Moapa dace (*Moapa coriacea*)

5-Year Review: Summary and Evaluation

photo: USFWS

U.S. Fish and Wildlife Service

Southern Nevada Fish and Wildlife Office

Las Vegas, Nevada

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I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

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

Species Overview:

The Moapa dace (*Moapa coriacea*) is a thermophilic minnow that exists as a relict species of the pluvial White River system in southeastern Nevada, running approximately 322 km (200 mi) from the present-day White River to the Colorado River near Lake Mead. Today, few sections of this historic channel exhibit surface flow; the springs that form the headwaters of the Muddy River, now support eight endemic aquatic taxa, including the Moapa dace. The entire range of the Moapa dace includes approximately 5.6 km (3.5 mi) of stream habitat. The species has no close extant relatives and represents the sole member of the genus *Moapa*. Threats to Moapa dace and other native fish of this system are typical of the desert Southwest, including the introduction of nonnative fishes, and the modification of stream habitat for human development (e.g., agricultural, municipal, and recreational), and adequate in-stream flow. In the 1960s, significant concerns in declining population size, unique biodiversity, and heavily human-impacted spring habitats resulted in the listing of Moapa dace under the Endangered Species Preservation Act of 1966, and later the ESA of 1973 (32 FR 4001). Recovery efforts are ongoing and notably include the establishment of two protected areas, the Moapa Valley National Wildlife Refuge (1979) and the Warm Springs Natural Area (2007), that collectively encompass most the species range. Since 2006, the management of threats and recovery of the species is carried out by the Muddy River Biological Advisory Committee (BAC), a technical working group of the Muddy River Recovery Implementation Program (Service 2006).

Methodology Used to Complete This Review:

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

Contact Information:

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

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

Listing History:

Original Listing

Species: Moapa dace (*Moapa coriacea*)

Date listed: March 11, 1967

FR Notice: 32 FR 4001

Classification: Endangered

State Listing

Moapa dace (*M. coriacea*) was listed as Endangered by the state of Nevada (NAC 503.065.2) on August 19, 2011.

Associated Rulemakings:

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

Review History:

Since the time of listing in 1967, the status of the Moapa dace has not been revisited in a previous 5-year review.

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

The recovery priority number for Moapa dace is 1, based on a 1-18 ranking system (48 FR 43098). This number indicates that the taxon is a monotypic genus that faces a high degree of threat and high potential for recovery.

Recovery Plan or Outline:

Name of Plan or Outline: *Plan for the Rare Aquatic Species of the Muddy River Ecosystem*

Date Issued: May 16, 1996

II. REVIEW ANALYSIS

Information on the Species and its Status

Species Biology and Life History

The Moapa dace is a small-bodied stream minnow first described by Hubbs and Miller (1948). Identification among co-occurring fishes is straightforward given its conspicuous black spot on the base of the tail and small embedded scales. Coloration is olive-yellow above and white on the belly; a diffuse golden stripe is sometimes apparent. The maximum size and age of Moapa dace is believed to be about 120 mm (4.7 in.) fork length (FL) and approximately four years (Scoppetone et al. 1992). The largest adults historically occurred in the mainstream river where more abundant food items drift downstream (Scoppetone et al. 1987). Moapa dace feed primarily on drifting food items, where fish congregate using cover from overhanging vegetation (Service 1995) or near depressions at the base of riffles (Scoppetone et al. 1987). Stomach contents reveal that their diet is omnivorous and diverse, and variously include beetles, moths and butterflies, true flies, true bugs, caddisflies, mayflies, damselflies and worms, as well as algae, vascular plants, and detritus (Scoppetone et al. 1987).

Moapa dace spawn year-around, but predominantly in the spring, and to a lesser extent in the fall (Scoppetone et al. 1992). Adults are sexually mature around 38 - 45 mm (1.5 - 1.75 in.) fork length (FL) which occurs around 1 year of age (Hubbs and Miller 1948, Scoppetone et al. 1987). The largest fish are the most fecund; eggs counts range from 60 at 45 mm (1.75 in.) FL to 772 at 90 mm (3.5 in.) FL (Scoppetone et al. 1992). Underwater videography determined that Moapa dace selected spawning habitats of 30 – 34 cm (13 in.) depth, water velocities of 0.11 and 0.17 m/s (0.36 - .56 ft/s), cobble substrate, and overhead in-stream cover (Ruggirello et al. 2020.)

Spatial Distribution

Distribution of the entire species is restricted to a single population occurring in the headwaters of the Muddy River, Clark County, Nevada (La Rivers 1962). The Muddy River emerges from a series of small to medium-sized seeps and springs, referred to as the Muddy River Springs Area. The historic range would have included the five major spring systems and extended downstream several miles. Some report that historic range may have approximated 16 km (10 mi) of stream habitat (Ono et al. 1983). The downstream extent of the species is thermally limited as water cools moving downstream (La Rivers 1962). For the last 30 years, the length of occupied habitat is approximately 9.7 km (6 mi), extending from the headwaters to near the bridge at Warm Springs Road (Figure 2). However, the occurrence of Moapa dace in the lower mainstream river is rare at present as indicated by the biannual sampling of the BAC in 2023 (Table 3).

