White River Spinedace
Lepidomeda albivallis

5-Year Review:
Summary and Evaluation

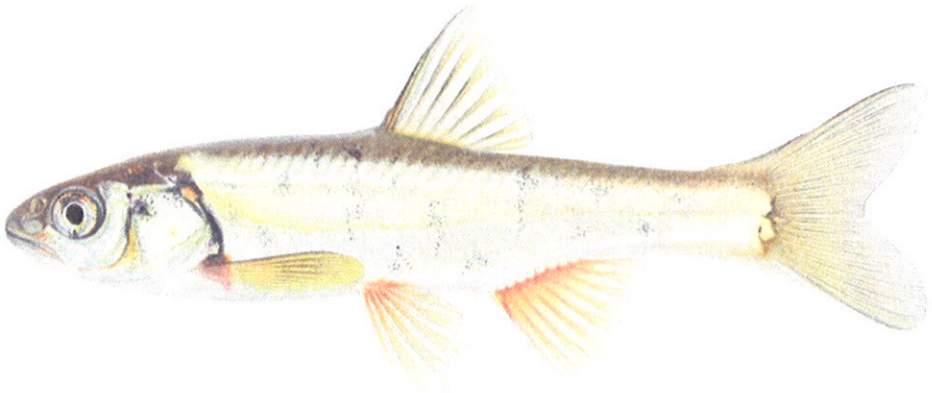

Illustration by Joseph R. Tomelleri

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

January 29, 2010

5-YEAR REVIEW

White River spinedace (*Lepidomeda albivallis*)

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. 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:

As summarized from the Recovery Plan for this species (Service 1994), White River spinedace are endemic to the White River system in Nye and White Pine Counties, Nevada. The White River spinedace is a member of the cyprinid tribe Plagopterini known only from the lower Colorado River Basin (Miller and Hubbs 1960). The Plagopterini tribe of cyprinid fishes includes the monotypic genera *Meda* (spikedace) and *Plagopterus* (woundfin), and the polytypic genus *Lepidomeda* (spinedace). Members of this tribe are distinguished from other cyprinids by: 1) the spinelike character of the pelvic and pectoral fin rays, and the two anterior dorsal fin rays; 2) a membranous connection between the innermost ray of the pelvic fins and the belly; 3) bright silver coloration; and 4) the absence or diminutive development of body scales (Miller and Hubbs 1960). Spinedace are the most generalized and diverse of the genera. White River spinedace consume a variety of food items, which indicates that the species is a habitat and dietary generalist (Scoppettone *et al.* 2004a). Analysis of stomach contents from White River spinedace that were collected in the 1960's and observations of actively feeding spinedace suggest that they feed on drifting invertebrates and plant material (Scoppettone *et al.* 2004a). No life history, food preference, or habitat requirement studies have been completed for the White River spinedace.

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 March 2008. We used information from the Recovery Plan, and survey information from the U.S. Geological Survey (USGS) and Nevada Department of

Wildlife (NDOW) collected from 1997 to 2008. The White River Recovery Implementation Team (WRRIT), comprised of representatives from the Service, NDOW, USGS, Nevada Natural Heritage Program, Nye County Commission, U.S. Forest Service (USFS), Bureau of Land Management (BLM) and Southern Nevada Water Authority (SNWA), meets twice annually to establish goals to meet recovery criteria. The Recovery Plan, survey data, and personal communications with experts were our primary sources of information used to update the species' status and threats. We received no information from the public in response to our Federal Register 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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Lead Field Office: Todd Gilmore, Fisheries Biologist, Nevada Fish and Wildlife Office, Reno, Nevada; (775) 861-6300.

Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on March 22, 2006 (Service 2006). No information was received as a result of that announcement.

Listing History:

Original Listing
FR Notice: 50 FR 37194
Date of Final Listing Rule: September 12, 1985
Entity Listed: White River spinedace (*Lepidomeda albivallis*), a fish species
Classification: Endangered

State Listing
White River spinedace (*Lepidomeda albivallis*) was listed by the State of Nevada as endangered on December 11, 1982.

Associated Rulemakings: Critical habitat was designated for this species at the time of listing on September 12, 1985 (Service 1985).

Review History: No reviews have been conducted for this species.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for White River spinedace is 2C according to the Service's 2009 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 (Service 1983). This number indicates that the taxon is a species that faces a high degree of threat 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: White River Spinedace, *Lepidomeda albivallis*, Recovery Plan
Date Issued: March 28, 1994

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 Endangered Species Act (Service 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

The White River spinedace is not listed as a DPS, nor is there any relevant new information regarding the application of the 1996 policy that suggests this species should be listed as a DPS.

Information on the Species and its Status

Species Biology and Life History

Spatial Distribution

White River spinedace (spinedace) were historically found throughout the upper White River drainage in seven spring systems (Figures 1-3). When the type specimen of the spinedace was collected in 1938, the species was known from the White River below the mouth of Ellison Creek, Preston Big Spring, Nicholas Spring, Lund Spring, Arnoldson Spring, Flag Springs (comprised of North, Middle and South Flag Springs which interconnect and flow into Sunnyside Creek), and the confluence of Nicholas and Preston Big Springs (Miller and Hubbs 1960). At the time of listing in 1985, the species' distribution was limited to Lund and Flag Springs (Service 1985). In 1991, spinedace remained only in a single 70-meter (m) (229.7 foot [ft]) stream reach at North Flag Spring (Scoppettone *et al.* 2004b).

When the recovery plan was published in 1994, distribution of spinedace was limited to the headwater spring pools of North Flag Spring. In 1995, due to lack of reproduction, 20 adult spinedace were moved out of the cold headwater pools into warmer downstream reaches of the

North Flag Spring outflow (Hobbs 2002a,b, 2003a,b, 2004a,b; B. Hobbs, NDOW, pers. comm. 2006). Currently, spinedace are able to freely migrate between each spring and their associated outflows and downstream into Sunnyside Creek, inhabiting approximately 2.5 kilometers (km) (1.55 miles [mi]) of habitat at Kirch Wildlife Management Area (WMA) (Hobbs, pers. comm. 2006).

In 2003, the Service finalized a Safe Harbor Agreement with the private landowner at Indian Spring and implemented habitat restoration measures to establish a refugium for spinedace. In spring 2004, spinedace from Flag Springs were stocked in Indian Spring in an attempt to establish a refugium population (Hobbs 2004b).

Abundance

At the time of listing in 1985, four spinedace were trapped in Flag Springs and 18 spinedace were trapped in Lund Spring (Courtenay, Jr. *et al.* 1985). By 1987, surveys confirmed that the Lund Spring population of spinedace had been extirpated, and spinedace were only found in Flag Springs in two headwater pools with fewer than 100 individuals sighted (Withers 1987).

Beginning in 1995, USGS (1995-1997) and NDOW (1995-2008) started conducting biannual snorkel surveys to estimate the total spinedace population within Flag Springs and downstream in Sunnyside Creek (Table 1). As of March 1995, the population of spinedace at Flag Springs was reduced to fewer than 50 adult individuals with no signs of reproduction (Scoppettone *et al.* 2004a). As described above, USGS and NDOW captured 20 adult fish from the North Flag Spring pools and relocated them downstream to an area deemed more appropriate for reproduction in the outflow channel (Stein 1999). In September 1996, the relocated fish appeared to have reproduced and 68 spinedace were counted in the outflow channel (Scoppettone *et al.* 2004b). The observed spinedace were all less than 100 millimeters (3.94 inches [in]) and likely represented recent recruitment (Stein 1999).

