BEFORE THE SECRETARY OF THE INTERIOR

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PETITION TO LIST THE VIRGIN RIVER SPINEDACE *LEPIDOMEDA MOLLISPINIS MOLLISPINIS* AS THREATENED OR ENDANGEREED UNDER THE ENDANGERED SPECIES ACT

NOVEMBER 20, 2012
CENTER FOR BIOLOGICAL DIVERSITY

Notice of Petition

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PETITIONER

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center is supported by more than 450,000 members and activists throughout the United States. The Center and its members are concerned with the conservation of endangered species, including Virgin River fishes, and the effective implementation of the ESA.

Submitted this 20th day of November, 2012

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b); Section 553(e) of the Administrative Procedure Act, 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity, Tierra R. Curry, James P. McMahon, and D. Noah Greenwald, hereby petition the Secretary of the Interior, through the United States Fish and Wildlife Service ("FWS," "Service"), to list the Virgin River Spinedace (*Lepidomeda mollispinis mollispinis*) as a threatened or endangered species and to designate critical habitat to ensure its recovery.

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on the Service. Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id*. Petitioners need not demonstrate that listing of the Virgin River Spinedace is warranted, rather, petitioners must only present information demonstrating that such listing may be warranted. While petitioners believe that the best available science demonstrates that listing of the spinedace is in fact warranted, there can be no reasonable dispute that the available information indicates that listing the species may be warranted. As such, FWS must promptly make a positive initial finding on the petition and commence and complete a status review as required by 16 U.S.C. § 1533(b)(3)(B). Petitioners also request that critical habitat be designated for the Virgin River Spinedace concurrently with the species being listed as endangered or threatened, pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12.

EXECUTIVE SUMMARY

The Virgin River Spinedace is a silvery minnow that was once common throughout the Virgin River basin in northwestern Arizona, southeastern Nevada, and southwestern Utah. Due to widespread habitat loss and degradation, competition and predation from non-native fishes, and other factors, the spinedace has undergone a range decline of 55 percent (Olden and Poff 2005, p. 81). Existing conservation efforts have not succeeded in abating threats to the species, stabilizing populations, or reintroducing self-sustaining populations throughout the majority of its historic range. The Endangered Species Act states that a species shall be determined to be endangered or threatened based on any one of five factors (16 U.S.C. § 1533 (a)(1)). The Virgin River Spinedace is threatened by four of these factors and thus warrants listing as a threatened or endangered species:

Loss and Degradation of Habitat

The Virgin River Spinedace is threatened by modification and curtailment of habitat and range due to water development and flow depletion, changes in channel morphology, and decreased water quality due to a suite of factors. Voluntary efforts to protect the spinedace have not alleviated these threats and spinedace habitat continues to be lost. Water shortage has overshadowed habitat restoration efforts, and flows in the Virgin River show a clear declining trend as demands on water continue to grow. Threats to spinedace habitat are increasing due to human population growth, drought, and global climate change. Attempts to restore the spinedace to the stated goal of 80 percent of its historic range have failed.

Disease and Predation

The Virgin River Spinedace is threatened by parasites and by competition and predation from non-native fishes and crayfishes.

Inadequacy of Existing Regulatory Mechanisms

There are no existing regulatory mechanisms which adequately protect the spinedace. The Virgin Spinedace Conservation Agreement and Strategy (VSCAS) has not met its goals despite having been in effect for 17 years. Long standing water development projects and new water development projects deplete the Virgin River and its tributaries of the water the spinedace needs to survive and recover, and voluntary agreements have failed at restoring flows sufficient to support healthy populations of spinedace. The VSCAS simply does not provide an adequate mechanism to ensure sufficient instream flow to promote spinedace recovery. All existing mechanisms have failed at curbing habitat loss and restoring sustainable spinedace populations. There has been a net loss of habitat quality while the conservation agreement has been in place (FWS 2008, p. 20), and threats to the spinedace are increasing due to increasing water demand, drought, and climate change.

Other Factors

The Virgin River Spinedace is threatened by several other factors including drought, flooding, global climate change, and entrainment at water diversion structures.

Due to these threats, the spinedace warrants protection under the Endangered Species Act.

The Virgin River Below the Confluence of Ash and LaVerkin Creeks. ©Center for Biological Diversity

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
INTRODUCTION	7
NATURAL HISTORY	7
RANGE	9
CONSERVATION STATUS	10
POPULATION STATUS	11
THREATS	
OVERVIEW	12
HABITAT LOSS AND DEGRADATION	12
DISEASE AND PREDATION	22
INADEQUACY OF REGULATORY MECHANISMS	23
OTHER FACTORS	31
CONCLUSION	33
REQUEST FOR CRITICAL HABITAT DESIGNATION	33
WORKS CITED	34

Santa Clara River, a tributary to the Virgin River. © James McMahon

INTRODUCTION

The Virgin River Spinedace is a two to four inch long silvery minnow with black blotches that is native to the Virgin River basin in Arizona, Nevada, and Utah. The spinedace has undergone drastic decline in both abundance and range and needs Endangered Species Act protection in light of ongoing threats to its survival. This petition summarizes the natural history of Virgin River Spinedace, the conservation and population status of the species, and the threats to the spinedace and its habitat. The petition shows that, in the context of the ESA's five statutory listing factors, the spinedace warrants listing as endangered or threatened under the Act due to loss or curtailment of habitat or range, disease and predation, the inadequacy of existing regulatory mechanisms to safeguard the species, and other factors including drought, flooding, global climate change, and entrainment in water diversion structures. Lastly, the Center requests that critical habitat be designated for the Virgin River Spinedace concurrently with listing.

NATURAL HISTORY

Taxonomy

The Virgin River Spinedace (*Lepidomeda mollispinis mollispinis*) is a minnow in Class Actinopterygii, Order Cypriniformes, Family Cyprinidae (Lee et al. 1980, Robins et al. 1991). It was previously referred to as *L. vittata*. It is one of two recognized subspecies of *L. mollispinis*, the other being *L m. pratensis*, the Big Spring Spinedace.

Description

The Virgin River Spinedace is a medium-sized silvery minnow with scattered black blotches and a brassy sheen. Reddish-orange coloration develops at the base of the paired and anal fins during the breeding season. The spinedace averages approximately 5 to 10 cm (2 to 4 inches) in length and reaches a maximum length of approximately 15 cm (6 inches). Its body is flat-sided and broad and the top line curves smoothly. The species has a well-scaled body, with 77-91 scales on the lateral line and two rows of pharyngeal teeth which typically number 2, 5-4, 2 (Sigler and Miller 1963, Addley and Hardy 1993). The dorsal fin has eight rays and the anal fin usually includes nine rays, but may vary from eight to ten rays. The species' name is based on a weak fusion of the first two dorsal rays which creates a spine at the leading edge of the dorsal fin (La Rivers 1962, Page and Burr 1991). During the breeding season, females become more robust and plump while males remain streamlined. Both sexes show reddish-orange coloration at the bases of the paired fins, but the female vent becomes swollen and the ovipositor becomes a reddish color (Rinne 1971).

Habitat

Virgin River Spinedace prefer cool, clean tributaries and inflow areas of larger streams; they are not generally found in the mainstem of larger streams (FWS 2009). Spinedace are most abundant in runs or pools with cover such as boulders, logs, overhanging vegetation, or undercut banks, though they tend to avoid heavily shaded areas (Williams and Deacon 1998). They are generally found near the shear zone between low and high velocity waters. Substrates in occupied habitats include rubble/cobble, gravel, sand, and silt (FWS 1995b). Larvae are associated with backwaters or slowly moving water along stream margins, particularly in areas with filamentous algae. Adults are detected most frequently at depths of 10-88 cm (4-35 in) at current velocities ranging from 0.1-1.0 meters per second (0.3-3.25 ft/s) (Williams and Deacon 1998). Spinedace generally occur in streams below 1,372 m (4,500 ft) elevation (FWS 2009).

The Virgin River Spinedace has a relatively narrow thermal niche, and exhibits low thermal lability (Hardy et al. 2003, p. 23). Virgin River fish experience physiological limitations and loss of equilibrium at approximately 31°C (88°F) (Deacon et al. 1987, Rehm et al. 2006, FWS 2011). The critical thermal maximum temperature for spinedace in the Virgin River is about 37°C (or 99°F) with mean upper thermal preference varying from 19-23°C (or 66-73°F) depending on the overall stream temperature (Williams and Deacon 1998). The critical thermal maximum based on rapidly changing temperature is from 30 to 37°C (Hardy et al. 2003). Spinedace are vulnerable to decreased flow and high summer temperatures. Because spinedace prefer inflow areas of larger streams (FWS 1995, FWS 2009), they are vulnerable to habitat changes that occur when tributary flows are piped or diverted.

Reproductive Biology

Virgin River Spinedace typically spawn from April through June when photoperiod is greater than 13 hours per day and water temperature ranges from 13-17 degrees Celsius (55-63 degrees Fahrenheit) (Williams and Deacon 1998). Peak spawning is closely correlated with peak spring flows, and laboratory results indicate that flowing water is required to stimulate spawning behavior (Williams and Deacon 1998, p. 6). Under natural conditions spinedace live for approximately three years, but an estimated 90 percent of the reproducing population is comprised of one-year old females (Williams and Deacon 1998). One-year old females are approximately 3.0 inches long and produce an average of 459 eggs per female. Two-year olds are about 3.3 inches long and produce an average of 788 eggs/female, and three-year olds are about 5 inches long and produce an average of 693 eggs/female. Though two-year olds produce more eggs per female, the one-year old cohort contributes more offspring to the population because one-year olds make up the vast majority of the population (Williams and Deacon 1998, FWS 2001).

Ecology

Virgin River Spinedace feed on a variety of insects including larvae of beetles and flies and adult mayflies and caddisflies. Spinedace eat primarily insects, but shift diets seasonally depending on food availability, consuming organic debris and filamentous algae when insect availability is decreased (FWS 2001). Angradi et al. (1991) found that adult ephemeroptera and trichoptera and stratiomyid and hydropsyche larvae are important food items for spinedace. Virgin River Spinedace typically feed on drifting prey and feed continuously during the day (Williams and Deacon 1998).