Abundance

The population size of Moapa dace is estimated biannually in the winter (February) and summer (August) seasons. Early surveys for this species (Scoppetone et al. 1998) found that snorkeling was an effective method to estimate population size without handling stresses associated with other methods. Surveys are conducted by stream segment from downstream to upstream to eliminate turbid conditions caused by upstream counters (Figure 3). In recent years, snorkel surveys have been conducted using trained representatives from the Service, Nevada Department

of Wildlife, and the Southern Nevada Water Authority. Surveys of Moapa dace have indicated fluctuations in population size. Figure 3 shows the biannual estimates for Moapa dace from 2005 to summer 2023. Abundance appears to be strongly influenced by both habitat restoration, fish passage or lack of connectivity, and the biological interactions of predatory non-native fishes, the impacts of which depend on site-specific habitat characteristics and species-specific interactions. Although the Muddy River Springs Area is now free of nonnative blue tilapia (*Oreochromis aureus*), western mosquitofish (*Gambusia affinis*) and short-fin mollies (*Poecilia sphenops*) remain in the system (BAC 2023).

The gradual increase in population size after 2012 (Figure 1) is suspected to correspond to the period following population expansion after blue tilapia (invasive predator) was eradicated from the system. Concurrently, significant habitat improvements were completed between 2013 and 2016 on the Warms Springs Natural Area in reach 5.5 (Figure 3). Also noteworthy is that the mainstream Muddy River and upper areas of the North and South Fork (reaches 15 and 16, respectively), at present, do not support significant numbers of Moapa dace. The upper reaches have not been recolonized since the piscicide treatments to remove blue tilapia. The larger habitat of the mainstream Muddy River (reaches 11, 12 and 13) does not support large numbers of dace but has increased in recent years. Given the historical importance of the mainstream channel to support large numbers of large dace (and associated higher fecundity typical of larger fish), understanding the causes for low abundance in these reaches remain a research priority.

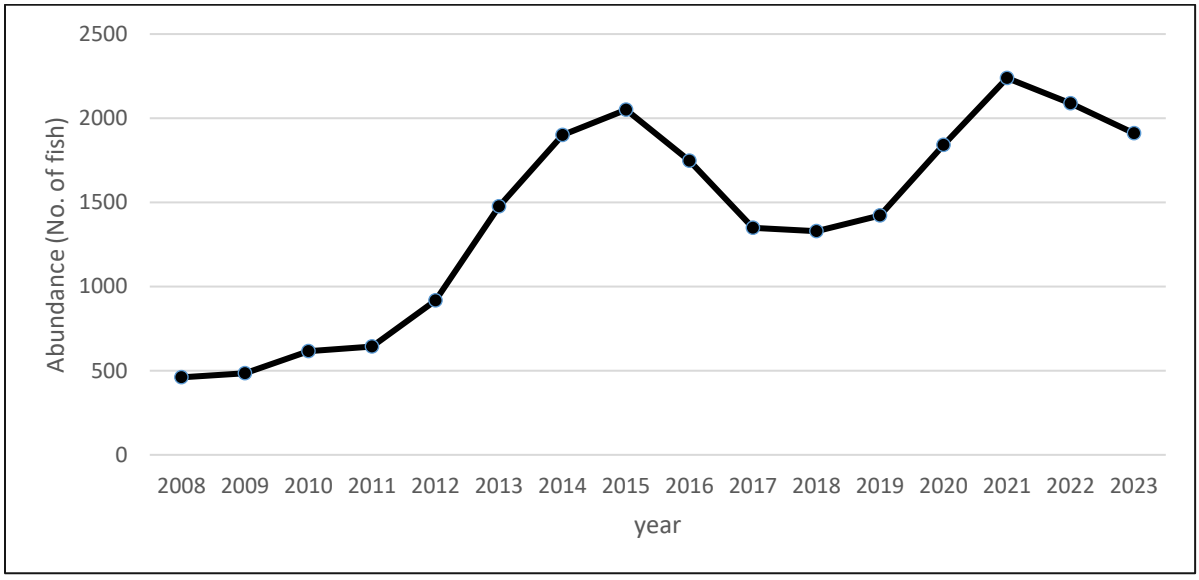

Figure 1. Average annual abundance of Moapa dace from 2008-2023. Biannual data of February and August counts are presented in Table 1 (BAC 2023)

Habitat or Ecosystem

The Moapa dace is unusual among minnows (family: Cyprinidae) given its unique biological requirements for both thermal and flowing spring water. The springs of the Muddy River collectively discharge approximately 50 cfs from about 20 spring outflows at 31.0 to 32.0 ℃ degrees (88-90 ℉). Waters cool with distance from the source, and Moapa dace occupy the

upper 2 km (1.2 mi) between 26.0 and 32.0 °C (Scoppetone 1993). Their habitat includes spring pools, tributaries and the mainstream Muddy River. Spring pools are characterized by pebble and organic substrates, with tributaries exhibiting areas of clay, sand, pebble and cobble substrates. Habitat use varies by life-stage, with larval fish found only near the spring sources with low velocity (Scoppetone et al. 1992). Juvenile fish occur in tributaries and faster moving water as they grow larger. Adult dace historically occurred throughout the system, and frequently in the cooler and larger mainstream habitats, but also traverse upstream to spawn (Scoppetone et al. 1992).