The abundance of spinedace has increased substantially in Flag Springs and Sunnyside Creek and 1,000 or more individuals are typically present in surveys (Table 1). However, the population has fluctuated both within and among seasons, which could be caused by seasonal population variations (reproduction, etc.) and other natural factors. Some variability is also due to changes in the minimum size fork length of spinedace included in the counts and periodic increases in aquatic vegetation which decrease fish visibility. The presence of as many as four age classes of spinedace (*e.g.*, September 2008 survey) indicates successful recruitment over a series of years. Although the spinedace have increased their numbers and distribution in historical habitat at Flag Springs and upper Sunnyside Creek, their overall limited distribution and relatively low population size still leave the species highly susceptible to extinction.

In spring 2004 as part of the Safe Harbor Agreement, 86 spinedace were transferred from Flag Springs to Indian Spring, however, surveys in summer 2004 indicated that the spinedace might not have survived (Hobbs 2004a,b). In June 2005, an additional 91 spinedace were moved to Indian Spring from Flag Springs. A later survey in 2005 observed only two spinedace (Hobbs 2005). However, an electrofishing survey conducted throughout the Indian Spring system during April 2006 found 11 spinedace in the spring source pools (Hobbs, pers. comm. 2006). During

May 2006, an additional visual survey was conducted and 14 adult spinedace were sighted at Indian Spring (B. Nielsen, Service, pers. comm. 2006). Extensive trapping surveys in July 2008 found one adult spinedace, which was likely one of the fish stocked in 2003 or 2004 (Hobbs, pers. comm. 2008). The Indian Spring refugium population is no longer considered viable, and no further spinedace translocations there are planned due to the lack of documented reproduction.

Habitat or Ecosystem

The pluvial White River flowed continuously from east central Nevada south to the Colorado River (Hubbs and Miller 1972). Today, the White River is discontinuous, receiving water from snowmelt-fed streams and springs (Scoppettone *et al.* 2004a). Springs play an important role in the hydrology of the White River Flow System, especially in the summer months when snowmelt-fed stream flows are intermittent or dry (Hubbs and Miller 1972). As such, an interconnected groundwater system within the White River Valley plays an important role in the White River ecosystem.

When White River spinedace were collected in the 1930's, they occupied habitats with clear, cool (18-22 degrees Celsius [^{o} C], 64.4-71.6 degrees Fahrenheit [^{o} F]) water. Available data on water temperature, discharge rates, and dissolved oxygen levels of springs historically occupied by White River spinedace indicate relatively similar temperatures among springs, but disparate discharge rates and dissolved oxygen values (Service 1994).

Most of the historical spinedace habitat has been modified for irrigation purposes and is not capable of supporting self-sustaining spinedace populations. The last known successfully reproducing population of spinedace is found in Flag Springs and upper Sunnyside Creek (Scoppettone *et al.* 2004b). North Flag Spring habitat consists of two pools. The upper pool's surface area is 300 square meters (m^2) (3,229 square feet [ft^2]) with a maximum depth of 1 m (3.3 ft), and the lower pool is 75 m^2 (807.3 ft^2) with a maximum depth of 0.7 m (2.3 ft); the outflow consists of a shallow riffle (approximately 10 centimeters [3.9 in] deep) (Scoppettone *et al.* 2004a). Pools vary from 5 to 27 m (16.4 to 88.6 ft) in diameter with bottoms comprised of gravel, sand, and mud. Emergent aquatic vegetation is common and often dense, and the riparian corridor consists of willow (*Salix*), cottonwood (*Populus*), currant (*Ribes*), and wild rose (*Rosa*) (Scoppettone *et al.* 2004, Service 1994). The current in the spring outflows and Sunnyside Creek is swift to moderate (Miller and Hubbs 1960). Discharge rates from North, Middle and South Flag Springs were 0.05, 0.02 and 0.07 meter per second (ms^{-1}) (1.77, 0.71 and 2.47 cubic feet per second [cfs]), respectively (Service 1994).

A limited amount of habitat monitoring has been conducted within spinedace habitat. The most recent habitat monitoring was completed at Flag Springs in 2006 (Hobbs 2006). In 2006, water temperature within Flag Springs varied from 16.0 to 20.5^{o} C (60.8 to 68.9^{o} F), with the warmest water discharging from South Flag Spring. Discharge rates were not reported.

Changes in Taxonomic Classification or Nomenclature

No taxonomic changes have been made for the White River spinedace.

Genetics

The Service is unaware of any new information concerning genetics for White River spinedace. The self-sustaining population at Flag Springs originated from less than 25 individuals. However, the effects of this population bottleneck on genetics has not been evaluated.

Species-specific Research and/or Grant-supported Activities

Southern Nevada Native Fishes Recovery and Conservation Implementation-NDOW: Most of the species status information (distribution and abundance) included herein (Table 1) has been provided by NDOW through surveys funded (since 1995) through the Service's Section 6 grant program. Specifically, the cooperative grant provides funding to the State of Nevada to: 1) coordinate WRRIT efforts including implementation of the species management plan for White River spinedace and other White River native fishes, 2) conduct population monitoring and status assessment for native fishes in the Flag Springs/Sunnyside Creek system and in occupied Upper White River Valley habitats, 3) monitor the need for nonnative fish eradication and avian predator control efforts in occupied and potential native fish habitats, 4) conduct aquatic habitat management and restoration efforts in the Flag Spring/Sunnyside Creek system and other native fish habitats, 5) assist the Service and other cooperators in evaluation, monitoring and restoration efforts in Upper White River Valley native fish habitats, 6) reestablish White River spinedace in identified historical habitats, 7) develop and implement a programmatic Candidate Conservation Agreement with Assurances for native fish habitats on private lands, and 8) assess distribution of and develop control strategies for nonnative aquatic species. The goal of this cooperative grant is to protect White River spinedace and their habitat in the Upper White River Valley. The cooperative grant enables NDOW to conduct biannual snorkel surveys in the upper White River Valley, especially at Flag Springs and Sunnyside Creek. Grant funding is provided annually and is ongoing.

Flag Springs Restoration Project-NDOW: Restoration efforts at Flag Springs were completed the first week of November 2009 and included restoring the Middle Flag Spring outflow to its historical channel, removing the old cross-hill ditch that connected Middle Flag to South Flag Spring, adding rock vane structures to the mid- and lower South and North Flag Spring outflows to reduce average gradient and improve pool structure, and adding structure below the diversion on South Flag Spring to provide passage between the upper spring and the outflow channel. In addition, a weir structure provided by SNWA was installed in the upper Middle Flag Spring outflow for future water monitoring for the Groundwater Development Project (described in Factor A below).

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

During the past century, available suitable habitat for spinedace has been reduced by channeling, piping, and diversion of spring flows to improve water conveyance for local residential and agricultural uses. At the time of listing, habitat alteration and destruction was listed as a major threat to the continued existence of White River spinedace (Service 1985).