RANGE

The Virgin River Spinedace is endemic to the Virgin River system in northwestern Arizona, southeastern Nevada, and southwestern Utah (Figure 1). The Virgin River originates in south-central Utah and flows generally along the Hurricane Fault, which forms the boundary between the Colorado Plateau and the Great Basin. The river flows in a southwesterly direction for approximately 320 kilometers (200 miles) from Utah to northwestern Arizona and southeastern Nevada before emptying into Lake Mead.

Historically, Virgin Spinedace distribution included several Virgin River mainstem reaches and tributaries in southwestern Utah, northwestern Arizona, and southeastern Nevada. Museum records and species survey information indicate that the spinedace historically occurred in most of the clear water tributaries and in several mainstem reaches of the Virgin River (FWS 1995b). The estimated historic range of Virgin River Spinedace was 231.6 km (144 mi) of stream, but its distribution has been reduced by at least 40 percent to 140 km (87 mi) of stream (Valdez et al. 1991, Addley and Hardy 1993). The range loss has occurred due to human impacts which include the introduction of nonnative fishes, dewatering for agricultural and other purposes, urban development, and mining (FWS 1996).

Olden and Poff (2005) estimate a 55 percent decline for the Virgin River Spinedace, based on the change in distribution expressed as a percentage of total kilometers where the species was observed from before 1960 through the 1990s (p. 81). The goal of the Virgin Spinedace Conservation Agreement and Strategy, which went into effect in 1995, is to return the fish to 80 percent of its historic range. In comprehensive surveys in 2010, the spinedace was detected at only 52 percent of sites sampled throughout the Virgin Basin (Cox and Fridell 2011).

Current distribution of Virgin River Spinedace is primarily in Utah and includes portions of the main stem Virgin River (including the lower reaches of the North and East Forks) and seven of its tributaries including North Creek, La Verkin Creek, Ash Creek, Quail Creek, Leeds Creek, the Santa Clara River, and Beaver Dam Wash (Valdez et al. 1991, Addley and Hardy 1993, Cox and Fridell 2011). Additional populations exist in sub-tributaries to the Virgin River including Shunes Creek, Magotsu Creek, and Moody Wash (Cox and Fridell 2011).

LAND MANAGEMENT / OWNERSHIP

The Virgin River Spinedace occurs in waterways which are under private, state, and federal management. A high percentage of the land area in the Virgin River basin is administered by the Bureau of Land Management (BLM), Forest Service, or National Park Service. Private lands constitute less than 10 percent of the area; states, counties, and municipalities control an even smaller percentage (Deacon 1988, p. 18).

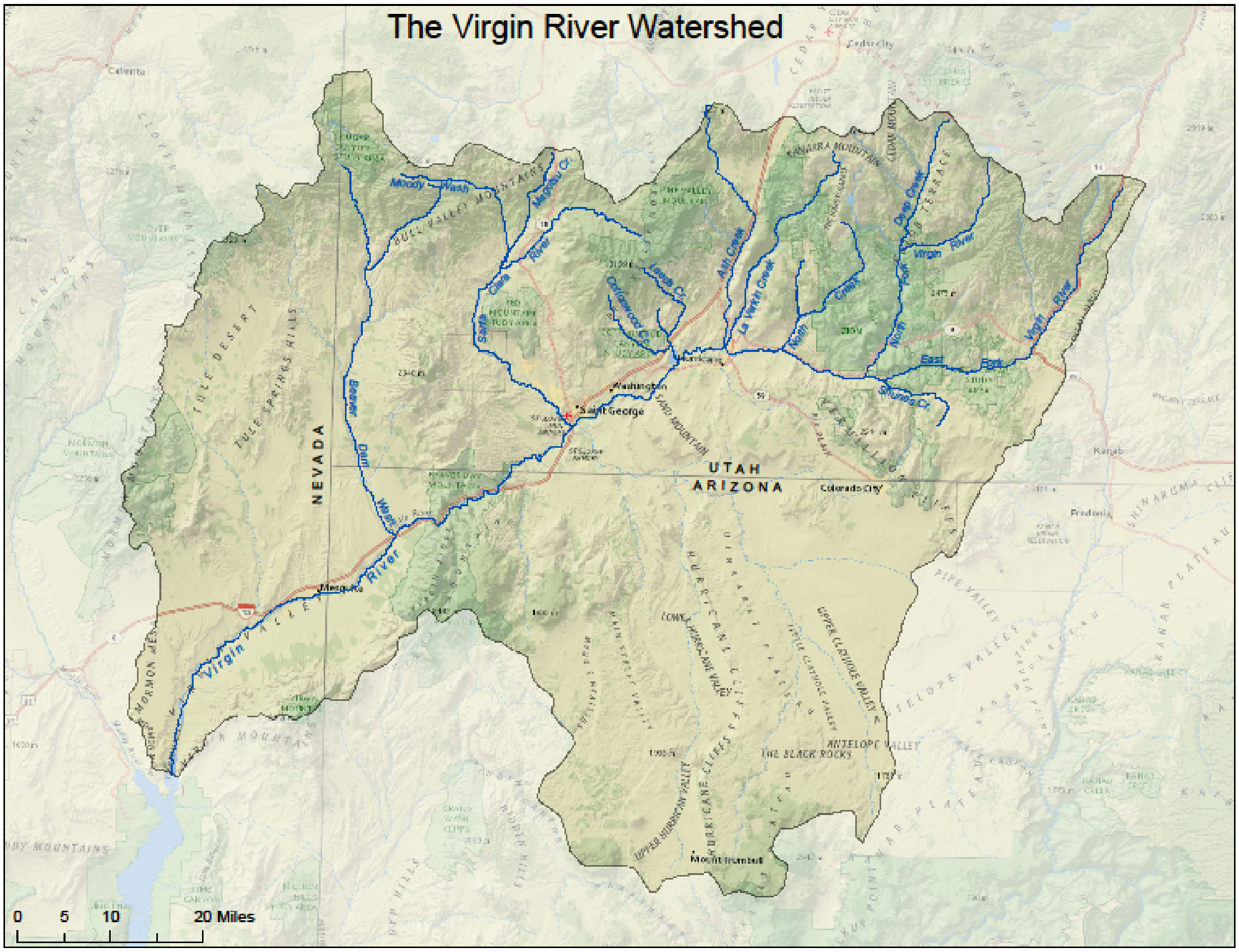

Figure 1. The Virgin River Watershed. © Curt Bradley, Center for Biological Diversity

CONSERVATION STATUS

In 1979, the Virgin Spinedace was recognized as a threatened species by the scientific community. The Endangered Species Committee of the American Fisheries Society added it to its list of threatened and endangered fish after assessing criteria consistent with the Endangered Species Act (Deacon et al. 1979). The Virgin Spinedace is still ranked as threatened by the American Fisheries Society (Jelks et al. 2008), meaning that is a taxon considered by the society to be in imminent danger of becoming endangered throughout all or a significant portion of its range. The society considers the spinedace to be threatened based on the present or threatened destruction, modification, or reduction of its habitat or range and other natural or anthropogenic factors that affect its existence (p. 390).

The Virgin River Spinedace is ranked by NatureServe (2011) as critically imperiled (G1G2S1T1). It is designated as a Sensitive Species by the state of Utah (UDNR 2011). It is classified as protected and at-risk by the state of Nevada (NDOW 2010) and as endangered by the state of Arizona (AGFD 2001). It is a Bureau of Land Management Sensitive Species (BLM 2012b).

In a study of long-term fish distribution trends in the Lower Colorado Basin, Olden and Poff (2005) concluded that the Virgin Spinedace should be considered for federal endangered status based on declining temporal trend and reduced distribution (p. 87).

The Bonneville Chapter of the American Fisheries Society and the Southern Utah Wilderness Alliance petitioned for federal protection for the Virgin Spinedace in 1992. It was proposed for listing as threatened in 1994 (59 FR 25875), with critical habitat proposed in 1995 (60 FR 17296). The State of Utah initiated the Virgin Spinedace Conservation Agreement and Strategy in response to the proposed federal listing. The listing proposal was withdrawn in 1996 (61 FR 04401) following the development of the Conservation Agreement which was signed on April 11, 1995. Seventeen years later, the Conservation Agreement has not succeeded in restoring flows and has not met the goal of returning the spinedace to 80 percent of its historic range. The spinedace meets the criteria for protection under the Endangered Species Act due to ongoing threats to its survival and due to the inadequacy of existing mechanisms to abate those threats.

POPULATION STATUS

The Virgin River Spinedace was once common to abundant throughout most of the tributaries and upper main stem of the Virgin River (Valdez et al. 1991, FWS 1996). Spinedace populations have declined since at least the 1930s due to physical and chemical habitat deterioration (Cross 1975, Hardy et al. 2003, p. 25). By the mid 1970s, spinedace occurred in 70 percent of upper mainstem collections, 33 percent of middle mainstem collections, and 50 percent of collections from the lower reaches of tributary creeks (Cross 1975, Hardy et al. 2003, p. 25). By 1975 spinedace were extirpated in the lower Santa Clara River below Windsor Dam, but were abundant in upper Santa Clara river reaches, typically making up one-third of total collected fauna (Cross 1975). Cross (1975) identified portions of the middle Santa Clara River and its tributaries, the North Fork Virgin and lower East Fork Virgin in Zion National Park, and Lower Beaver Dam Creek as notable population strongholds.

By 1993 spinedace had disappeared from 37 percent of probable historic habitat, and had been severely depleted in an additional seven percent (Addley and Hardy 1993). Basin-wide sampling in 2010 found that the spinedace was not present in 48 percent of tributaries throughout the Virgin Basin (captured at 55/105 sampled sites throughout the basin) (Cox and Fridell 2011).