Changes in Taxonomic Classification or Nomenclature

There have been no changes in systematics of the Moapa dace with within the species entity, i.e., the species was originally described as, and is still considered to be represented by a distinct, single population occurring in the headwaters of the Muddy River. Hubbs and Miller (1948) in the species description note that the genus *Moapa* shares affinities with both *Gila* and *Rhinichthys* based on morphology. Phylogenetic studies of related taxa have not revealed new populations of the species, range expansions or hybridization. However, recent taxonomic affinities at the genus-level may place the species within the genus *Gila* (Smith et al. 2002, Tan and Armbruster 2018), as noted in Eschmeyer's Catalog of Fishes (Fricke et al. 2023).

Genetics

The conservation genetics of Moapa dace was evaluated by Hereford (2014a). This study compared genetic variation and population structure at three sampling sites. During this time, Moapa dace abundance was heavily impacted by non-native fishes and therefore limited the study design to only include the stream segments of Apcar, Pedersen and Plummer, identified below as Reach 1, 5 and 7, respectively (Figure 3).

Overall, Hereford considered Moapa dace genetically diverse for a species with limited range and census size. Analyses showed allelic richness (R_S) and heterozygosity (H_E) were high (R_S = 11.05 ± 6.03, H_E = 0.70 ± 0.23), but the genetic effective population size (N_e) estimates were very low in Apcar (N_e = 22 - 34), slightly higher in Pederson (N_e = 21 - 71) and highest in Plummer (N_e = 82- 104). Further, a population bottleneck was estimated in the recent past using patterns of genetic diversity, a conclusion of which coincides with the population crash evidenced by the snorkel survey data in 2007 and 2008. Analyses of population structure indicated three genetic units indicating habitat fragmentation. The results of the study suggest that Moapa dace retain notable genetic variation and evolutionary potential, but that resource managers should consider removing barriers and improving fish passage.

Species-specific Research and/or Grant-supported Activities

The Service currently provides funds for monitoring of non-native fishes throughout the Muddy River to benefit the Moapa dace. Specific projects include:

- Annual contracting for traditional fish sampling of the middle and lower Muddy River;
- Development of eDNA markers for rapid detection of non-native fish above and below barriers;

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

- Participation in the BAC;
- Conducting routine population monitoring and non-native species control (mechanical and chemical removal) in the Muddy River;
- Providing technical assistance for habitat restoration actions conducted by the Service and Southern Nevada Water Authority;

The Service currently provides separate, non-section 6 funds to Nevada Department of Wildlife (NDOW) the for the development of methods used in fisheries science. Specific projects include:

- Determining the feasibility of captive spawning Moapa dace for experimental and research purposes;

The Southern Nevada Water Authority (SNWA) purchased lands for the establishment of the Warm Springs Natural Area via a grant from the Southern Nevada Public Lands Management Act in 2007. Specific ongoing projects include:

- Participation in the BAC;
- Restoration of aquatic and riparian habitats, with special consideration of Moapa dace;
- Providing education and public outreach for the conservation of endemic species;

Selected research conducted since the 1995 recovery plan includes:

- Scoppettone, G.G., Rissler, P.H., Nielsen, M.B. and Harvey, J.E. 1998. The status of *Moapa coriacea* and *Gila seminuda* and status information on other fishes of the Muddy River, Clark County, Nevada. *The Southwestern Naturalist*, pp.115-122.

- Scoppettone, G.G., Salgado, J.A. and Nielsen, M.B. 2005. Blue tilapia (*Oreochromis aureus)* predation on fishes in the Muddy River system, Clark County, Nevada. *Western North American Naturalist*, *65*(3), pp.410-414.

- Mayer T.D., Congdon R.D. 2008. Evaluating climate variability and pumping effects in statistical analyses. *GroundWater* 46:212–227

- St. Saviour, A., 2011. A food web analysis of a Mojave desert geothermal spring system and feeding ecology of Moapa dace (*Moapa coriacea*).

- Hatten, J.R., Batt, T.R., Scoppettone, G.G. and Dixon, C.J. 2013. An ecohydraulic model to identify and monitor Moapa Dace habitat. *PloS one*, 8(2), p.e55551.

- Perry, R.W., Jones, E. and Scoppettone, G.G. 2015. A stochastic population model to evaluate Moapa dace (*Moapa coriacea*) population growth under alternative management scenarios (No. 2015-1126). US Geological Survey.

- Ruggirello, J.E., Bonar, S.A., Feuerbacher, O.G., Simons, L.H. and Powers, C. 2018. Propagation of endangered Moapa dace. *Copeia*, *106*(4), pp.652-662.

- Ruggirello, J.E., Bonar, S.A., Feuerbacher, O.G. and Simons, L.H. 2020. Use of underwater videography to quantify conditions utilized by endangered Moapa Dace while spawning. *North American Journal of Fisheries Management*, *40*(1), pp.17-28.