Both Preston Big Spring and Lund Spring outflows were modified for agriculture in the late 1970's and early 1980's (Service 1994). The Preston Big Spring pool remains open with approximately 600 m (1,968 ft) of flowing stream before the entire outflow enters a pipeline system. The Lund Spring pool also remains open, but the outflow was piped 35 m (115 ft) from the springhead. This has limited habitat available for the reintroduction of the spinedace. Irrigation districts for these springs have expressed interest in extending the pipeline from the existing intake structure on Preston Big Spring upstream to the headwaters, which would eliminate the last remaining spring outflow habitat.

The Service initiated the development of a spinedace habitat restoration partnership with private landowners and the Preston and Lund Irrigation Districts in the White River Valley (Nielsen, pers. comm. 2006). In 2003, the private landowner of Preston Big Spring secured an $89,000 Private Stewardship Grant from the Service to restore 2.0 km (1.2 mi) of designated critical habitat at Preston Big Spring (*i.e.,* remove small portions of the pipelines, restore habitat along the springs and streams, and install fish screens at the intakes of the pipelines). The Preston and Lund Irrigation Districts own all of the water rights associated with Preston Big Spring, therefore their participation and approval was necessary for successful implementation. After several years of collaboratively working with both districts, they unanimously decided to not approve the restoration project due to their uncertainty over the future of farming and water rights. However, the Lund Irrigation District has expressed interest in working with the WRRIT in the future to recover endemic fishes of the White River Valley (R. McKenzie, Lund Irrigation District, pers. comm. 2006). The Service will continue to develop these partnerships and seek creative and collaborative solutions to recovering this species via the WRRIT while meeting the needs of the private landowners and irrigation districts.

Habitat within Flag Springs is limited in size and may be enhanced through implementation of restoration plans. Through collaborative efforts by the WRRIT, a water conservation project resulted in the reconstruction of an irrigation system at Kirch WMA on South Flag Spring during 2002. A pipeline with an appropriately-sized screened intake replaced an open earthen irrigation ditch, which entrained native fishes including spinedace. The new irrigation system eliminated fish entrainment and decreased water evaporative losses, which increased flows in the South Flag Spring outflow by approximately 0.03 ms^{-1} (1 cfs) (D. Johnson, NDOW, pers. comm. 2005). This action likely increased the amount of available habitat and, as a result, bolstered the population of spinedace at Flag Spring by over 30 percent by 2006 (Hobbs 2006). The downstream distribution of spinedace along Sunnyside Creek is limited by habitat, water temperatures and artificial fish barriers that limit upstream migration of nonnative fishes. Although the spinedace have increased their numbers and distribution in historical habitat at Flag Springs, their overall limited distribution and relatively low population size still leave the species

highly susceptible to extinction.

Farming and ranching have been the two primary economies in eastern Nevada for over 150 years. However, increasing populations in Clark and Lincoln Counties to the south have increased the level of recreational uses and tourism in White Pine County. An ever increasing number of farms are subdividing their properties to accommodate the construction of residential homes and this pressure is becoming more apparent in the White River Valley (McKenzie, pers. comm. 2006). This increase in residential housing density has resulted in increased water usage which affects the local groundwater aquifer.

The increasing population of Las Vegas, Nevada, and the associated increasing water demand is presenting a new threat to the White River spinedace, which has the potential to either modify or destroy occupied spinedace habitat by reducing the total output of water from Flag Springs. To meet projected future water demands in the Las Vegas Valley and to lessen southern Nevada's reliance on Colorado River water, SNWA has proposed the Clark, Lincoln, and White Pine Counties Groundwater Development Project (SNWA 2008). As part of this project, SNWA intends to develop up to 23,133,955 cubic meter per year (cmy) (18,755 acre-feet per year (afy) of existing groundwater rights from three Hydrographic Basins (HB) of the White River Flow System (5,770,229 cmy [4,678 afy] from Cave Valley HB, 14,294,133,677 cmy [11,584 afy] from Dry Lake Valley HB, and 3,075,071 cmy [2,493 afy] from Delamar Valley HB; collectively referred to as the DDC basins) and export this water via an underground pipeline to the Las Vegas area.

Groundwater flow within the White River Groundwater Flow System is primarily north to south, but in certain areas may move from east to west between basins under pre-pumping (current) conditions. Specifically, there may be one or more locations between the DDC basins and the White River, Pahroc, and Pahranagat Valleys where groundwater flows east to west (*e.g.*, through Shingle Pass from Cave Valley to southern White River Valley). If so, pumping in the DDC basins may capture some or all groundwater flowing west into White River, Pahroc, and (or) Pahranagat Valleys from the DDC basins, lowering groundwater levels and discharge from regional springs in the White River and Pahranagat Valleys to a degree that cannot be presently anticipated. Flag Springs, in particular, is located downgradient of Shingle Pass in the White River Valley and may be affected. Groundwater-dependent resources located further north in White Pine County, including currently unoccupied historical spinedace habitat (*e.g.*, springs of the Preston-Lund area), are not expected to be affected by groundwater pumping in the DDC basins. However, these, and other pumping-related effects cannot be anticipated or quantified at this time.

On January 7, 2008, prior to the Nevada State Engineer's administrative hearing on SNWA's applications to withdraw groundwater from the DDC basins, the Department of Interior (on behalf of the Service, National Park Service, BLM, and Bureau of Indian Affairs) entered into a stipulated agreement (Stipulation) with SNWA regarding the applications. The parties to the Stipulation will work cooperatively to manage the development of groundwater by SNWA in the DDC basins without causing injury to Federal water rights and/or "unreasonable adverse effects" to Federal resources, including White River spinedace and its habitat. To achieve this goal, the parties to the Stipulation are developing biological and hydrological monitoring plans. The

hydrologic monitoring plan is currently in draft form. The biological monitoring plan is under development and will be finalized in early 2010. The hydrological monitoring network will consist of springs and groundwater monitoring wells in the DDC basins and adjacent White River and Pahranagat Valleys. A subset of these monitoring wells may be useful in characterizing the movement of groundwater (or lack thereof) from Cave Valley to the vicinity of Flag Springs, or any changes in interbasin flow that may occur once pumping begins. Per the Stipulation and the Nevada State Engineer's ruling, baseline (pre-pumping) hydrologic and biological data will be collected for a minimum of 2 years. Baseline data collection, as well as ongoing monitoring activities, will include continuous monitoring of discharge from one of the three springs comprising the Flag Springs. The other two springs at Flag Springs will be monitored biannually. To date, what constitutes an "unreasonable adverse effect" to White River spinedace and/or its habitat, and the specific actions that will be taken to avoid or mitigate such an effect, has not been determined. Any monitoring or actions undertaken as part of the Stipulation biological monitoring plan will be coordinated with the WRRIT.

Nicholas, Arnoldson, and Cold Springs historically supported seasonal use by spinedace. Spinedace would migrate downstream from these smaller springs to the larger Lund Spring and Preston Big Spring and only use the small springs on an intermittent basis (Service 1994). However, currently the outflows are no longer connected and as such the springs are isolated and no longer support spinedace.