Spinedace populations fluctuate based on flow conditions (Golden and Holden 2002, Hardy et al. 2003, p. 54; Cox and Fridell 2010, p. 6). As of 2005, the populations in the North Fork, East Fork, Lytle Ranch, and the mainstem above the Quail Creek Diversion were considered stable (UDWR 2005). The La Verkin Creek population was considered low but stable. The populations in Moody Wash and Motoqua were fluctuating. The Santa Clara and North Creek populations were low but being augmented (UDWR 2005).

The population at Ash Creek is currently extirpated. Spinedace were captured at Ash Creek from 2005 to 2007, but were not detected from 2008-2010 (Cox and Fridell 2010, 2011). In contrast, in 1977, 32.5 spinedace per 100 m^2 were detected near Ash Creek (Williams and Deacon 1998). Williams and Deacon (1998) report that prior to the construction of reservoirs on Ash and Quail creeks, spinedace were so abundant in both creeks that hundreds could be collected in a single seine haul (p. 16).

Overall population data are not available for the spinedace, but it is obvious that both abundance and range have decreased dramatically. The Conservation Agreement has not succeeded in restoring the spinedace to its historic distribution or abundance (e.g. AGFD 1996, p. 5; Cox and Fridell 2011).

THE VIRGIN SPINEDACE WARRANTS PROTECTION UNDER THE ESA

The Virgin River Spinedace is threatened by four of the five listing factors under the Act including modification or curtailment of habitat or range, disease and predation, other factors including climate change, drought, and entrainment at water diversion structures, and by the inadequacy of existing regulatory mechanisms to protect it. The spinedace was threatened by these factors at the time of its proposed listing in 1994 and as of 2012 it is still threatened by these factors. The Virgin River Conservation Agreement and Strategy which was signed to protect the species has not succeeded in abating these threats, and the agreement has not met its goals in the 17 years it has been in effect. The spinedace has not been restored to the bulk of its range, populations remain unstable, adequate flows are not being provided, development and stream channel alteration projects are ongoing, and threats from drought, climate change, and human population growth are increasing. The spinedace warrants protection under the Endangered Species Act.

THREATS

Overview of Threats

There are numerous threats to the survival of the Virgin River Spinedace. The spinedace is threatened by habitat loss and degradation from water development and flow depletion, changes in channel morphology, decreased water quality, and human population growth. It is threatened by disease, predation, and other factors including drought, climate change, and entrainment at water diversion structures. There are no existing regulatory mechanisms to adequately ensure the persistence of the spinedace.

PRESENT OR THREATENED DESTRUCTION, MODIFICATION OR CURTAILMENT OF HABITAT OR RANGE

Overview of Habitat Loss

Habitat loss and degradation is a primary threat to the survival of the Virgin River Spinedace. Factors discussed below which threaten the spinedace‘s habitat and survival include water development and flow depletion, changes in channel morphology, decreased water quality, and human population growth.

Water Development and Flow Depletion

Without adequate flow the spinedace cannot survive and reproduce. Flow depletion is thus a major threat to spinedace survival (FWS 1995, p. 12, 26; FWS 2008, p. 20). Numerous water diversions and reservoirs have caused loss and degradation of spinedace habitat as well as direct fish mortality (Cross 1975, Deacon 1988, Valdez et al. 1991, Addley and Hardy 1993, Gregory and Deacon 1994, FWS 1996, Holden and Zucker 1996, Williams and Deacon 1998, p. 23). Reduced flows, altered hydrologic regime, and periodic dewatering of several reaches suppress or extirpate spinedace populations in the mainstem Virgin and its tributaries (FWS 1996; Hardy et al. 2003, p. 51; FWS 2011, p. 22). Overall trends in spinedace abundance are correlated to the amount of available water, and flow is a primary limiting factor in spinedace survival and recovery (FWS 1995, p. 26; Williams and Deacon 1998, Holden et al. 2001, Golden and Holden 2002, Hardy et al. 2003, p. 54; Golden and Holden 2004).

By 1902 more than 20 major irrigation diversions were operating on the Virgin-Muddy River system, and by 1910 flows were essentially fully appropriated (FWS 2008, p. 8). Water diversions are capable of removing the entire flow in various sections of the Virgin River (Deacon 1988, p. 18). In the upper Virgin River, the Hurricane and La Verkin Ditch diversions were constructed in the late 1890s and early 1900s and routinely dewatered the river downstream to Pah Tempe Springs during low flow conditions (FWS 2011, p. 16). In 1985 the Hurricane and La Verkin Ditch diversions were replaced by the Quail Creek Diversion, which has the capacity to dry dam the river. The Quail Creek Reservoir operations require a minimum bypass flow of 86 cubic feet per second (cfs) (or the natural flow as measured at the Virgin River gage at Virgin, Utah if the natural flow is less than 86 cfs) to the Washington Fields Diversion. The Quail Creek Reservoir is not being operated in compliance with the Biological Opinion (FWS 1982) which states that "a minimum of 86 cubic feet per second (cfs) will always bypass this diversion structure (unless natural flows are less then the bypass will be the natural flow)" (FWS 1982, p. 1). A bypass of only 3 cfs is being released (Lentsch et al. 1995) and this is simply not enough flow to allow for the survival and successful reproduction of the Virgin River Spinedace. The decreased flow below Quail Creek is especially problematic because the capacity of the river to dilute the increased output from Pah Tempe Hot Springs is diminished, causing water quality issues and subsequent decline in fish abundance (Gregory and Deacon 1994; Williams and Deacon 1998, p. 23).

The Quail Creek Diversion is not the only diversion that threatens the survival of the spinedace. The Washington Fields Diversion can also divert the entire flow of the river, and the river's entire flow has been diverted here periodically since the early 1900s through authorized water rights (FWS 2011, p. 16). A minimum flow of 5 cfs passes the Washington Fields Diversion through the operation of a fish screen, but this level of flow is not adequate to sustain healthy populations of native fishes. In the lower river, three additional diversion structures capture significant amounts of water during low flow periods, removing the bulk of remaining streamflow—the Mesquite Diversion, Bunkerville Diversion, and Riverside Diversion (Deacon 1988, p. 18; FWS 2011, p. 16). The Mesquite diversion at times takes the entire flow of the river for agricultural and commercial use (Williams and Deacon 1998, p. 18). Drought exacerbates the threat posed to spinedace by diversions, with flows of 0-5 cfs being recorded at Mesquite Bridge and Riverside during recent drought periods (Golden and Holden 2004; FWS 2011, p. 16).

Water development and flow depletion also threaten the spinedace in the Virgin's tributaries. In Ash Creek, reservoir construction resulted in decreased spinedace abundance (Williams and Deacon 1998, p. 16). Numerous ongoing projects on Ash Creek threaten the spinedace, and populations in the creek are frequently extirpated. The Lichfield Diversion, for example, can take the bulk of the creek's flow (Wiley et al. 2008, p. 15). There are current plans to further destroy spinedace habitat on Ash Creek by constructing a new reservoir and pipeline (BLM 2012).

On the Santa Clara River (Figures 2, 3), numerous dams and diversions threaten the spinedace (Williams and Deacon 1998, p. 20). The Dixie Power Company diverted the entire flow of the Santa Clara River as early as 1925. A protest filed by the Veyo Irrigation Company on June 16, 1925 reads: "[A]t the present time the enlargement of the canal has virtually worked a change in the creek bed because all of the water has been diverted into the canal and only at unusual high water periods does any water run down the old creek channel" (Veyo Irrigation Company 1925). The power company's dry damming of the river may have eliminated spinedace populations above Veyo Pool. The construction of Baker Dam in 1950 created another barrier to fish dispersal, and the stocking of the reservoir with trout and their escape into the river further threatens native fish. The ongoing operation of three hydroelectric plants on the Santa Clara now owned by PacifiCorps—Gunlock, Sand Cove, and Veyo, currently degrades and divides spinedace habitat. For example, only 3-5 cfs are released for fish below the Gunlock Reservoir (FWS 2008, p. 8). This low level of flow is not sufficient to allow natural river processes to occur which are needed to create healthy spinedace habitat.

Lack of habitat connectivity due to water development projects, reduced flows, inhospitable conditions, and invasive species also threatens the spinedace (Valdez et al. 1990, Addley and Hardy 1993). Dams and diversions act as barriers to fish movement, fragmenting spinedace habitat and populations and inhibiting or precluding dispersal (Lentsch et al. 1995). When water quality conditions deteriorate, fish cannot disperse to better areas and mortality can result. Populations are also threatened with genetic isolation due to lack of connectivity.

Reduced flow results in high water temperatures that pose a present and increasing threat to spinedace survival in both the upper and lower river and tributaries (Deacon et al. 1987, Albrecht et al. 2007, FWS 2008, p. 28). Extreme reductions in stream volume, loss of riparian vegetation, groundwater decline, and increasing air temperatures all contribute to rising stream temperatures that can be lethal for fish (Carveth et al. 2004, p. 9). Periodic high water temperatures can directly cause fish mortality and can also cause chronic impacts such as altered behavior, reduced growth and fitness, and increased susceptibility to disease (Cross 1975, Deacon 1988, Addley and Hardy 1993). During summer, water temperatures in the Virgin River often exceed the behavioral and critical thermal maxima for native fishes (FWS 2008, p. 34; FWS 2011, p. 17). Though the Virgin River Program has identified addressing high summer water temperatures as a top priority, efforts have not been adequate to maintain flows that are sufficient to ensure summer survival. The threat posed to the spinedace by reduced flow and increased temperature is exacerbated by growing demand for water supplies, drought, and global climate change.

