State Supervisor: December 12, 2012

FIELD OFFICE APPROVAL:

State Supervisor, Nevada Fish and Wildlife Office

Approve Edward D. Koch ____________ Date 12/18/12