Ellison Creek crosses private and Federal lands used for recreation, fishing, and livestock grazing. The upper portion of Ellison Creek, located on USFS lands, is fed by thermal springs throughout the year and supplemented with annual precipitation run off. This reach of Ellison Creek is currently suitable for native fishes; however, native White River fishes have not been seen there since the 1930's due to dramatic habitat alteration during that period. This reach of Ellison Creek is secure from nonnative fishes and livestock grazing has been reduced resulting in improved riparian habitat conditions.

As described above, the Service began working with private landowners in May 2001 to establish a potential spinedace refugium site at Indian Spring, located north of Kirch WMA. Introduction of spinedace into Indian Spring was initiated in March 2004. Indian Spring was surveyed in July 2008 and only one spinedace was captured, which was likely a fish that was stocked in 2004 (Hobbs 2008). At this time, we believe the population at Indian Spring is unsuccessful and efforts to establish this refugium population have been terminated.

Private property located at the southern end of the White River Valley (Moon River Ranch) is currently for sale (Hobbs, pers. comm. 2006). This property includes two spring sources which, in sum, have a flow less than 0.17 ms^{-1} (6 cfs). This property currently provides habitat for the Moorman White River springfish (*Crenichthys baileyi thermophilus*), one of five subspecies of springfish found in Nevada. The WRRIT surveyed the property in 2006 to ascertain the potential for habitat restoration, specifically for spinedace. Prior to irrigation modifications, these springs were once connected to the White River which provided connectivity to Flag Springs. Although the spinedace were never found at these springs historically, they may have been extirpated before fisheries surveys of the valley were completed. The WRRIT recently determined that these springs most likely provided habitat for the spinedace. Therefore, the WRRIT has

recommended that spring system acquisition and habitat restoration be pursued. The NDOW is actively negotiating with the landowners (Hobbs, pers. comm. 2009). If the Moon River Ranch was acquired, the WRRIT believes that habitat restoration efforts to reconnect these springs to the White River system could be implemented, which would allow the establishment of a self-sustaining population of spinedace.

Summary of Factor A

The lack of suitable habitat, competition by nonnative fishes, and water diversions have contributed to the decline of spinedace and continue to limit recovery of the species (Service 1994). Six of the seven historical habitats for spinedace have been dramatically altered and without restoration and rehabilitation of these privately-owned spring systems, repatriation of the species to these areas is not possible. Currently, the only successfully reproducing population of spinedace is found in Flag Springs and upper Sunnyside Creek, which are on State-owned land. The Service has initiated a number of conservation actions in an attempt to restore springs to their natural conditions and reestablish spinedace populations. To date, the only conservation measure that has been successful is the water conservation project at Flag Spring. A new threat to spinedace that could change the flow system in White River Valley is the ever increasing water demand from the Las Vegas Valley. The SNWA is proposing a water development project that would pump up to 23,133,955 cmy (18,755 afy) from three HB within the White River Flow System and export this water via an underground pipeline to the Las Vegas area. Removing up to 23,133,955 cmy (18,755 afy) of water from the White River Groundwater Flow System could significantly alter the discharge of Flag Springs and threaten the only remaining population of spinedace. In an attempt to reduce the impacts of the water development project, SNWA and the Department of the Interior entered into a Stipulation, agreeing to collaboratively create a hydrological and biological monitoring plan.

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

Overutilization for commercial purposes was not identified as a threat in the 1985 final listing rule (Service 1985). Overutilization for any purpose still does not appear to be a threat at this time.

FACTOR C: Disease or Predation

Disease was not considered a threat to White River spinedace at the time of listing (Service 1985), nor is it currently considered a threat. However, nonnative fish species such as guppies (*Poecilia reticulate*), mosquitofish (*Gambusia affinis*), and goldfish (*Carassius auratus*) have been implicated in the decline and listing of spinedace due to predation and/or competition for available resources (Service 1985). To date, nonnative fish species have not been introduced at Preston Big Spring; however, the irrigation pipeline that supplies water to the farm fields serves as a highly effective fish passage barrier. Lund Spring is populated by guppies and is hydraulically isolated as a result of an extensive irrigation diversion structure and pipeline. Flag Springs were inhabited by predatory largemouth bass (*Micropterus salmoides*) and rainbow trout (*Oncorhynchus mykiss*) within the last 15 years (Service 1994). Due to extensive partnership

efforts by the USGS, NDOW and the Service, three fish barriers were constructed and nonnative fishes have been successfully eradicated upstream of the barriers. Even though all three critical habitats are currently free of nonnative fishes, the threat of deliberate or inadvertent introductions of such species will always be present and requires vigilant monitoring of these habitats.

Predation on spinedace by double crested cormorants (*Phalacrocorax auritus*) was documented in 2001 by NDOW biologists (Hobbs 2002a,b). The increasing population of cormorants across western North America has led to increasing numbers of cormorants utilizing reservoirs and streams in eastern Nevada (Hobbs, pers. comm. 2006). During the winter of 2001 in the White River Valley, unusually cold weather resulted in ice-covered reservoirs which prevented cormorants from accessing their normal food sources. However, Flag Springs remained open due to its warmer flowing waters. As such, cormorants over utilized Flag Springs for feeding and caused the spinedace population to sharply decline. NDOW received a depredation permit from the Service to harass or remove the cormorants from the site. NDOW implemented cormorant aversion techniques including hazing, netting, and the removal of individuals found within critical habitat. It was later confirmed through necropsy that the birds had indeed been feeding heavily on spinedace (Hobbs 2004b). While most fish populations can sustain some losses due to natural predation by birds, the spinedace are confined to short open channel reaches with little structural habitat in which to hide. NDOW also restored portions of Adams-McGill Reservoir which limited cormorant nesting habitat, thus limiting the numbers of cormorants in the area and the threat to spinedace by avian predators. Constant monitoring of this isolated population of spinedace is required to determine any causes of population decline, including predation by birds.

Summary of Factor C

Although disease is not considered a threat to spinedace, avian predation is an ongoing concern. Currently, there are no nonnative species within critical habitat; however, there is a constant threat that nonnative species may be introduced into habitats required for recovery. In order to ensure that disease and predation do not threaten the existence of spinedace, constant monitoring is required.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

Inadequacy of existing regulatory mechanisms was not considered a threat to White River spinedace populations at the time of listing (Service 1985). A number of Federal and State regulations provide varying levels of protection for this species, as described below.

State of Nevada Protections

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 wildlife and plants that are listed by the

State is prohibited under Nevada Administrative Code 503.093 and 503.094 (Nevada Revised Statues 501.105 and 501.181) and Nevada Administrative Code 527.250 to 527.460 (Nevada Revised Statutes 527.050 and 527.300) for wildlife and plants, respectively. Special permits may be obtained from NDOW or the Nevada Division of Forestry.

Federal Protections

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 an analysis of the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the lead Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations may 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 (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 USACE'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 Endangered Species Act. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts.

The USACE 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 into question this definition. 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, USACE 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 USACE and the U.S. Environmental Protection Agency (USEPA) have recently 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 of 1973, as amended: The Act is the primary Federal law providing protection for this 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 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 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

Summary of Factor D

In summary, the Act is the primary Federal law that provides protection for this species since its listing as endangered in 1985. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations 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

At the time of listing, the use of copper sulfate for control of algae in Preston Big Spring was considered to be a threat to spinedace (Service 1985). Currently, the threat has been reduced and/or eliminated through improved awareness and location of occupied habitat (the only occupied habitat is on Kirch WMA and NDOW is not using this method to control algae). Fire and climate change are new threats that were not identified at the time of listing. Some of the potential effects of fire and climate change on spinedace are discussed below.