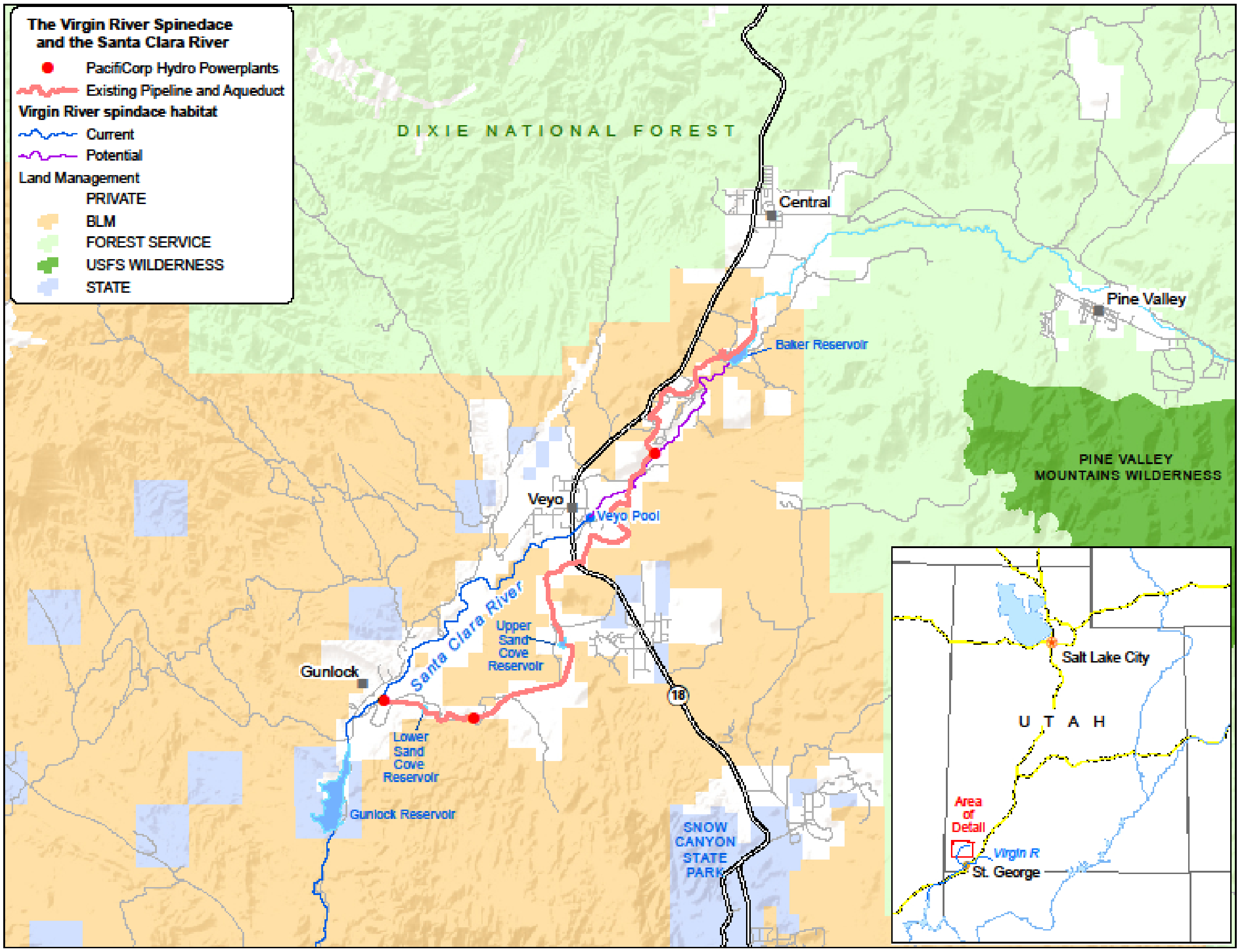

Figure 2. Santa Clara River Spinedace Habitat. © Curt Bradley, Center for Biological Diversity

There is no question that the spinedace's habitat is threatened by water development and flow depletion. The natural baseflow of the Virgin River is estimated at 80-100 cfs (FWS 2008, p. 67). Total lack of flow obviously threatens the spinedace, but severely reduced flow also threatens to drive the species to extinction. Low levels of discharge from reservoirs do not provide adequate spawning and larval rearing habitat and do not allow for natural dynamic processes such as riffle construction and maintenance. Variable daily and seasonal temperature characteristics that would provide environmental cues to trigger demographic events in the fish life cycle are also lost (Hardy et al. 2003, p. 70). Lack of stable flow and low water levels resulting from diversions negatively impact water quality, affect aquatic vegetation, increase water temperature, decrease dissolved oxygen levels, and concentrate pollutants (Lentsch et al. 1995, p. 8). Low flow also exacerbates the negative effects of livestock grazing, mining, development, exotic species, and other threats (Hardy et al. 2003, p. 25). Diminished flow also results in decreased turbidity which causes fish to crowd into habitats with cover, increasing competition, predation, stress, disease, and parasitism (Hardy et al. 2003, p. 70). As will be further discussed in the Inadequacy of Existing Regulatory Mechanisms section below, the current approach to spinedace conservation has neglected to restore and integrate natural flow processes which are critical to spinedace survival and recovery.

The Virgin River Spinedace needs Endangered Species Act protection because not enough water is being left in the river and its tributaries to ensure the spinedace's survival. Despite actions undertaken under the Conservation Agreement, there has been a net loss of habitat quality in the Virgin River with low flows and drought conditions overshadowing conservation efforts (FWS 2008, p. 20).

Figure 3. PacifiCorp Diversion on the Santa Clara River at Veyo © James McMahon

Changes in Channel Morphology

The Virgin River Spinedace is threatened by changes in channel morphology that have negatively impacted habitat quantity and quality. Flood management, floodplain encroachment, tamarisk (*Tamarix sp*.) invasion, and sediment storage behind diversions have all contributed to reduced habitat complexity and loss of biological productivity along the Virgin River and its tributaries (FWS 2000, p. 4142). The Virgin River channel has become narrower and more incised over time which has decreased habitat quality and caused a loss of fish rearing habitat (Hardy et al. 2003, p. 70).

Flood management projects are ongoing in the Virgin River Basin (ACOE 2008). Flood management and bank stabilization projects reduce habitat heterogeneity and alter river function by preventing natural meandering and habitat creation (FWS 2011, p. 26). This results in a simplified river channel and loss of habitat complexity needed by native fish to complete their life history requirements.

Changes in channel morphology and loss of natural river dynamic processes threaten the spinedace throughout its range, and restoration efforts have focused only on returning very low flows to specific isolated sections rather than restoring watershed function throughout the basin. Channelization and loss of function threaten the spinedace even in Zion National Park. The North Fork of the Virgin in Zion National Park was aggressively channelized by the Park Service in the 1930s when it was straightened, entrenched, and armored. This resulted in diminished natural function and a change from a very wide, braided, and active channel to a narrower, single channel. The East Fork of the Virgin has never been channelized, but has also undergone a shift in morphology resulting from changed flooding patterns and altered watershed condition (Sharrow 2004).

Floodplain encroachment has likewise reduced habitat quality and quantity in the Virgin River and its tributaries through the loss of natural river dynamics. The Virgin River floodplain is integral to preserving the integrity of the physical and biological features essential to the conservation of the spinedace. Floodplain encroachment has degraded habitat quality and resulted in the loss of upland and bottomland habitats that would normally be inundated during spring flows and that are valuable in maintaining healthy fish communities (FWS 2000, p. 4141). Because the Virgin River contains a minimum amount of organic matter, its native fishes are heavily dependent on energy inputs from the floodplain to support the food base. Floodplain encroachment has reduced the input of terrestrially-derived nutrients which are necessary to enhance fish growth, fecundity, and survival (FWS 2000, p. 4141). Floodplain encroachment and the loss of habitat complexity and biological productivity is an increasing threat to the spinedace due to ongoing development in the Virgin Basin.

Tamarisk was introduced to the United States from Asia in the 1830s and has taken over the riparian zone and floodplain of the Virgin River system, especially in low gradient areas with sandy substrates (FWS 2008, p. 35). Tamarisk invasion has altered normal river function, armored the stream channel, unnaturally stabilized stream banks, eliminated native riparian vegetation, and reduced low flow turbidity needed by native fishes (Williams and Deacon 1998, p. 18; FWS 2008, p. 35).

Pollution and Decreased Water Quality

The Virgin River Spinedace is threatened by decreased water quality and pollution from numerous sources. Low flow conditions exacerbate pollution impacts. Factors which contribute pollution to spinedace habitat include agriculture, livestock grazing, mining, sediment sluicing from impoundments, runoff from burned portions of the drainage, fire and fuels management activities, recreation, and urban development (Cross 1975, Cross 1978, p. 525; Lentsch et al. 1995, FWS 1996, Williams and Deacon 1998, FWS 2004, p. 189; FWS 2008, p. 15; Cox and Fridell 2010).

Most segments of the Virgin River in Utah are on the state's list of impaired 303(d) waters for 2010. The North Fork of the Virgin River and tributaries from the confluence with the East Fork Virgin River to the Kolob Creek confluence is listed as impaired for temperature (EPA 2012). The North Fork of the Virgin River and tributaries from the Deep Creek confluence to the headwaters is listed as impaired for *Escherichia coli.* The Virgin River from the Utah state line to the Santa Clara River confluence is listed as impaired for temperature and boron. The Virgin River and tributaries from the Santa Clara River confluence to the Quail Creek Diversion is also listed as impaired for temperature and boron. In Nevada, the Virgin River is on the state's 2006 list of impaired waters for nutrients (total phosphorus), metals (boron, iron, manganese, selenium) and temperature (EPA 2012). The U.S. Geological Survey reports water samples from the Virgin River that vastly exceed the drinking water standards for lead and uranium (Bills et al. 2010).

Agricultural activities threaten the spinedace through riparian degradation, flow reduction, irrigation leaching, and pollution (Williams and Deacon 1998, FWS 2004). Agricultural practices have altered the riparian zone along the river and its tributaries causing stream bank erosion, siltation, and devegetation (Lentsch et al. 1995). Peak irrigation demand coincides with natural low water periods, heightening the risk of fish mortality from high water temperature (Cross 1978, p. 525). Irrigation return flows to the river contain pesticides and other pollutants which threaten the spinedace, and return flows can make up a significant portion of the entire stream flow, resulting in undiluted contamination (Cross 1978, p. 526; Lentsch et al. 2002, p. 7).