- Syzdek, D.J., Simons, L.H., Guadalupe, K. and Schwemm, M.R. 2021. Restoration to historic and artificial habitat of a rare desert fish, the Moapa dace in Nevada, USA. *Global conservation translocation perspectives: 2021, Case studies from around the globe*, p.46.

FIVE-FACTOR ANALYSIS

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

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

Habitat Modification

Habitat modifications throughout the headwaters of the Muddy River were extensive, the effects of which still impact the species to some degree. Most of the spring systems were developed for irrigation purposes early on, and later industrial and municipal uses as well (Service 1995). Springs and streams were modified by concrete channelization and the rerouting of water via diversion structures. Such changes in structure cause reduction of suitable habitat and fragmentation. Given the importance of continuity of habitat required for Moapa dace, many areas were completely extirpated.

Significant habitat alteration impacted the persistence of the species and resulted in the establishment of the Moapa Valley National Wildlife Refuge (MVNWR) in 1979. This refuge was unique for its time, as few refuges were established expressly for endangered fishes. The Refuge is comprised of three spring systems, Plummer, Pedersen, and Apcar, (Figure 2) and represents approximately 10% of the species' historic range. When acquired, no Moapa dace remained on the spring systems protected as Refuge, as the Plummer and Pedersen streams were previously converted to chlorinated swimming pools for recreational use, and Apcar was modified from its natural course for municipal use. Many of the historic channels were modified to earthen and concrete ditches (Service 1995). Since these areas were now part of the Refuge, habitat restoration efforts have returned most wetted habitats to flowing streams and Moapa dace were repatriated to most spring systems (Scoppettone and Burge 1994). Restoration efforts up through the early 1990s were extremely successful and estimates for the population size of Moapa dace ranged from 1565 - 3841 fish, as estimated by snorkel surveys (Scoppetone et al. 2005).

Later, in 2007, the Southern Nevada Water Authority purchased nearly the remainder of the upper Muddy River habitat for the Warm Springs Natural Area via a grant from the Southern Nevada Public Lands Management Act. This tract afforded conservation and management specifically for Moapa dace and involves the restoration of degraded habitats previously

modified for agriculture, among other uses (SNWA 2011). Specifically, restoration typically includes building and renovating stream segments in partnership with the Service. This parcel is sufficiently large that restoration has been ongoing since 2007 and will still require many years and external funding to restore.

Availability of water is also important. Recent published studies (Hatten et al. 2013) show that water depth predicts the distribution of Moapa dace, and most importantly, changes in water flow is related to the amount of habitat available. Thus, the Service has increasingly considered the effects of groundwater pumping on the recovery of Moapa dace. Within the last decade Moapa dace occurs almost entirely within the tributary springs and streams. Spring discharge in this area reflects head pressure in the aquifer, and the flows in the springs provide an indication of available water required to support aquatic species (Mayer and Congdon 2008). In particular, the springs on the Refuge are among the highest elevation in the Muddy River, and at present are the basis for agreements between the Service and nearby water users (Service 2006). The USGS water gauging station at Warms Spring West near Moapa, collectively measures the two highest springs (Pedersen and Pedersen East springs) and is used by the Service to guide water conservation through protective water flow triggers and voluntary curtailment. At present, the water level measures immediately above the first threshold, so the current threat of decreased water availability is high.

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

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

Factor C: Disease or Predation

Disease

The Service (1995) documentation for species decline includes limited reference to disease, and its level of impact on the Moapa dace. Yet, non-native fish introductions have resulted in fish parasites negatively affecting native fish in the Muddy River, including tapeworms, nematodes, and anchorworms (Deacon and Bradley 1966, Heckman 1988). Anchor worms have been identified as as a parasite of Moapa dace (Deacon and Bradley 1966). Anchor worms may cause mortality directly from tissue damage from heavy infestation, but also result in secondary infections from bacteria, fungi, and viruses.

Predation

Prior to the species description of Moapa dace, early documentation supports the presence of one invasive fish species, the western mosquitofish in the Muddy River. However, early reports mention that Moapa dace was relatively common in 1938 and remained so until approximately 1950 (Hubbs and Miller 1948, La Rivers 1962). Notable species-level declines in abundance of Moapa dace occurred after the introduction of non-native shortfin mollies around 1963 (Deacon and Bradley 1972). The need to understand the interaction between shortfin mollies and Moapa dace led to several investigations, showing that mollies overlap in occupied habitat with Moapa dace (Deacon and Bradley 1972, Scoppetone 1993), and that laboratory experiments reported that shortfin mollies predate on fish larvae (Scoppetone 1993).

The well-studied effects of predation allowed recovery efforts to mitigate these negative effects, along with the concurrent establishment of the MVNWR. The early 1990s saw large increases in Moapa dace. However, the invasion of blue tilapia in 1995 (Scoppetone et al. 2005) was catastrophic. By 2001, surveys estimated that native fish were almost eliminated from the Muddy River Springs Area. By late 2000s, the population of Moapa dace was around 500 total fish (BAC 2023). Efforts to chemically and physically remove nonnative fishes from the system, including the installation of physical fish barriers to prevent reintroduction, have been successful, and blue tilapia have been eliminated from the habitat of the Moapa dace. As a result, numbers of Moapa dace have significantly increased since that time.