Fire

The threat of fire was not characterized in the Recovery Plan (1994) or at the time of listing even though the Kirch WMA has not burned or been grazed for over 35 years, increasing the potential for large scale fires due to fuel loading. The Flag Springs population of spinedace is threatened with the possibility of catastrophic fire due to lightning strikes or accidental ignitions. For

example, within the last 5 years, two separate fires covered a total of nearly 2,428 hectares (6,000 acres) of rangeland within 4.8 km (3 mi) of the Kirch WMA. The causes were attributed to discarded cigarettes from vehicles (Hobbs, pers. comm. 2006). North, Middle, and South Flag Springs are located within 300 m (984 ft) of Highway 318. This highway is a primary trucking route between Las Vegas and eastern Idaho, and the main highway that leads from Las Vegas to eastern Nevada's (Ely/Eureka) recreational opportunities. Now that NDOW staff live onsite at Kirch WMA, the threat of fire has been reduced due to faster fire detection and response time.

Spinedace could be directly affected by fire due to increases in water temperatures to lethal levels, fire induced changes in pH, increased ammonia levels from smoke gases absorbed into surface waters, and increased phosphate levels leached from ash (Brown 1989, Norris and Gregory 1991, Spencer and Hauer 1991, Rinne 1996, Rieman and Clayton 1997, Gresswell 1999, Ranalli 2004, Neary *et al.* 2005).

Spinedace could be indirectly affected by fire due to accelerated soil erosion, loss of vegetative cover, oxidation of soil organic matter, and impairment of other soil physical, chemical, and biological properties, which reduce the chance of native regeneration because of loss of essential topsoil. Not only does this impact upland habitat through loss of cover, but it also impacts riparian areas through indirect effects (Dwire and Kauffman 2003). Post fire erosional processes that deliver sediment to streams over long periods of time due to roads, fire lines, or the lack of re-vegetation, can have long-term negative effects on aquatic ecosystems (Lotspeich *et al.* 1970, DeByle and Packer 1972).

Most negative effects to aquatic species post-fire are due to the immediate loss or alteration of habitat and indirect effects. When riparian vegetation is directly consumed by fire an increase in water temperature and the loss of cover for aquatic species may result (Gresswell 1999).

The effects of fire on macroinvertebrates have been well studied since the early 1980's. Macroinvertebrate communities are strongly influenced by substrate instability associated with post fire erosional processes. Effects include changes in functional feeding groups (La Point *et al.* 1983), abundance, diversity, and species richness (Roby 1989, Lawrence and Minshall 1994, Minshall *et al.* 1995, Roby and Azuma 1995, Mihuc *et al.* 1996, Minshall 2003), and more annual variation (Richards and Minshall 1992). These effects can persist for many years which could reduce the potential for spinedace populations to rebound. Studies have shown that post fire hydrologic events can extirpate local fish populations (Novak and White 1990). Recolonization rates depend on the proximity and relative location of refugia, access from refugia to disturbed areas (*i.e.*, no fish barriers), and the occurrence of complex life history traits and overlapping generations (Gresswell 1999). Isolated fish populations are at a much higher risk of extinction because they cannot recolonize after a large or intensive disturbance (Rinne 1996). Additionally, effects on small headwater streams are more severe because entire drainages are burned at these smaller spatial scales, in contrast to larger stream orders, where relatively small proportions of the drainage burn.

In addition to the effects of the fire itself, fire suppression activities can also affect the species. Fire suppression methods include the construction of fire lines; back burning; application of water from pumps or aerial drops; use of fire retardants and suppressant foams; and construction

and use of helicopter landings, material storage and refueling areas, and fire camps (Backer *et al.* 2004). The effects to aquatic species and their habitat include increased erosion and overland flow from fire line construction, increased risk of mass failure from mechanical fire line construction on landslide prone terrain, and temporary reduction or cessation of flows in small streams when drafting or dipping water. In addition, fire retardants and suppressant foams are known to be toxic to aquatic species (Norris and Webb 1989, Wells *et al.* 2004).

While the indirect and direct effects of fire have not been studied for spinedace, fire is a tangible threat given the highly localized nature of the species and the proximity to human dwellings and highways.

Climate Change

Research has shown that the annual mean temperature in North America has increased from 1955 to 2005; however, the magnitude varies spatially across the continent, is most pronounced during spring and winter months, and has affected daily minimum temperatures more than daily maximum temperatures (Field *et al.* 2007). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles *et al.* 2006), earlier spring run-off (Stewart *et al.* 2005), longer and more intense fire seasons (Brown *et al.* 2004, Westerling *et al.* 2006, Bachelet *et al.* 2007), and more frequent extreme weather events (Diffenbaugh *et al.* 2005, Rosenzweig *et al.* 2007). These changes in climate and subsequent effects can be attributed to the combined effects of greenhouse gases, sulphate aerosols, and natural external forcing (Karoly *et al.* 2003, Barnett *et al.* 2008).

Warming trends seen over the past 50 years in the United States are predicted to continue to increase (Field *et al.* 2007). The Intergovernmental Panel on Climate Change (IPCC) states that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change (Kundzewicz *et al.* 2007). However, quantifying the potential site-specific effects to the spinedace, and the time scale at which they would occur, is problematic. The species is geographically isolated and dependent on groundwater discharge to maintain its spring system habitats. Difficulties remain in reliably simulating and attributing climate change effects at such small, localized scales. Natural climate variability is relatively larger-scaled, thus making it harder to distinguish changes expected due to external, human-related sources (IPCC 2007). Our concern with this threat is linked to the extent that climate change may affect the water supply of spinedace through lowering groundwater levels and increasing the frequency and intensity of wildfires in the area.

Summary of Factor E

At the time of listing, the use of copper sulfate was considered a threat to spinedace. However, it is not a current threat within occupied habitats. Since the time of listing, fire and climate change have been identified as two threats that could reduce or eliminate spinedace populations. While the threat of fire is fairly well understood, the threat from climate change to small localized populations is largely unknown.

III. RECOVERY CRITERIA

An approved final recovery plan for the White River spinedace was completed in 2004. 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, over all, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist. 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.

Recovery Objective: Improve the species' status so that it may be reclassified to threatened status.

Recovery Criteria: Spinedace may be considered for reclassification when the following criteria are met:

1) A self sustaining population exists in each of the three designated critical habitats for at least 5 consecutive years.

This recovery criterion has not been fully accomplished.

The three designated critical habitat sites include Preston, Lund, and Flag Springs (see Figures 1-3). The population at Flag Springs has been self sustaining since 1996 (Scoppettone *et al.* 2004a). However, neither Preston Big Spring nor Lund Spring can support a self sustaining population of spinedace without substantial habitat restoration. There have been no on-the-ground efforts to restore habitat or repatriate spinedace to these springs since the 1994 Recovery Plan was published. If collaborative efforts result in the implementation of habitat restoration and fish protection measures, this criterion should be achievable. In addition, the WRRIT is collaboratively working to identify additional locations for spinedace refugia that would lead to other self sustaining populations outside of historical and critical habitat.