Cattle and sheep grazing and runoff from feedlot operations have adversely affected the spinedace along the mainstem and tributaries of the Virgin River through physical habitat degradation and pollution from organic waste effluent (Cross 1978, p. 526; Lentsch et al. 1995, Williams and Deacon 1998, p. 18, 20, 21; Hardy et al. 2003, p. 24; FWS 2004, p. 189). Virgin Spinedace are frequently found in cool, clear pools with some type of protection such as undercut banks, boulders or debris. Livestock grazing can eliminate these habitat areas and cause declines in spinedace abundance (Magaña 2002, p. 5). Increased sedimentation from grazing can alter the benthic invertebrate community and disrupt the spinedace's food supply (Angradi et. al. 1991). Given that the Virgin

Spinedace is a short-lived species, disturbance of localized habitat by livestock may have a long-term affect on the species (Magaña 2002, p. 5). The Santa Clara River in particular is heavily grazed with negative effects on spinedace habitat (Wiley et al. 2008, p. 8). Cattle have been observed directly in the Santa Clara River.

Sediment sluicing-- the periodic release of sediment that accumulates behind dams, threatens the spinedace with direct mortality and with habitat degradation. Very dirty flood events from sluicing and storms have caused several documented fish kills in the Virgin River. Sediment sluicing contributes to lethally low dissolved oxygen levels due to large oxygen demand from sediment. In 2007 two events of extensive sluicing from behind the Quail Creek Diversion coincided with storm events and decimated the native fish population between Pah Tempe Hot Springs and Washington Fields Diversion (FWS 2011, p. 19). Hardy et al. (2003) also report fish kills from sediment sluicing, and note that these events may have been unreported in the past (p. 69). The greater the accumulation of sediment behind dams, the higher the regular stream flow needs to be to safely transport the sediment downstream (FWS 2008, p. 35). The threat posed to the spinedace from sediment sluicing is magnified by low flow levels due to water development.

Both fire and fire management activities threaten the Virgin River Spinedace and its habitat. Pollution from runoff from burned portions of the drainage periodically threatens the spinedace with impaired water quality (FWS 2011, p. 19). Fire and fuels management treatment activities conducted by various agencies along the Virgin River can degrade habitat quality for the spinedace (FWS 2004). Treatment activities include prescribed fire and mechanical and chemical treatments which threaten water quality and could have lethal and sublethal impacts on spinedace. Fish are also at risk of being pumped from the river during fire suppression actions. Fire management actions upstream or on state and private lands may pose an even greater threat than activities on federal lands because federal best management practices may not be implemented during these actions. Suppression activities may result in increased effects from vegetation loss and negative changes to water and habitat quality (FWS 2004, p. 189).

Habitat loss and degradation from pollution from several types of mining threatens the Virgin River Spinedace (FWS 1996, Williams and Deacon 1998, p. 15, 20; Valdez et al. 1990, Hardy et al. 2003, p. 24).

The Virgin River Spinedace is threatened by habitat loss and degradation from recreational activities which can fragment, modify, or destroy upland and riparian habitat and negatively affect water quality and quantity (FWS 2004, p. 189). Popular recreational activities along the Virgin River and its tributaries include off-road vehicle riding, camping, hiking, rafting, kayaking, skim-boarding, tubing, wading, and swimming. These activities threaten the spinedace's habitat with increased pollution, streambank alteration, trampling and suppression of native vegetation, and erosion (FWS 2004, p. 188). In addition to habitat degradation, disturbance from humans and dogs can alter fish behavior and disrupt activities such as feeding or spawning (FWS 2011, p. 26).

Publicly available land and water bodies in the Virgin River watershed experience heavy recreational usage. Camping and hiking is extensive in the region, especially along the Virgin, Santa Clara, and Ash Creek with campers frequently using the banks and the floodplain. Off-highway vehicle use is common in floodplain and upland areas. Few sanitation facilities are available, putting the spinedace's habitat at risk of contamination from sewage (FWS 2001, p. 3-19). Irrigation for golf courses, parks and other offsite recreational areas places additional demands on the river (FWS 2001, p. 3-19).

The healthiest populations of Virgin River Spinedace occur in the river in Zion National Park where they are somewhat buffered from the impacts of development and water withdrawals. Populations in the park, however, are threatened by impacts from recreation (Williams and Deacon 1998). More than 2.8 million people visited Zion National Park in 2011 and visitation has continually increased in recent years (NPS 2012). During the summer months, approximately 2,000 visitors per day wade recreationally in-stream in the North Fork of the Virgin River in Zion (Smith 2009, p. 392). Instream wading can both disturb and displace spinedace and can alter the food web on which they depend.

Several studies have documented mechanisms by which instream recreation can negatively affect spinedace. Sappington (1998) sampled fish in the North Fork of the Virgin River in Zion to assess the effects of recreational activities and found that pools with high levels of wading and float tubing contained altered population distributions and altered community structure compared to pools generally lacking recreational activities (p. iii). Fish abundance was lower and fish distribution was patchier in areas used for recreation. The abundance of larval fish in particular was lower in pools experiencing recreational disturbance, and larval fish may be disproportionately affected by in-stream recreational activities (Sappington 1998, p. iii). Valdez et al. (1990) found that spinedace abundance may be lower within recreationally disturbed areas of the North Fork of the Virgin River. Smith (2009) found that high numbers of recreational hikers in the Virgin River are negatively impacting the structure and function of the benthic algal cyanobacterial community. Caires (2007) found that hiking in the river affects aquatic invertebrates at a localized scale, and that the abundance of the most common taxon of macroinvertebrate was lower at high visitor use sites than at sites with lower use. Shakarjian and Stanford (1988) found that high levels of instream hiking can dislodge river substrate and negatively affect zoobenthos, and that grazing invertebrates are more abundant at sites with less usage. They concluded that as levels of hiker trampling increased, the biomass and density of benthic invertebrates decreased.

In sum, pollution and decreased water quality from numerous activities poses a present and increasing threat to the survival of Virgin River Spinedace.

Development and Human Population Growth

The Virgin River Spinedace is threatened by habitat loss and degradation resulting from development and human population growth. Municipal, residential, and industrial development is a present and increasing threat to the spinedace (Wiley et al. 2008, p. 23). The Virgin River watershed is undergoing rapid urbanization and population growth, and growth is expected to continue (Deacon 1988, Williams and Deacon 1998, FWS 2004, p. 121, 189; FWS 2011, p. 18, 26). Ongoing development and increased groundwater pumping is a primary threat to Virgin River fishes (FWS 2007, p. 101). In addition to increased water demand to support subdivisions, golf courses, resorts, hotels, and other developments, population growth and urbanization threaten the spinedace and its habitat in numerous ways. Increased stormwater runoff diminishes water quality. Increased wastewater discharge into rivers and streams threatens the spinedace with pollution and endocrine disruption from unregulated contaminants including pharmaceuticals and personal care products (Caliman and Gavrilescu 2009). Increased human presence also exacerbates the negative impacts from recreational activities.

Development has led to stream channelization, decreased flow, and increased pollution (Valdez et al. 1990, Williams and Deacon 1998, Hardy et al. 2003). Population growth requires more infrastructure which leads to direct habitat loss. Increasing urbanization throughout the basin increases pressure for stream bank stabilization projects that directly alter spinedace habitat (Wiley et al. 2008, p. 23). River alterations to prevent flood damage to infrastructure threaten the spinedace throughout the majority of its range. In December 2005, the National Resources Conservation Service Emergency Watershed Protection Project began river alterations on the Virgin River, Santa Clara River, Beaver Dam Wash, La Verkin Creek, and Ash Creek to prevent damage to infrastructure from large flood events (Wiley et al. 2008, p. 4). These alterations directly threaten the spinedace and its habitat.

The transfer of federal land in the Virgin Basin to private ownership for development further threatens the spinedace (e.g. Heck 2011). Land disposals that provide additional private acreage for development, along with the cumulative effects of development of existing private lands are expected to significantly reduce flows in the river and habitat for the spinedace (FWS 2007, p. 101). Conversion of agricultural lands to municipal and industrial lands diminishes return flows which currently make up a significant portion of total flow at certain times. Agricultural diversions tend to be less “complete” than those made for municipal and industrial purposes, which require greater reliability of the diversion structures and delivery systems. In consequence, earthen diversion structures and canals are being replaced by watertight dams and pipes that do not allow for seepage of water back into the river system.

Population growth in the riverside communities of St. George, Utah and Mesquite, Nevada has outpaced national averages for decades. At current growth rates, water demand projections for the City of St. George suggest available resources will be depleted by the year 2020. A proposed 160 mile pipeline from Lake Powell to Washington County, Utah could supply as much as 70,000 acre feet of water annually for municipal and industrial use in the upper Virgin River drainage (FWS 2011, p. 18). If completed, this pipeline could potentially in the short term alleviate demand on the water the spinedace needs to survive. In the long term, however, the pipeline will promote further unsustainable population growth in an increasingly arid region. Increased development made possible by the pipeline will increase floodplain encroachment, increase urban runoff and water pollution, increase recreational activity in the floodplain, and also has high potential to introduce invasive aquatic species.

Continuing drought exacerbates the threat posed to the spinedace by increasing human population and water demand (USACE 2008). Both the mean annual flow and seasonal flows in the Virgin River are showing significant declining trends. A higher percentage of the total flow is necessary to meet priority water rights. A trend toward lower residual flows is occurring due to drought at the same time that water demand is increasing to support population growth in the basin (Hardy et al. 2003, p. 39). The Virgin River Spinedace warrants Endangered Species Act protection due to threats to its habitat from ever decreasing flows, diminishing groundwater, and rapidly increasing demand for the water it needs to survive.

DISEASE AND PREDATION

Disease

Parasitism threatens the survival of the Virgin River Spinedace (Deacon 1988, p. 23; Hardy et al. 2003, p. 24). The spinedace is threatened by the Asian Carp Tapeworm (*Bothriocephalus acheilognathi*), a cestode parasite. The Asian Carp Tapeworm is also known as the Chinese Tapeworm and synonyms include *B. opsariichthydis*, *B. opsalichthydis*, *B. fluviatilis*, *B. gowkongensis*, *B. phoxini*, and *Schyzocotyle fluviatilis* (Hauck 2009).