Factor D: Inadequacy of Existing Regulatory Mechanisms

National Environmental Policy Act (NEPA)

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

Clean Water Act

Under section 404, the U.S. Army Corps of Engineers (ACOE) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the ACOE criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any action with the potential to impact waters of the United States must be reviewed under the Clean Water Act, NEPA, and the Act. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts.

The ACOE interprets "the waters of the United States" expansively to include not only traditional navigable waters and wetlands, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. However, On April 21, 2020, the U.S. Environmental Protection Agency and the Department of the Army published the Navigable Waters Protection Rule in the Federal Register (85 FR 22250) that finalized a revised definition of "waters of the United States" under the Clean Water Act.

Endangered Species Act (Act)

The Act is the primary Federal law providing protection for these species. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a

project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

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

Federal Land Policy and Management Act of 1976 (FLPMA)

The Bureau of Land Management is required to incorporate Federal, State, and local input into their management decisions through Federal law. The FLPMA (Public Law 94-579, 43 U.S.C. 1701) was written "to establish public land policy; to establish guidelines for its administration; to provide for the management, protection, development and enhancement of the public lands; and for other purposes". Section 102(f) of the FLPMA states that "the Secretary [of the Interior] shall allow an opportunity for public involvement and by regulation shall establish procedures…to give Federal, State, and local governments and the public, adequate notice and opportunity to comment upon and participate in the formulation of plans and programs relating to the management of the public lands". Therefore, through management plans, the Bureau of Land Management is responsible for including input from Federal, State, and local governments and the public. Additionally, Section 102(c) of the FLPMA states that the Secretary shall "give priority to the designation and protection of areas of critical environmental concern" in the development of plans for public lands. Although the Bureau of Land Management has a multiple-use mandate under the FLPMA which allows for grazing, mining, off-road vehicle use, etc., the Bureau of Land Management also has the ability under the FLPMA to establish and implement special management areas such as Areas of Critical Environmental Concern, wilderness, research areas, etc., that can reduce or eliminate actions that adversely affect species of concern (including listed species).

The Lacey Act

The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any United States or

Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

Nevada State Protection

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

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

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

Invasive and nonnative vegetation

The introduction of aquatic invasive plants has changed conditions in the Muddy River. Root masses from palm trees have choked portions of the stream and constricted outflow since the early 1980s (Service 1995). Narrowed channels speed up the flow and reduce the slower, marginal habitat required by larval and juvenile Moapa dace (Scoppetone et al. 1992). Palm trees also increase evapotranspiration and likely contribute to water loss in the system (Service 1995). Since the 1980s, the MVNWR has an ongoing program to remove palms. The distribution and number of palm trees on the Refuge and surrounding areas is vast, and given the cost associated with removal, this task will continue for many years.

Recreation

Recreational impacts were significant at the time of listing. As noted above in *Habitat Modification,* much of MVNWR was converted to concrete swimming pools and associated infrastructure. Over the past 40 years, much of this infrastructure has been removed after acquisition of property. Of all contributing factors to species decline, the direct effect of recreation has largely diminished. Both the Refuge and the Warm Springs Natural Area still permit visitation compatible with resource management, and effects of current visitors on Moapa dace is likely negligible.

Stochastic Events

Since the species habitat is limited, it is susceptible to catastrophic events that may adversely modify habitat conditions. Small populations have an inherent risk of extirpation due to stochastic events. Fire and flooding are natural events that occur within Moapa dace habitat but are exacerbated by manmade factors such as extensive groves of palm trees and unnatural ignition of fires. Several catastrophic fires have occurred in recent history and nearly eliminated dace from stream segments. In 1994 a large fire nearly extirpated the Refuge Spring system (Service 1995). Another fire in 2010 has similar effects on the Warm Springs Natural Area.

III. RECOVERY CRITERIA

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

The recovery criteria (Service 1995) state that Moapa dace may be considered for reclassification from endangered to threatened when "existing instream flows and historical habitat in three of the following five occupied spring systems and the upper Muddy River have been protected through conservation agreements, easements, or fee title acquisitions." The five spring systems include the Apcar, Balwin, Cardy Lamb, Muddy Spring, Refuge, and Upper Muddy River. At present, four of five springs are now under protective custody by the Service (MVNWR) or SNWA (Warm Springs Natural Area) for the recovery of Moapa dace. Instream flows are protected under a 2006 MOA between the Service and water users (Service 2006). The second criteria for downlisting specifies that "4500 adult Moapa dace are present among the five spring systems and the upper Muddy River." At present, less than 2000 total fish are estimated (Figure 1). The last criteria for downlisting includes the presence of three or more age-classes, with reproduction and recruitment documented from three spring systems. This criteria is satisfied today (BAC 2023). The criteria for downlistiung and the current status of Moapa dace is summarized in Table 1. Delisting criteria further recommends 6000 adult Moapa dace in 75% of the historical habitat, and that non-native fishes are no longer adversely affecting the population.