This criterion addresses listing factor A (the present or threatened destruction, modification, or curtailment of its habitat or range) and listing factor C (disease or predation) by requiring that a self sustaining population exists in each of the three designated critical habitats for at least 5 consecutive years.

2) Each critical habitat is secure from all known threats.

Recovery criterion 2 addresses listing factors A, C, and E.

Recovery criterion 2 sets a high standard that may never be fully achievable. There are still threats such as diversion of spring outflows, nonnative species and groundwater withdrawal affecting one or more of the critical habitats, as discussed in the Five Factor Analysis section. Of the three sites, Flag Springs is the most secure due to its location on Kirch WMA and various conservation actions that have reduced threats such as predation and competition by nonnative species.

3) All native fish are present in Flag Springs, Preston Big Spring, and Lund Spring that were present historically.

This recovery criterion has not been fully accomplished.

This criterion relies on historical survey information to determine which native species should be present in each of these three spring systems. Other native fish species include: White River desert sucker (*Catostomus clarki intermedius*), White River speckled dace (*Rhinichthys osculus velifer*), and Preston White River springfish (*Crenichthys baileyi albivallis*). Historical fish surveys at Preston Big Spring and Lund Spring found all four species; however, springfish were the one species never found at Flag Springs (Scoppettone *et al.* 2004b). More recent surveys for spinedace have found White River speckled dace and desert sucker to be numerous in Flag Springs and Sunnyside Creek; therefore, the native fish species complement is intact (Scoppettone *et al.* 2004b). Surveys conducted by NDOW in 2003, determined that springfish and speckled dace are the only remaining species at Preston Big Spring and Lund Spring. Therefore, this recovery criterion has only been met for one of the three spring systems.

This criterion addresses listing factor A (the present or threatened destruction, modification, or curtailment of its habitat or range), listing factor C (disease or predation), and listing factor E (other natural or manmade factors affecting its continued existence).

IV. SYNTHESIS

White River spinedace were not listed as a DPS nor is there relevant new information that would lead the Service to consider designating them as a DPS in accordance with the 1996 policy. The Recovery Plan (Service 1994) identifies three measurable and objective criteria which, if implemented, will lead to reclassification to threatened status. The population of spinedace in the one remaining occupied spring system, Flag Springs, has been fluctuating within and among seasons which may indicate that habitat is a limiting factor. However, the Flag Springs population of spinedace has increased over the survey period (1995-2008) from less than 25 to between 1,000 and 2,000 individuals, which demonstrates progress towards recovery.

Improving the status of this species beyond its current condition will require partnerships between agencies, irrigation districts, and the local communities of Preston and Lund. Considering the slow progress in establishing a partnership with the Preston and Lund Irrigation

Districts for habitat restoration within critical habitats, the WRRIT is exploring new opportunities for improving the species' status by developing partnerships with the USFS and with willing landowners at the northern and southern ends of the White River Valley. The WRRIT is committed to continue partnership development with the communities of Preston, Lund and Sunnyside to ensure that opportunities for recovery are secured.

Because of the continued restrictions on restoring two critical habitats located on private lands, the species' distribution remains limited and it continues to have a high degree of threats and existing conflicts to recovery, but also has a high recovery potential. The recovery criteria established in the Service's 1994 Recovery Plan called for down listing to threatened status only when spinedace populations are self sustaining at Preston Big Spring and Lund Spring, which has not occurred. Therefore, we recommend the status of the spinedace remain as endangered 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

New Recovery Priority Number and Brief Rationale: No change is recommended at this time.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

The Service recommends that continued funding be provided to NDOW through Section 6 of the Act, for monitoring of spinedace and continued implementation of the Recovery Plan. The Service recommends the following actions be implemented in the future:

- Continue collaborative partnership development with the Preston and Lund Irrigation Districts as well as other willing private and public landowners to further the establishment of spinedace at known historical habitats.

- Conduct further studies of spinedace habitat requirements and spawning habitat needs at Flag Springs.

- Investigate additional springs and streams to determine viability of spinedace reintroduction outside of the designated critical habitats. Specifically, pursue acquisition of the Moon River Ranch and the development of a recovery population of spinedace on USFS lands along Ellison Creek.

- Collect and analyze spring flow and groundwater monitoring data to identify and determine effects of groundwater development projects on critical habitats and other potential recovery habitats.

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

White River spinedace (*Lepidomeda albivallis*)

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:

Review Conducted By: Todd Gilmore, Nevada Fish and Wildlife Office

Date Submitted to Region 8: __January 29, 2010__

APPROVAL:

Lead State Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date __January 29, 2010__