The tapeworm was spread to the spinedace when infected baitfishes were released into Lake Mead by anglers (Kolar et al. 2005, p. 56). Tapeworm infection weakens fish and makes them more vulnerable to other stress factors such as low water levels (FWS 1996). The tapeworm can kill fish by perforating their intestines, especially in incidents of heavy infection (Hauck 2009). Infection can shorten fish life span and stunt growth (Hauck 2009).

Infection with *Bothriocephalus acheilognathi* has been shown to reduce a fish's ability to cope with stressors such as reduced food availability. Competing with intestinal parasites for nutrients may lead to reduced body condition, anemia, reduced growth, and temperature dependent mortality, especially in juvenile fish. Other known pathogenic effects include intestinal inflammation, protein depletion and altered digestive enzyme activity (Hejna 2012). Hickman et al. (1987) reported tapeworm infection rates in spinedace of 12 percent (Hardy et al. 2003, p. 25).

Tapeworm infection may severely complicate efforts at conservation and recovery for the spinedace (Hejna 2012).

Predation

Predation is a primary threat to Virgin River Spinedace (FWS 2001, FWS 2008, p. 47). Predation and competition from non-native fish and crayfish species negatively impact spinedace distribution and abundance (Cox and Fridell 2010). Predation from numerous species poses a constant threat to spinedace because fish escape from impoundments connected to the Virgin River and its tributaries (FWS 2008, p. 40). The proposed Lake

Powell Pipeline Project could also facilitate the introduction of invasive species to Virgin River Spinedace habitat (AGFD 2008).

Known invasive species that threaten spinedace include: black bullhead (*Ameiurus melas*), bluegill (*Lepomis macrochirus*), Bonneville redside shiner (*Richardsonius balteatus*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), bullfrogs (*Lithobates catesbeianus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), golden shiner (*Notemigonus crysoleucas*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), mosquitofish (*Gambusia affinis*), rainbow trout (*Oncorhynchus mykiss*), red shiner (*Cyprinella lutrensis*), virile crayfish (*Orconectes virilis*) (Valdez et al. 1990, FWS 2001, p. 3-13; Cox and Fridell 2010).

Depleted flow and drought exacerbate predation impacts. Crowding of fishes into pools increases predation and spread of disease and parasites (Cross 1978). During low flow periods, relatively stable stream conditions can lead to extremely high crayfish densities in the Virgin River Basin. Consequently, monitoring has revealed a high incidence of Virgin Spinedace exhibiting crayfish induced injuries during these periods (Cox and Fridell 2010, p. 13).

Since 1988, the Virgin River has been chemically treated between the Washington Fields Diversion and the Utah-Arizona border to remove red shiner and other non-native species. The treatment regime has intensified since 1996 and has drastically reduced red shiner populations, but eradication projects have to be conducted on an ongoing basis.

Treatments have become more complicated in recent years due to a massive stream bank stabilization project to repair flood damage incurred in 2005 in Washington County. The flood repairs include construction of miles of rock revetment which are allowing water to flow into the Virgin River channel and providing refuge for invasive fishes during rotenone treatments (FWS 2008). The use of gabion baskets in flood repair could also create unintentional habitat for non-native fishes (FWS 2011, p. 2).

Rotenone treatments are particularly complicated in the Virgin River system due to the associated marsh habitats and irrigation return canals that provide refuge during treatments. Mechanical removal is conducted in conjunction with chemical treatment, but the effects are short-term. Lake Mead is a source of red shiner and other nonnative species, and invasive fishes pose an ongoing threat to the spinedace in both the upper and lower river (Golden and Holden 2002, Albrecht et al. 2007, FWS 2008).

INADEQUACY OF EXISTING REGULATORY MECHANISMS

There are no existing regulatory mechanisms at the federal, state, or county level which are adequate to protect the Virgin River Spinedace.

The spinedace was proposed for protection as “threatened” under the Endangered Species Act in 1994 (59 FR 25875), and critical habitat was proposed in 1995 (60 FR 17296). In response to the proposed federal listing, the State of Utah initiated the Virgin Spinedace Conservation Agreement and Strategy (VSCAS) which was signed on April 11, 1995. The VSCAS provides a guiding document for a multi-agency voluntary collaborative effort to conserve Virgin Spinedace. Following the development of the VSCAS, the proposed federal listing was withdrawn in 1996 (61 FR 04401). The conservation agreement was modified and revised in 2002 (Lentsch et al. 2002). In 2009 a Memorandum of Understanding (MOU) was signed extending the VSCAS through February 1, 2019. The signatory parties to the MOU include the Utah Department of Natural Resources (UDNR), U.S. Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), National Park Service (NPS), Nevada Department of Wildlife (NDOW), Washington County Water Conservancy District (WCWCD), Arizona Game and Fish Department (AGFD), and the Forest Service (FS).

The VSCAS is not an adequate substitute for the regulatory protection which the species warrants under the Endangered Species Act. This voluntary agreement has proven to be inadequate for many reasons including ongoing loss and degradation of spinedace habitat during the 17 years the agreement has been in effect, inability of the agreement to ensure sufficient instream flow, ongoing fluctuation and extirpation of populations, increasing threats from human population growth, growing water demand, drought and global climate change, and failure of the agreement to meet its goal of restoring the spinedace to 80 percent of its historic habitat. The agreement is discussed in detail below.

The goal of the VSCAS is to return Virgin Spinedace populations to at least 80 percent of their historic habitat. To achieve this goal, seven required actions are described in the VSCAS, including: 1) establish existing conditions of historic habitat as baseline; 2) re-establish population maintenance flows; 3) enhance and maintain habitat; 4) selectively control non-indigenous fishes; 5) re-establish Virgin Spinedace populations; 6) monitor populations; and 7) mitigate for projects that impact Virgin Spinedace (Lentsch et al. 2002).

Seventeen years have passed since the VSCAS was implemented, and the goal of returning the spinedace to 80 percent of its historic habitat has not been met. In 2010, distribution monitoring was completed within tributaries throughout the Virgin River Basin, and spinedace were captured at only 52 percent of sampled sites (Cox and Fridell 2011).

Seven required actions are outlined in the VSCAS. The first of these is to establish existing conditions as baseline to evaluate potential impacts of proposed projects. Existing conditions are to be described in terms of three primary attributes: 1) basin hydrology averaged over the last 20 years; 2) water rights and depletions; and 3) Virgin Spinedace populations. Using these baseline conditions, all management actions are to be evaluated for effectiveness and proposed modifications to the existing conditions are to be evaluated for potential impacts to Virgin Spinedace.

It is not adequately protective of spinedace to use existing conditions as the baseline by which to evaluate project impacts because existing conditions themselves are not adequately protective of the species. The flow pattern currently occurring in the Virgin River system is detrimental to the spinedace. Basin hydrology averaged over the last 20 years does not accurately reflect historical conditions or conditions necessary to the survival and recovery of the species. Existing water development projects have caused significant flow reduction in the Virgin River and its tributaries, and current conditions threaten the spinedace. Not only are existing conditions not adequately protective, but water development projects, projects that alter the stream channel, and floodplain development are ongoing and continue to cause loss and degradation of spinedace habitat despite the goal of maintaining the existing baseline.

The second required action is to re-establish population maintenance flows. This action has not been executed. The goal was set to re-establish and maintain population maintenance flows in approximately 39 km of de-watered historic habitat and this has not been achieved (Wiley et al. 2008, p. 22). Flows of 3 to 5 cfs are being released in some areas, but these flows are not adequate to maintain populations as is evidenced by the fact that populations continue to fluctuate or be extirpated. These very low flows are also not adequate to maintain healthy habitat and stream channel conditions as discussed above in the Threats section under Habitat Loss and Degradation. The low flows being provided in some areas are also not adequate to provide habitat connectivity. Not only are these low flows not adequate to protect the spinedace, but problems have been continually encountered in delivering them including flow disappearing below the outflow channel, leasing issues, operational problems, sediment-clogged pipelines, and water shortages (Wiley et al. 2008, p. 6, 7, 14).

In 17 years, the conservation agreement has not succeeded in establishing population maintenance flows for the spinedace. The agreement defines "population maintenance flows" as "flows of sufficient magnitude to maintain self-sustaining Virgin spinedace populations during low-flow periods. These flows are dependent on flow events of sufficient magnitude, timing, and duration to maintain channel characteristics and provide environmental cues" (Lentsch et al. 2002, p. 2). The flows which are being provided do not meet this definition.

The third required action is to enhance and maintain habitat. The VSCAS requires habitat enhancement projects in approximately 26 km of occupied habitat. Projects are to include maintenance and construction of boundary-line fences between federal and private parcels to control unauthorized grazing and recreational use along riparian zones, establishment of intensive grazing management programs for federal lands along streams, and development of barriers and conservation easements within the Virgin River floodplain to reduce additional agricultural, recreational, and developmental impacts. Habitat enhancement projects have taken place, but spinedace habitat continues to be lost and degraded due to a variety of factors as discussed above in the Threats section. There has been a net loss of habitat quality in the Virgin River system during the tenure of the VSCAS, and habitat degradation is ongoing, despite habitat enhancement efforts (FWS 2008, p. 20).

The VSCAS has not succeeding in abating threats to spinedace habitat, and threats from many factors are increasing including development, recreation, water demand, and climate change. The piping of Ash Creek (BLM 2012) provides an egregious example of ongoing loss of spinedace habitat despite the VSCAS. The major river alterations undertaken by the Natural Resources Conservation Service Emergency Watershed Protection Project on the Virgin River, Santa Clara River, Beaver Dam Wash, La Verkin Creek, and Ash Creek in 2005 and 2006 provide another example. The major river alterations in 2005-2006 provide an example both of ongoing habitat degradation and also of the inability of the voluntary measures in the VSCAS to protect the spinedace. In this instance, major in-stream alterations occurred during the spawning season (Wiley et al. 2008, p. 5) despite the stated recommendation that work should not be performed in the stream channel or other flowing water from April 1 through June 30 to protect spawning fish and eggs (Wiley et al. 2008, p. 3).