Table 1. Downlisting criteria and current status of the Moapa dace.

downlisting criteria in recovery plan (1995)	*status in 1995*	*status in 2023*
conservation agreement/ easement/title for 3 of the 5 major springs	no	yes
4500 adult Moapa dace	no	no
3 or more age-classes	yes	yes

IV. SYNTHESIS

The abundance of the Moapa dace has significantly improved, declined, and improved again since the time of its listing, 56 years ago (Table 3). Increases in population size reflect significant recovery actions on the part of land managers for both the MVNWR and the Warm Springs Natural Area, beginning in 1979 and 2007, respectively. Also, the relative impacts of threats have fluctuated over time and space. In general, direct habitat alternations such as various concrete structures for water conveyance, and historic swimming pools have been removed and replaced with natural channels. These improvements provided clear and lasting benefits. However, such as the case with the blue tilapia invasion in 1995, a novel, non-native predator was prohibitive to the recovery of the species and set-back years of recovery progress. Other effects are legacy in nature and still require mitigation (e.g., old weirs, high gradient falls). Finally, some threats such as overmining of groundwater are increasing over time with human development and climate change in the Mohave desert.

Table 2. Summary of threats and associated effects on Moapa dace over 56 years.

threats and associated impacts on Moapa dace	*1960s (time of listing)*	*1990s (research and restoration)*	*2020s (present time)*
irrigation/industry	moderate	moderate	low
habitat alternation (direct)	high	moderate	low
habitat fragmentation	high	moderate	moderate
predation (fishes)	moderate	high	low
invasive vegetation	high	high	moderate
catastrophic fire	high	high	moderate
recreation (direct)	high	moderate	low
water availability	moderate	moderate	high

After reviewing the best available scientific information, we conclude that Moapa dace (*Moapa coriacea*) remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species at listing determination remains an accurate reflection of the species' current status.

V. RECOMMENDATIONS FOR FUTURE ACTIONS

Over the next 5 years, mangers should focus on outstanding impediments to population growth. In general, the recovery goals identified in the 1995 *Plan for the Rare Aquatic Species of the Muddy River Ecosystem* are attainable. Several of the recently restored habitats near the headwaters support reliable and stable populations in similar sizes to those documented prior to invasion of blue tilapia. Ongoing discussion by the BAC in recent years revolves around increasing the geographic distribution of Moapa dace. Restored areas in the headwaters and stretches within the mainstream Muddy River have not been recolonized, while others support robust populations of Moapa dace.

Recommendations for future actions include:

- Research to compare the physical and biological attributes of mainstream reaches of today with those documented in the early 1990s when population sizes were highest;
- Remove impediments to fish passage, especially in cases where known barriers exist between restored, high quality habitats;
- Expand a program to monitor for invasive species (traditional and molecular methods) in the lower Muddy River, where future invasions of predatory fish are likely;
- Develop a long-term plan to mitigate vegetation growth for stream encroachment and catastrophic fire; and
- Maintain partnerships with water stakeholders to preserve and expand in-stream flows.

Field Supervisor, Fish and Wildlife Service

Approve GLEN KNOWLES Digitally signed by GLEN KNOWLES Date: 2023.09.29 09:44:33 -07'00' Date _____

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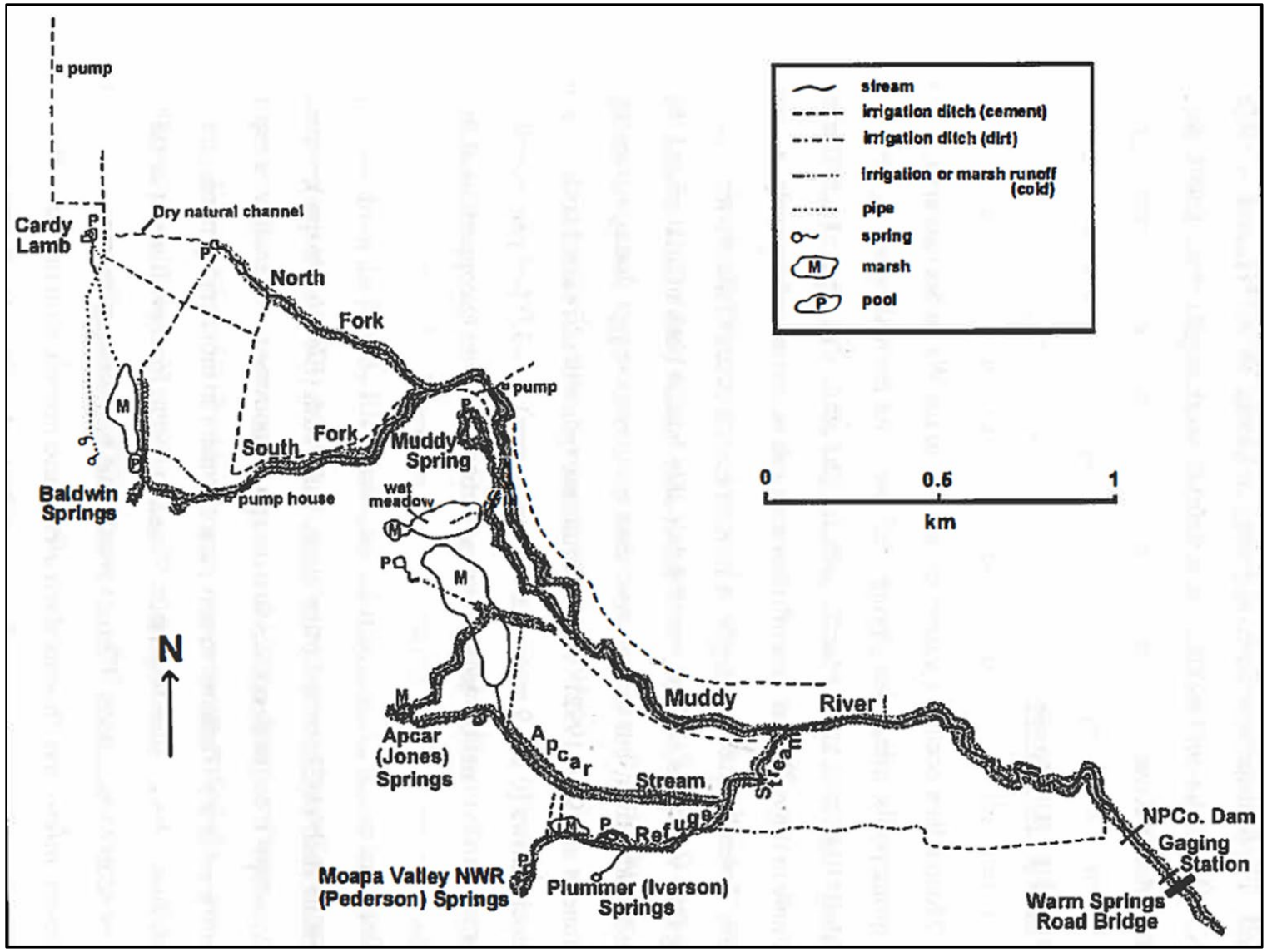

