Final report of the AFS/ASIH Joint Committee on the Names of Fishes on the taxonomy of *Gila* in the Lower Colorado River basin of Arizona and New Mexico

to the

Arizona Game and Fish Department,
Wildlife Management Division, Phoenix, Arizona 85086

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Members of the AFS/ASIH Joint Committee on the Names of Fishes has completed its review of information on morphological and genetic variation in the genus *Gila* in the lower Colorado River basin of Arizona and New Mexico (which includes the Little Colorado River, Bill Williams River, Gila River, Verde River, and Salt River drainages) and has concluded that the data available support recognition of only one species of *Gila*, the Roundtail Chub, *G. robusta* Baird & Girard 1853. Data do not support recognition of three species as listed in the two most recent editions of the *Common and Scientific Names of Fishes* (Nelson et al. 2004; Page et al. 2013), i.e., the Roundtail Chub, *Gila robusta*; Gila Chub, *Gila intermedia* (Girard 1856); and Headwater Chub, *Gila nigra* (Cope 1875).

The Committee's review included data and analyses in published studies and information from previous and ongoing studies presented orally at a meeting in Phoenix, Arizona, on 4 April 2016. Morphological studies have varied greatly in their conclusions, with recognition of one to three species (and sometimes subspecies) of *Gila* in the lower Colorado River basin (see Carter et al. 2016). Recent studies have relied on the characters presented by Minckley and DeMarais (2000), who recognized three species of *Gila* in the Gila River basin even though there was considerable overlap in all characters analyzed.

Staff of the Arizona Game and Fish Department (AGFD) have been unable to verify the species-level observations of Minckley and DeMarais, even though the allopatry of the putative species would be expected to facilitate identification. The view of the AGFD, most thoroughly demonstrated in the recent report by Carter et al. (2016), is that the characteristics used by Minckley and DeMarais are too variable and contradict one another in ways that make assignments of individuals to species impossible or, at best, arbitrary. In contrast, Brandenburg et al. (2015) concluded from a discriminant function analysis of morphological data on individuals collected in New Mexico that individuals could be assigned to *G. robusta*, *G. intermedia*, or *G. nigra.* However, in contrast to results of Minckley and DeMarais (2000), they found the three species to be sympatric in almost all localities sampled. They also noted that there "is overlap in several morphologic and meristic values used to distinguish species, and even those species-specific characters that do not overlap are separated by very small margins. The narrow

delineation in morphologic and meristic characters currently used to distinguish these three taxa presumes little intraspecific variation in populations both within and between systems. The strong evidence of hybridization in this suite of fishes further complicates species-specific determination."

This Committee is not aware of any basin in North America that contains a monophyletic group of species that cannot be distinguished from one another morphologically. If the populations of *Gila* in the lower Colorado River basin are an exception, this should be evident in the analysis of genetic data. However, the genetic data also do not support recognition of more than one species. Publications have sometimes indicated otherwise, but with caveats on taxonomic conclusions and invoking scenarios of hybridization – including hybrid origin of species. Genetic analyses on *Gila* from the lower Colorado River basin have been completed using mitochrondrial DNA (Gerber et al. 2001; Schwemm 2006; Schönhuth et al. 2013), nuclear DNA (Schwemm 2006; Schönhuth et al. 2013), and microsatellites (Dowling et al 2015). As noted by Dowling et al. (2015), none of these studies found genetic markers that distinguish species.

Most recently, Josh Copus and colleagues at the University of Hawaii were contracted by AGFD, with encouragement by this Committee, to again analyze morphological variation and conduct a genetic analysis using next-generation sequencing on samples of *Gila* from the lower Colorado River basin. The report is attached as Appendix A. Copus et al. (2016) found no morphological support for more than one species and concluded that "phylogenetic analyses of both mtDNA and nuclear genomes reveal extremely shallow coalescence of putative species, and no monophyly for currently recognized taxonomic units."

The variation in morphology in *G. robusta* in the lower Colorado River basin is greater than that usually found within a species in a single basin in North America. This appears to be the result of the extremely complex geological history of the western United States over the past 15 million years. Tectonic activity in the western U.S. (Flint 1971) has resulted in periods of geographic isolation of basins and differentiation of biological lineages followed by lineage mixing and hybridization. This has resulted sometimes in confusing morphological variation within and among populations and has confounded the taxonomy of chubs and several other groups of fishes in the western U.S. (Smith et al. 2010). The recent study of Unmack et al. (2014) on suckers (Catostomidae) clearly demonstrated that extant lineages identified through analysis of mitochondrial DNA data are the products of a long history of differentiation and hybridization reflecting periods of isolation and mixing as drainage patterns have changed.

In summary, no morphological or genetic data define populations of *Gila* in the lower Colorado River basin as members of more than one species. Differences that have been noticed among localities, and that led to the three-species hypothesis of Minckley and DeMarais (2000), are almost certainly the result of past periods of geographic isolation and differentiation followed by more recent lineage mixing and hybridization. Alternatively, differences may be due to phenotypic plasticity related to variation in stream size, flow and substrate. Phenotypic plasticity has long been known to occur in

fishes (Hubbs 1940), although populations of *Gila* may represent extreme examples (Schönhuth et al. 2014).

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