The strategy has completely failed to address the loss of natural river process. Dynamic river function has been dismantled throughout the river system. Releasing very low flows into isolated river segments that nowhere near mimic natural flow is not sufficient to protect and recover the spinedace. Habitat connectivity has not been restored, and the linkage between upland habitats and river health has been largely overlooked. Moreover, development and piping projects which degrade and destroy spinedace habitat and river health are ongoing.

The fourth required action is to selectively control non-indigenous fishes. Predation and competition from non-native fish and crayfish species is a primary threat to the spinedace. Much effort has gone into eradication efforts including mechanical removal and numerous chemical treatments, and some success has been met in some areas. Non-indigenous fishes will always present a major threat to spinedace survival, and removal and control efforts must be conducted continually.

The fifth required action is to re-establish spinedace populations. The agreement requires that Virgin spinedace populations will be re-established in areas within the historic distribution when suitable habitat conditions have been restored, and that natural colonization will likely be the primary mechanism to re-establish populations, but that artificial re-introduction will be used when natural colonization is unlikely because of habitat fragmentation. Due to the current flow regime in the Virgin system, natural colonization is nearly impossible because of low or missing flow, barriers, and inhospitable conditions. Spinedace have been released in several reaches and tributaries, but not enough flow has been provided for populations to become self-maintaining and abundant in most areas. Spinedace populations blink in and out based on flow, and suitable habitat conditions have not been restored in the seventeen years of the agreement to ensure the persistence and recovery of the species throughout the bulk of its range.

The sixth required action is to monitor populations. Virgin spinedace populations are monitored in a variety of ways including annual monitoring at set stations, distribution monitoring, and monitoring accomplished for all Virgin River fish. The primary tool for assessing Virgin spinedace populations are the annual monitoring stations developed in

1994 to assess spinedace population trends throughout their range in Utah. Annual Virgin spinedace density estimates for each station have been highly variable over the period of record. Populations are not stable and secure, and large fluctuations have been observed in both juvenile and adult densities due to spatial and temporal variation in habitat conditions related to variations in annual discharge.

The seventh required action is to mitigate for projects that impact Virgin spinedace. To evaluate, assess, and mitigate any new water depletion or habitat alteration, the VSCAS requires a plan for mitigating future activities. Under the plan, any new water depletion or alteration of historic habitat baseline conditions will require prior evaluation, assessment, and approval. Alterations to baseline conditions are evaluated through either National Environmental Policy Act (NEPA) and/or state level Stream Channel Alteration (SCA) application processes. The Utah Division of Water Resources issues SCA permits for projects that may alter current stream channel conditions. This process is not adequate to protect the spinedace for several reasons. First, using current conditions as the baseline by which to evaluate impacts is not sufficient because current hydrological conditions in the Virgin Basin are already detrimental to the survival and recovery of spinedace. Second, NEPA requires that agencies take a hard look at proposed activities, but does not require the selection of the most environmentally protective alternative. Third, the NEPA and SCA evaluation process is not as protective of spinedace as would be Section 7 consultation under the Endangered Species Act. Finally, projects that are harmful to spinedace continue to be permitted and habitat continues to be lost and degraded.

The VSCAS reflects the expectation that maximum benefit to Virgin spinedace would be achieved through a combined, voluntary effort. The agreement has been in place for seventeen years, but the spinedace still warrants protection under the ESA because it remains threatened by present and ongoing threats from habitat loss and degradation, disease, predation, and other factors including drought, flooding, global climate change, and entrainment at water diversion structures. The goals of the agreement have not been met and its provisions do not adequately replace the regulatory protection for which the species qualifies under the Act.

The Virgin River Resource Management and Recovery Program (VRRMRP; “the Virgin River Program”) is an interagency voluntary program that was formally established in 2002 between FWS, BLM, NPS, UDNR, and WCWCD to undertake conservation actions including implementing the VSCAS and the Virgin River Fishes Recovery Plan. The goals of the program are to protect and recover listed and sensitive fish species in the Virgin River while ensuring that new and historical water uses are protected throughout the basin. The agencies began working cooperatively in 1995 to develop a program that would promote recovery of imperiled aquatic species and assist in meeting the growing need for water by industrial and municipal water users in the basin. The Virgin River Program coordinates, directs, and funds recovery actions for listed species including Woundfin (*Plagopterus argentissimus*) and Virgin River Chub (*Gila seminuda*). It also promotes conservation of imperiled species including the spinedace. The Program consists of eight elements, which overlap with the actions outlined in the VSCAS: 1) Complete description of baseline elements; 2) Provide and protect instream flows; 3)

Protect and enhance aquatic, riparian and 100-year floodplain habitat; 4) Protect and enhance native species communities; 5) Maintain genetically appropriate brood stocks; 6) Determine ecologically limiting factors; 7) Monitor habitat conditions and populations of native species; and 8) Improve education and communication on resource issues.

The Virgin River Program is a voluntary effort which has not proven to be an adequate mechanism to ensure the protection and recovery of Virgin River Spinedace for the same reasons discussed above detailing why the VSCAS does not substitute for the regulatory protection which the species warrants. The baseline used by the program to evaluate proposed projects is itself detrimental to spinedace; adequate instream flows are not being provided; loss of aquatic, riparian, and floodplain habitat is ongoing; spinedace populations continue to fluctuate dramatically and the species cannot survive in the bulk of its historic range; habitat connectivity has not been restored. The inadequacy of the program to substitute for the regulatory protection afforded by the ESA is magnified by the growing demand for water for development, and increasing water shortage due to drought, climate change, and human population growth. The basin's demand for water for human use is so high that adequate flows are not being provided for the spinedace or other native fishes. Under the auspices of the program, the Woundfin became extinct in the wild in 2005 due to failure to provide adequate flow. The program has failed to find a reliable means of ameliorating stressful conditions which has compromised recovery efforts for Woundfin and which keeps the Woundfin, and the Virgin River Spinedace, at perpetual risk of extinction.

Another conservation effort for the spinedace is the Lower Virgin River Recovery Implementation Team which focuses on issues in the lower river in Arizona and Nevada. The team has drafted a strategy to assist in the recovery of a variety of species and habitats along the Virgin River including the spinedace. FWS chairs this team which also includes the Southern Nevada Water Authority, BLM, NPS, NDOW, AGFD, and the U.S. Bureau of Reclamation. Not as well funded as the Virgin River Program, this group has concentrated on: implementing a long-term monitoring program for native fish in the lower river; studying the effect of mechanical removal of red shiner on native fish populations; developing hatchery-reared woundfin stocking protocols; and monitoring the advancement of other nonnative species (blue tilapia, striped bass, etc.) from Lake Mead into the Virgin River. This effort is not adequate to protect the spinedace because the species is nearly to likely extirpated in the lower river and conditions are not hospitable to begin reintroduction efforts.

The Virgin River Spinedace receives some benefit from recovery efforts for other listed species including Woundfin and Virgin River Chub. It also receives some benefit from critical habitat which has been designated to protect these species. ESA protection for these species cannot be considered adequate to protect spinedace because there are no regulatory mechanisms in place which protect spinedace specifically and because these species themselves are teetering on the brink of extinction due to lack of protective action on their behalf. The Woundfin became extinct in the wild in 2005 due to failure to provide adequate flow. In the 1970s and early 1980s more than one million Woundfin lived in the Virgin River. Ongoing habitat loss from the mid-1980s to the present has hindered the recovery of the Woundfin (see FWS 2008, p. 66). Habitat conditions throughout the vast majority of critical habitat for Woundfin and Virgin River Chub are compromised during the summer months in most years, and particularly during low water years. Critical and behavioral thermal maxima are exceeded for varying periods of time in most years (FWS 2008, p. 47). The high summer temperatures are a byproduct of the dewatering of the river and the blatant failure to provide adequate flow.

An egregious example of the failure to protect Virgin River fishes is the current operation of the Quail Creek Reservoir, which releases only 3 cfs for endangered fish. The Biological Opinion states for the project states:

> "Since the operation of the PQCRP (Proposed Quail Creek Reservoir Project) will ensure a year-round minimum release of 86 cfs to satisfy downstream water rights and because future projections call for additional water to be released (above the 86 cfs minimum) for agricultural purposes, it is likely that the operation of the PQCRP would result in an increase in woundfin habitat (as a result of increased flows above natural flows) in the Virgin River below the confluence of Quail Creek and the Virgin River . . . It is our opinion that the operation of the PQCRP will not significantly alter the temperature regime or any other water quality characteristics in the Virgin River" (FWS 1982, p. 10-11).

It is apparent that the Service expected a minimum flow of 86 cfs to be provided for Virgin River fishes; indeed, the Service expected additional water above the 86 cfs to be released as is plainly stated in the above passage from the opinion. The operations of Quail Creek have obviously significantly altered the temperature regime and other water quality characteristics in the Virgin River. The current operation of Quail Creek is not in compliance with the Biological Opinion and threatens the survival of spinedace.

To underscore why protections for other species cannot be considered adequate to protect spinedace, it is useful to look at the downlisting criteria progress for Woundfin and Virgin River Chub. The first downlisting criterion is to ensure river flows essential to the survival of all life stages of the species, including: development and implementation of operational criteria for existing dams, reservoirs, and diversions that provide for flows sufficient to sustain all life stages near historic levels of abundance; acquisition of priority water rights to ensure instream flows of sufficient water quality and quantity from Pah Tempe Springs downstream to Lake Mead to ensure the species' survival; and agreements to ensure passage, timing, and magnitude of flows necessary for channel maintenance during appropriate periods of the year. This has not been accomplished. Habitat conditions remain sub-standard in large reaches of the river, particularly during low water years. The Virgin River Program and Lower Virgin River Recovery Implementation Team have focused on the summer period as perhaps the most stressful and are working on ways to improve conditions, but efforts to resolve these limiting conditions have not provided enough relief to restore populations to some semblance of pre-development abundance (FWS 2008, p. 10). The ever-increasing threat posed by climate change and drought will make it even more difficult to ensure flows for Virgin River fishes (FWS 2008, p. 45).