Figure 2. Historic map of the upper Muddy River showing the five major spring systems and the distribution of Moapa dace. Figure is reproduced from the 1995 recovery plan (Service 1995), originally modified from Scoppetone et al. 1987; 1992).

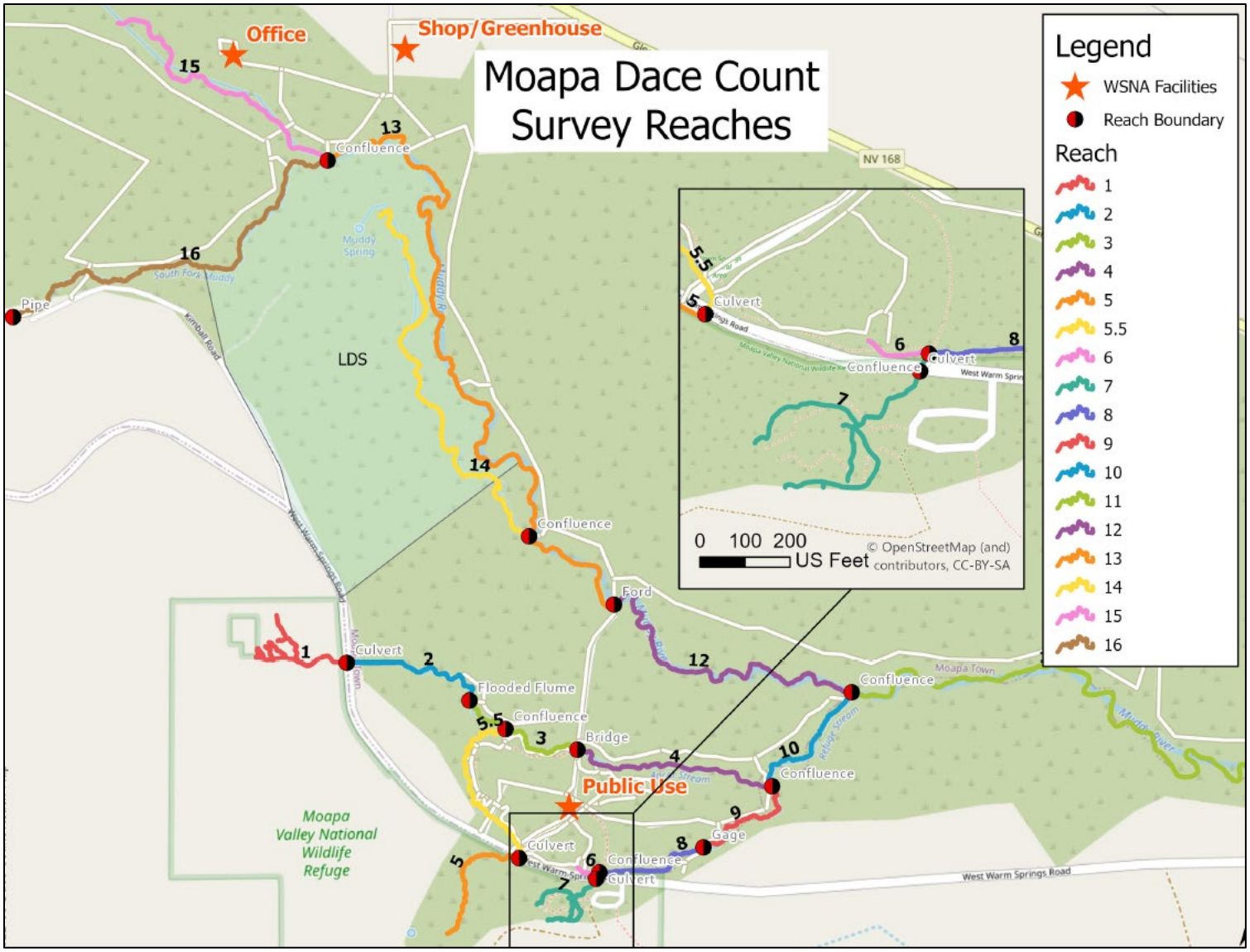

Figure 3. Current map showing the designated stream reaches (1 – 16) used during the standardized bi-annual Moapa dace counts. Reach numbers corespond to data shown in Table 1. (Figure provided by D. Syzdek, 2022).

Table 3. Abundance by stream reach of Moapa dace 2005 -2023 from bi-annaul counts conducted through the Muddy River Boliogical Advsory Committee.

Reach	Feb. 2005	Feb. 2007	Feb. 2008	Aug. 2008	Feb. 2009	Aug. 2009	Feb. 2010	Aug. 2010	Feb. 2011	Aug. 2011	Feb. 2012	Aug. 2012	Feb. 2013	Aug. 2013	Feb. 2014	Aug. 2014	Feb 2015	Aug. 2015
1	6	0	0	N/A	N/A	1	7	20	28	67	74	84	69	72	66	66	119	158
2	87	42	50	22	29	34	13	35	20	54	78	79	139	310	271	335	429	227
3	52	14	0	4	2	4	3	0	1	8	10	31	127	248	229	309	244	299
4	18	0	0	3	0	10	7	0	2	1	0	13	62	156	133	198	187	190
5	174	395	50	82	80	84	82	90	99	108	66	94	128	85	70	206	118	90
5.5*	N/A	N/A	N/A	N/A	29	51	71	84	96	88	99	376	244	318	573	471	329	415
6*	80	128	56	67	9	5	8	5	22	27	10	59	36	48	20	49	31	36
6.5*	--	--	19	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	177	170	148	208	187	218	166	393	188	206	109	159	113	144	49	121	91	148
8	406	282	59	28	61	42	118	40	78	55	180	112	141	161	113	240	186	270
9	166	47	40	24	23	39	43	29	40	85	27	157	153	185	103	122	152	220
10	62	54	14	1	32	15	11	1	0	13	0	17	14	0	5	52	30	123