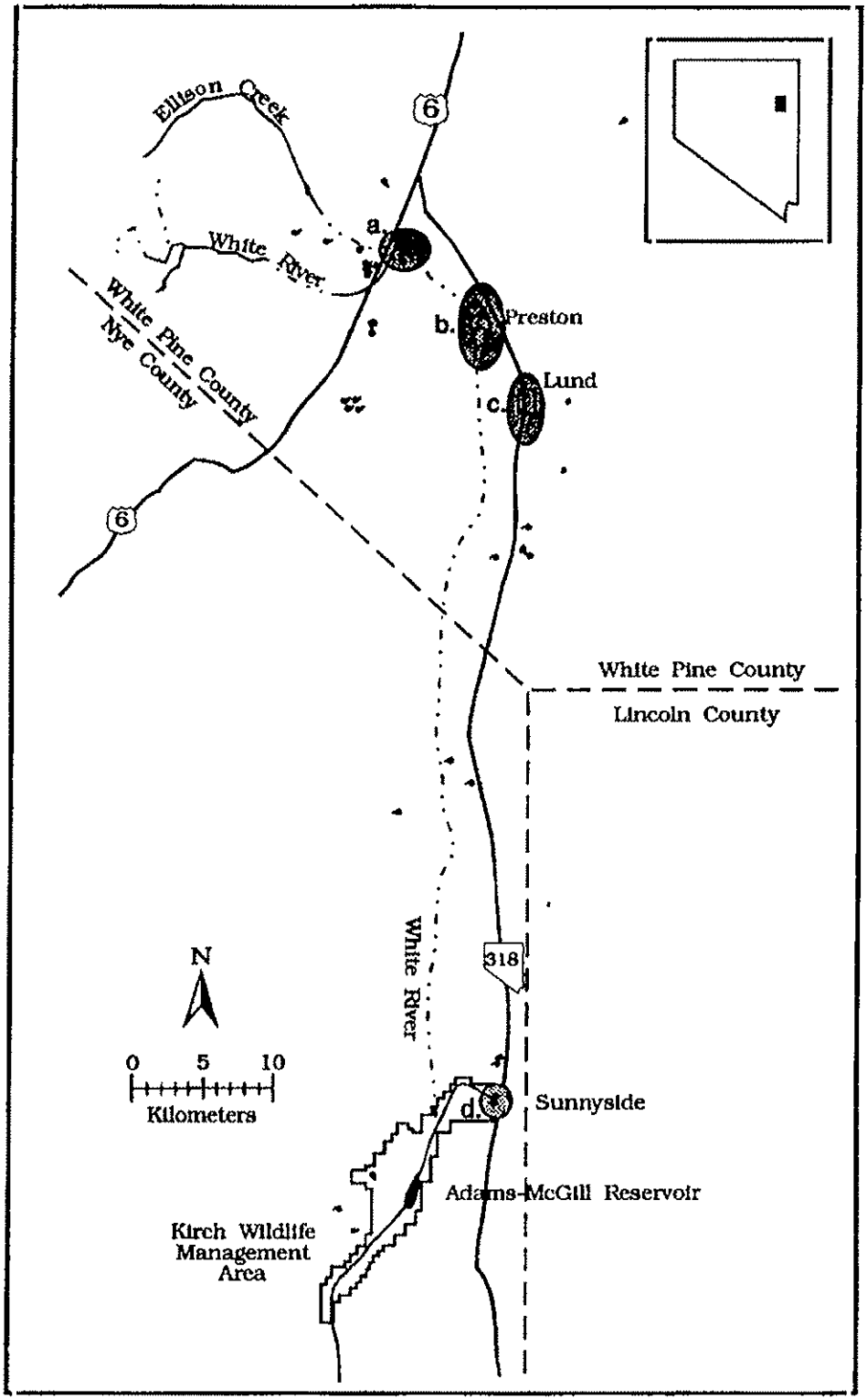

Figure 1. White River spinedace historic distribution, Nye & White Pine Cos., NV: a) White River near its confluence with Ellison Creek; b) Preston Big Spring, Cold Spring, Nicholas Spring and Arnoldson Spring; c) Lund Spring; and d) Flag Springs (modified from Scoppettone, et al. 1992).

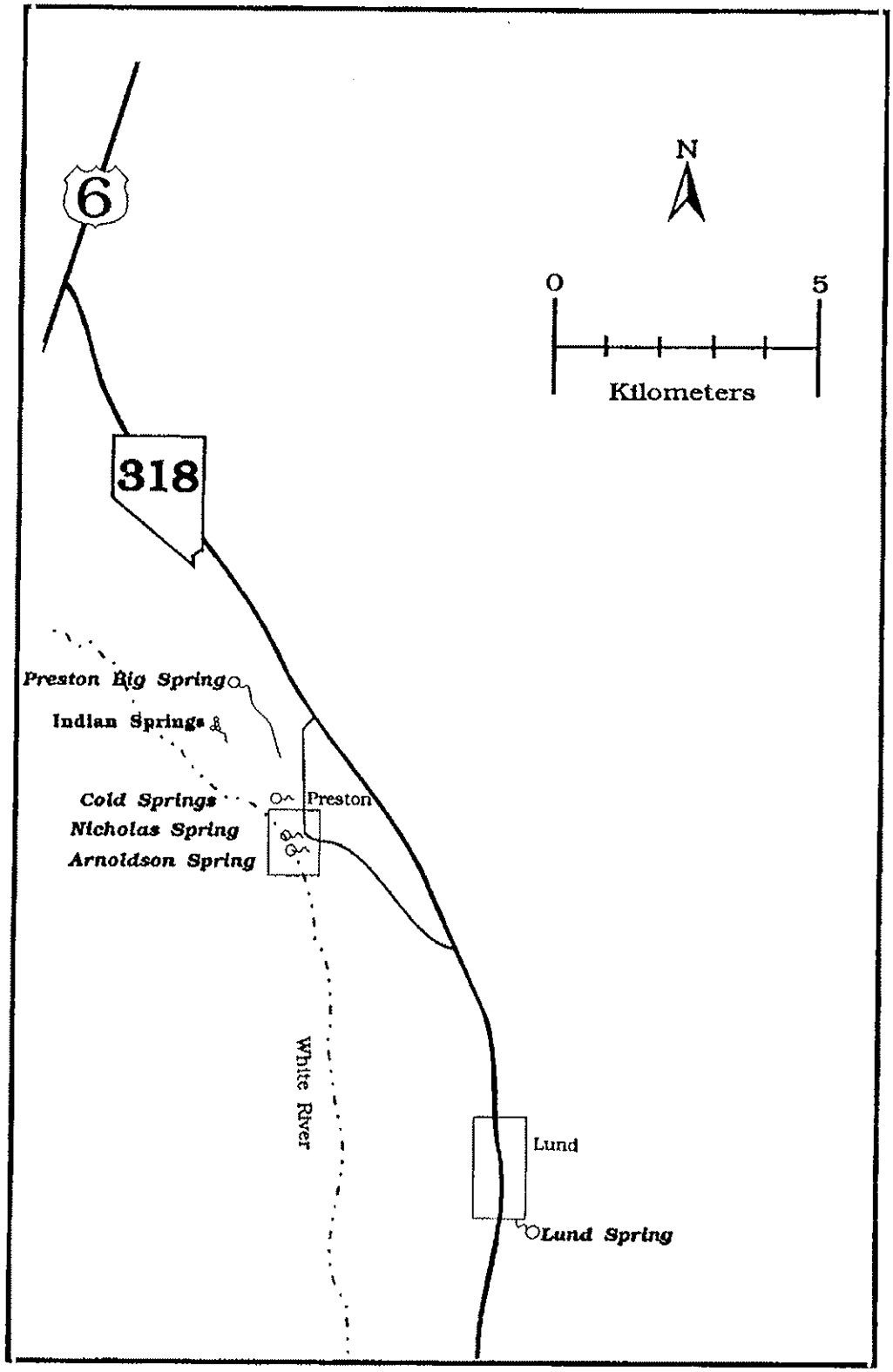

Figure 2. White River spinedace historic habitats in the vicinity of Preston and Lund, White Pine Co., Nevada (modified from Scopettone, et al. 1992).