The second downlisting criterion is that Virgin River habitats from Pah Tempe Springs to Lake Mead are to be improved and maintained to allow continued existence of all life stages at viable population levels. This has not been achieved. Though the Virgin River Program has expended significant resources on habitat restoration, long-standing water use and lack of adequate flow overshadow these efforts. Water depletion coupled with severe drought has resulted in a net loss of habitat quality despite restoration efforts (FWS 2008, p. 20).

The third downlisting criterion is that barriers to upstream movements of introduced fishes are established, and red shiners and other non-native species that present a major threat to the continued existence of the native fish community are eliminated upstream of those barriers. The Recovery Team, the Virgin River Program, and the Lower Virgin River Recovery Implementation Team have devoted considerable effort to controlling red shiner populations in the Virgin River system. Yet despite significant effort, this criterion has not been achieved (FWS 2008, p. 11).

The downlisting criteria for woundfin and chub have not been met and these fish remain highly endangered. In the 2008 5-Year Review for Virgin River Fishes, a peer reviewer commented, "With all the time and money that has been spent, nothing of real consequence has been done to benefit the two endangered fish. They are worse off now than ever before, and the things that are being done are minor accomplishments, at best" (p. 68). Existing mechanisms and efforts to abate habitat loss and degradation have not succeeded and cannot be considered adequate to protect Virgin River fishes including the spinedace.

Other federal mechanisms which provide some protection for spinedace include the BLM Sensitive Species Program, the Clean Water Act, and occurrence in a National Park. The spinedace is designated as a sensitive special status species by BLM (2012b). This program, however, does not provide regulatory protection because its provisions are discretionary. BLM Grazing Allotment Health Assessments also potentially benefit the spinedace, but do not substitute for the protections that would be in place under the ESA.

The provisions of the Clean Water Act theoretically provide some habitat safeguards for spinedace, but this protection does not equate to the protection the species warrants under the ESA. Because it is not a federally listed species, agencies are not required to consult on whether projects are likely to adversely affect spinedace, and the species continues to be harmed by a variety of federal projects. Projects in the Virgin River floodplain in particular have high potential to degrade spinedace habitat because projects outside the wetted channel are not always considered jurisdictional by the U.S. Army Corps of Engineers and there is no federal nexus for communicating with FWS about potential impacts to spinedace.

In a comprehensive watershed analysis of the Virgin River basin, the Army Corps of Engineers determined that watershed wide plans are lacking, linkage between uplands and floodplains is often not recognized, inconsistencies occur across jurisdictions, there is no comprehensive watershed scale coordination and data sharing, and with growing populations and drought the demand on the finite water supply will only continue to grow (ACOE 2008, p. 2).

The spinedace is found in Zion National Park and the most stable populations of the fish occur there. Even within Zion, the fish is threatened by recreational impacts and by upstream water degradation (Deacon 2005). Occurrence in Zion alone is not adequate to ensure the survival of the species.

At the state level, the spinedace is designated as a sensitive species by the state of Utah, a protected species by the state of Nevada, and as endangered by the state of Arizona (UDNR 2011, NDOW 2010, AGFD 2001) but none of these designations provide any substantial regulatory protection for the spinedace or its habitat other than restrictions on collection. State permitting processes theoretically provide some protection for spinedace habitat, but the Service has acknowledged that the States of Utah, Arizona, and Nevada are hard pressed to fully process and assess state permit applications for impacts to Virgin River fishes due to human population growth and rapidly increasing development in the basin (FWS 2008, p. 40).

There are several efforts at the county level to protect spinedace, including county participation in programs discussed above. These efforts have not succeeded and are eclipsed by the devastating impacts of water withdrawals by the Washington County Water Conservancy District. The Washington County Habitat Conservation Plan does not provide any substantial protection to spinedace. The conservation measures outlined in Washington County's water conservation plan and in the Virgin River Watershed Management Plan developed by the county are also inadequate to protect spinedace.

In sum, all existing mechanisms have failed to protect and recover the Virgin River Spinedace and its habitat, and the species warrants protection under the Endangered Species Act. Restoring flows and habitat for the fish is in conflict with development and other forms of economic activity, and voluntary measures are not sufficient to ensure the long-term protection of the spinedace.

OTHER NATURAL OR HUMAN-MADE FACTORS

The Virgin River Spinedace is threatened by several other factors which affect its continued existence including drought, floods, global climate change, entrainment at water diversion structures, and demographic variables coupled with human-induced hydrology changes which render it vulnerable to extinction (Lentsch et al. 1995, Hardy et al. 2003, p. 39; Olden and Poff 2005, p. 79; FWS 2008, p. 46).

The spinedace is threatened by severe weather events including drought and flooding. Recent and ongoing drought conditions have resulted in reduced streamflows in the Virgin River (FWS 2008, p. 45). Flows in the Virgin show a clear declining trend in terms of both mean annual and seasonal flow (Hardy et al. 2003, p. 38). Severe and persistent drought has overshadowed conservation actions for Virgin River fishes (FWS

2008, p. 20). Much of the Southwest is being affected by a decade-plus long drought that is the most severe western drought of the last 110 years (U.S. Global Change Research Program 2009, p. 130). Drought conditions are being exacerbated by record warming, and projections point to an increasing probability of drought for the region (Ibid.).

Large flood events threaten the spinedace throughout its range (Wiley et al. 2008, p. 17; Cox and Fridell 2010, p. viii). Extreme flood events can result in decreased abundance of native fishes (FWS 2008, p. 26). Fish can be displaced and can also be killed by poor water quality conditions. Extremely high sediment and organic debris loads can depress dissolved oxygen levels and result in fish kills (Wiley et al. 2008, p. 15, Cox and Fridell 2010, p. 5). Upland fires and loss of vegetation increases flooding risk. Post-fire floods and run-off from burned areas degrades water quality for native fishes (Wiley et al. 2008, p. 15; Cox and Fridell 2010, p. 12). The threat posed to the spinedace by large flood events is magnified due to expected increases in flood frequency and intensity due to climate change (U.S. Global Change Research Program 2009, p. 132).

Global climate change poses a direct threat to the Virgin River Spinedace. There is high confidence that semi-arid areas in the United States will suffer a decrease in water resources due to climate change (IPCC 2007). Human-induced climate change appears to be well underway in the Southwest where recent warming is among the most rapid in the United States, and is significantly higher than the global average in some areas (Barnett et al. 2008, U.S. Global Change Research Program 2009). Climate change is of particular concern in the Colorado River System due to expected reductions in snowpack and streamflow (Barnett and Pierce 2008, U.S. Global Change Research Program 2009, p. 129). Mean annual runoff of the Colorado River is expected to decline by four to 12 percent by the mid 21st century, and natural streamflow is expected to decline between six percent and 45 percent (Ibid.). The spinedace is directly threatened with mortality from elevated water temperature due to reduced streamflow resulting from global climate change, because summer water temperatures already often exceed the critical thermal maximum for spinedace (Deacon et al. 1987, Hardy et al. 2003, Rehm et al. 2006, FWS 2011). Predicted changes in climate and streamflow will exacerbate already highly stressful conditions during drier years (FWS 2008, p. 45). Substantially more severe warming and drying is predicted for the Colorado River system in coming years (Seager et al. 2007, Cayan et al. 2010, Overpeck and Udall 2010).

An unquantified, but real threat to the Virgin River Spinedace is entrainment at water diversion structures throughout the Virgin River system (FWS 2008, p. 35). Steps have been taken to address entrainment mortality at the Washington Fields Diversion, but entrainment at other diversion structures poses a continuing threat to the spinedace (Ibid.).

The Virgin River Spinedace is threatened by demographic variables which, coupled with human-made changes to its habitat and the hydrology of the Virgin River system, render it vulnerable to extinction. The spinedace is relatively short-lived and populations in various areas fluctuate greatly or are extirpated when conditions are bad (Cox and Fridell 2010, 2011). Due to water diversions and inhospitable reaches, it is difficult to impossible for extirpated populations to be naturally recolonized. Olden and Poff (2005) examined the relationship between percent distributional decline and the probability of extirpation and found that the spinedace has a higher estimated risk of local extirpation than what would be expected based on its basin-level decline over time (p. 79). They concluded that based on temporal trend and extant distribution size, the Virgin River Spinedace should be considered for protection as "endangered" under the ESA (p. 87).

CONCLUSION

The Endangered Species Act requires that the Service promptly issue an initial finding as to whether this petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). There is no question that under the five listing factors of the Act, protecting the Virgin River Spinedace may be warranted. The spinedace is threatened by loss or curtailment of habitat or range, disease and predation, and various other factors including drought, global climate change, and entrainment at water diversion structures. There are no existing regulatory mechanisms which are adequate to protect the spinedace. For the spinedace to have the best chance at recovery, it should be promptly protected under the Act with designated critical habitat.

REQUEST FOR CRITICAL HABITAT DESIGNATION

Petitioners urge the Service to designate critical habitat for the Virgin River Spinedace concurrently with its listing. Critical habitat as defined by Section 3 of the ESA is:
(i) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) the specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species. 16 U.S.C. § 1532(5).

Congress recognized that the protection of habitat is essential to the recovery of listed species, stating that: classifying a species as endangered or threatened is only the first step in insuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence… If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat. H. Rep. No. 94-887 at 3 (1976).

Critical habitat is an effective and important component of the ESA, without which the spinedace's chance for recovery diminishes. Species with critical habitat are twice as likely to recover than species that lack designated critical habitat (Taylor et al. 2005). Petitioners thus request that the Service propose critical habitat for the Virgin River Spinedace concurrently with its proposed listing.

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