11	--	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	45	16	5	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	N/A	0	0	0	0	1	1	0	0	0	0	0	1	6
15	9	15	17	0	7	1	1	0	0	0	0	0	0	0	0	0	1	0
16	10	9	1	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1296**	**1172**	**459**	**462**	**462**	**508**	**534**	**697**	**574**	**713**	**654**	**1181**	**1226**	**1727**	**1632**	**2169**	**1918**	**2182**

(continued)

Reach	Feb 2016	Aug 2016	Feb 2017	Aug. 2017	Feb. 2018	Aug. 2018	Feb. 2019	Aug. 2019	Feb. 2020	Aug. 2020	Feb. 2021	Aug. 2021	Feb. 2022	Aug. 2022	Feb. 2023	Aug. 2023
1	106	135	105	129	64	87	53	138	65	116	125	218	134	239	113	220
2	349	208	169	296	230	256	382	187	143	178	301	239	273	317	383	135
3	218	182	170	236	300	377	371	265	243	361	405	380	293	278	302	247
4	93	66	44	56	10	100	125	68	54	227	199	253	214	175	221	72
5	105	46	29	32	49	51	88	48	46	44	27	205	30	41	31	39
5.5*	445	369	243	489	284	383	282	222	226	459	227	502	310	454	319	516
6*	17	84	15	24	6	12	25	46	19	35	43	64	12	30	5	24
6.5*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	106	134	90	52	40	60	46	46	36	89	65	74	90	133	89	215
8	242	209	133	105	68	57	55	118	188	197	122	104	165	121	119	126
9	105	150	77	42	42	60	47	57	88	100	83	51	140	108	81	88
10	68	41	69	55	2	44	11	42	65	175	83	130	90	115	100	71
11	0	0	0	0	1	0	0	0	0	15	6	21	13	31	14	13
12	0	0	1	2	0	3	0	1	5	9	1	29	35	33	25	13
13	0	0	5	1	0	1	0	1	5	0	10	9	21	21	16	16
14	2	11	12	14	42	28	22	35	76	133	64	45	47	47	55	48
15	0	0	0	0	0	0	0	3	0	3	4	0	0	0	1	0
16	3	0	3	0	0	0	20	40	81	201	268	120	89	78	59	45
Total	**1859**	**1635**	**1165**	**1533**	**1138**	**1519**	**1527**	**1317**	**1340**	**2342**	**2033**	**2444**	**1956**	**2221**	**1933**	**1888**