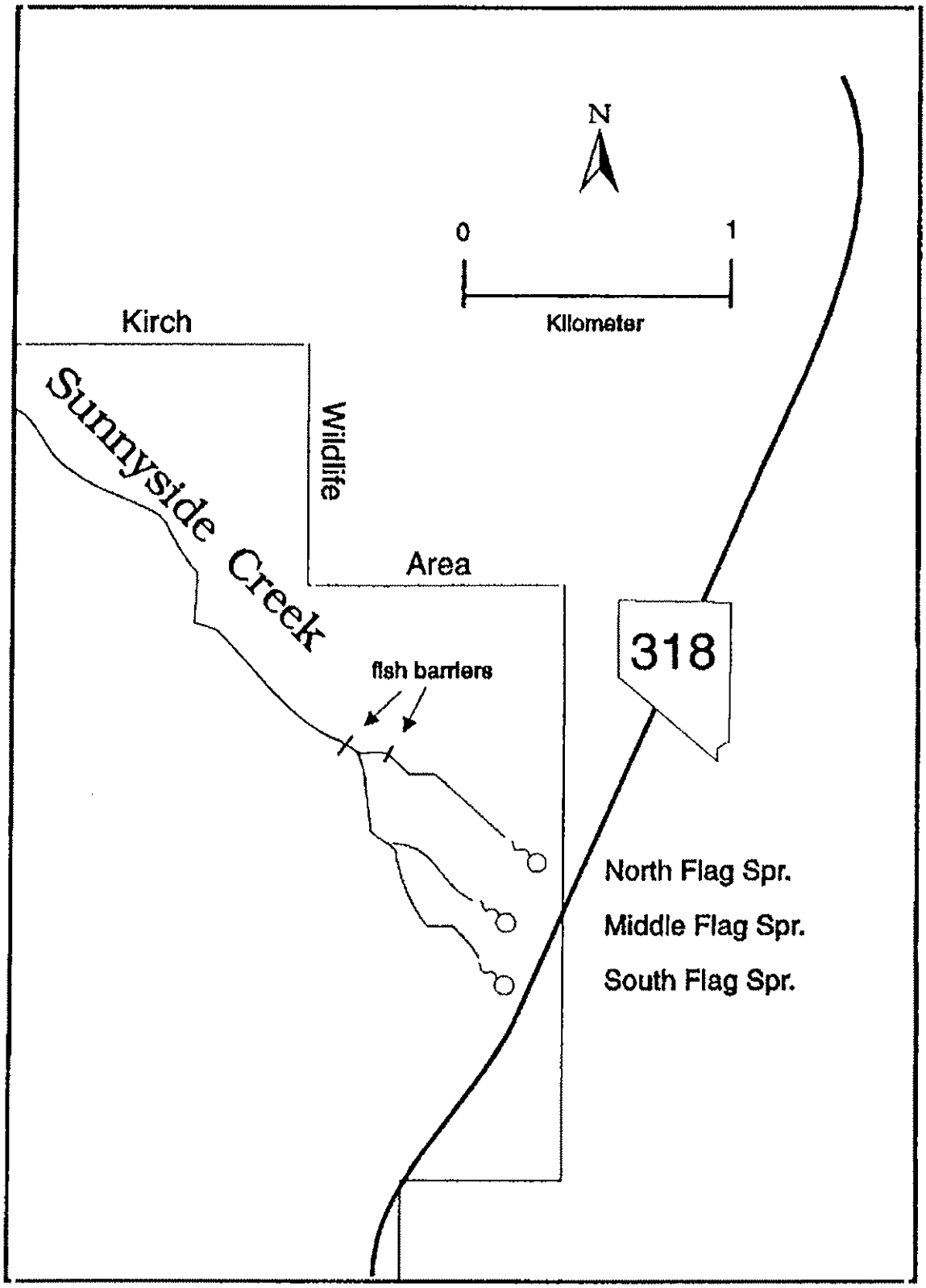

Figure 3. White River spinedace historic habitat at Flag Springs. (modified from Scoppettone, et al. 1992)

Table 1. Numbers and locations of White River spinedace (*Lepidomeda albivallis*) counted during biannual snorkel surveys (1995-2008) of historic habitats in Hot Springs and Sunnyside Creek at Ash Meadows National Wildlife Refuge and the Indian Spring refugium, Nye County, Nevada, plus other native fish observations

[* = White River desert sucker, *Catostomus clarki intermedius* (DS), White River speckled dace, *Rhinichthys osculus velifer* (SPD);]

Survey Year	Survey Month	White River Spinedace Count by Survey Location							Total WR Spinedace Count	Other Native White River Species Present	Comments and Reference(s)
		Hot Springs Complex				Sunnyside Creek		Indian Spring			
		North Headwater Pools	North Outflow	Middle Outflow	South Outflow	Above Culvert	Below Culvert				
1995	March	<25	20*					N/A	20-25*		Adult fish relocated from North Headwater Pools to North Outflow Stein (2000)
	Sept.							N/A			
1996	March		20*					N/A	20*		Adult fish relocated from North Headwater Pools to North Outflow Stein (2000)
	Sept		61				21	N/A	61		Documented reproduction Scoppettone et al. (2004)
1997	March						18	N/A	12		All fish < 100 mm FL Scoppettone et al (2004)
	Sept				81	50	11	N/A	112		All fish < 75 mm FL Scoppettone et al (2004)
1998	March							N/A	208	SPD, DS	Most fish in Middle Outflow Stein (1999)
	Sept.							N/A	269	SPD, DS	Stein (1999)
1999	March				538			N/A	538	SPD, DS	Stein (2000)
	Sept				1573			N/A	1573	SPD, DS	Poor age class agreement Stein (2000)
2000	March	---	---	---	---	---	---	N/A	---	---	No surveys due to weather
	Sept				556			N/A	556	SPD, DS	Aquatic vegetation limited surveys NDOW (2000)
2001	March				0			N/A	0	SPD, DS	An extremely cold winter froze local waters Positive outwash for ages in thermal streams
											Cormorant predation was considered to have seriously impacted spinedace (Hobbs, pers. comm.)
	Sept				715			N/A	715	SPD, DS	Aquatic vegetation limited surveys NDOW (2001)
2002	March				914			N/A	914	SPD, DS	Most fish in Middle Outflow Only fish > 40 mm FL counted Hobbs (2002a)
	Sept				1264			N/A	1264	SPD, DS	Most fish in Middle Outflow All size fish counted Hobbs (2002b)
2003	March				994			N/A	994	SPD, DS	Most fish in South/Middle Outflows Only fish > 40 mm FL Hobbs (2003a)
	Sept				1528			N/A	1528	SPD, DS	Most fish in South/Middle Outflows All size fish counted Hobbs (2003b)
2004	March				2910 (+/-86)			86	2910	SPD, DS	Most fish in Sunnyside Creek Most fish were 31-60 mm FL 86 fish transferred to Indian Spring refugium Hobbs (2004a)
	Sept				1177			0	1177	SPD, DS	Most fish in South Hot Spring Most fish were 31-60 mm FL Transplanted fish in Indian Spring (n=86) did not survive Hobbs (2004b)
2005	March				1493			91 (June)	1493	SPD, DS	Most fish in South/Middle Outflows Most fish were 31-60 mm FL Hobbs (2005a, b)
											91 fish transplanted to Indian Spring refugium in June Hobbs (2005a, b)
	Sept				1822			2	1824	SPD, DS	Most fish in South/Middle Outflows Most fish were 31-60 mm FL Hobbs (2005a, b)
2006	March	14	247	480	480	272		11-14 (April/May)	999	SPD, DS	Hobbs (2006), Nielsen (pers. comm.) comment: hobbs report combines south/middle outflows, 480 is combined number for both
	Sept.		442	734	734	1220	11	9-20	2396	SPD, DS	Hobbs (2006), Nielsen (pers. comm.) comment: hobbs report combines south/middle outflows, 734 is combined number for both
2007	March	15	151	362	362	575	9	N/A	1088	SPD, DS	Hobbs (2007) comment: hobbs report combines south/middle outflows, 362 is combined number for both
	Sept	0	117	274	274	657	12	N/A	1048	SPD, DS	Hobbs (2007) comment: hobbs report combines south/middle outflows, 274 is combined number for both.
2008	March		192	510	510	461	13	N/A	1123	SPD, DS	Hobbs (2008) comment: hobbs report combines south/middle outflows, 510 is combined number for both
	June		198	676	676	546		N/A	1422	SPD, DS	Hobbs (2008) comment: hobbs report combines south/middle outflows, 676 is combined number for both
	Sept	0	382	422	422	510	14	N/A	1319	SPD, DS	Hobbs (2008) comment: hobbs report combines south/middle outflows, 422 is combined number for both.