

DRAFT Bonytail Chub (*Pimephales promelas*) Thermal Tolerance Analyses – Juvenile and Adult, Summer
March 2016

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult bonytail chub and their justification are discussed below. The recommended tolerance values were developed in accordance with the “*DRAFT Methodology for Developing Thermal Tolerance Thresholds for Various Fish in Nevada – Juvenile and Adult, Summer*” (September 2015).

Chronic Thermal Tolerance Thresholds

Table 1 provides a summary of the range of chronic temperature tolerance values for bonytail chub for various lines of evidence. These values are based upon a review of 2 papers and publications, the details of which are summarized in Attachment A.

There is obviously a wide range of temperatures from which to select an appropriate value and best professional judgment is called for. NDEP’s approach is to accept the EPA recommendations from Brungs and Jones (1977) unless the literature review provides a compelling reason to utilize other values. However, in the case of the bonytail chub, EPA has not recommended a chronic thermal tolerance value. As discussed in the methodology, chronic temperature criteria are generally not set to ensure the most optimum conditions. In fact, Brungs and Jones (1977) recommends chronic criterion for a given fish species that is between the optimum temperature and the UUILT. Based upon the available data, the recommended chronic threshold for bonytail chub is 29°C. This value is consistent with the upper end of the range of values derived from the literature.

Table 1. Summary of Chronic Temperature Tolerances

Category	Temperature (°C)
Laboratory Optimal Growth Studies	
Optimum	25.2 – 25.9
Upper Optimum	30
Laboratory Temperature Preference Studies	
Average Preferences	17.9 – 25.1
Upper Preferences	21.2 – 29.8
Final Preferendum	24.2
Recommended Chronic Temperature Tolerance (MWAT)	29

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for bonytail chub for various lines of evidence. These values are based upon a review of twenty-five papers and publications, the details of which are summarized in Attachment B.

For ease of presentation, the UILT and CTM values have been summarized by acclimation temperature ranges. However, as discussed in the methodology document, only the UILT and CTM values for acclimation temperature near the recommended chronic criterion (29°C) are to be included in the acute criterion development process. For bonytail chub, UILT and CTM values for acclimation temperatures 25 - 30°C are utilized for criterion development.

Table 2. Summary of Acute Temperature Tolerances

Category	Temperature Tolerances (°C)	Potential Acute Criteria (°C)
Laboratory Lethal Studies – CTM		
Acclim. = 25 – 30°C	37.2 – 40.2	31.8 – 34.8 ¹
Threshold from Colorado		36.1
Recommended Acute Temperature Tolerance (MDMT)		33

¹CTM values reduced by 3.4°C to estimate quasi-UILT values. Quasi-UILT values then reduced by 2°C to provide 100% survival (See *Methodology*)

A review of the laboratory studies suggests that an appropriate acute criterion should fall between 31.2 and 36.1. NDEP's approach is to accept the EPA recommendations from Brungs and Jones (1977) unless the literature review provides a compelling reason to utilize another value. However, in the case of bonytail chub, EPA did not provide a recommended acute threshold. Based upon the available data, the recommended acute threshold for bonytail chub is 33°C. This value is within the range identified by the CTM study.

References

Brungs, W.A. and B.R. Jones. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA-600/3-77-061. Environmental Research Laboratory, Duluth, Minnesota.

Bulkey, R. V., C. R. Berry, R. Pimental, and T. Black. 1981. Tolerance and preferences of Colorado River endangered fishes to selected habitat parameters. United States Fish and Wildlife Service, Completion Report, Contract 14-16-0008-1061 A-2, Utah Cooperative Fishery Research Unit, Logan, Utah, USA.

Carveth, C.J., A.M. Widmer, and S.A. Bonar. 2006. Comparison of upper thermal tolerances of native and nonnative fish species in Arizona. Transactions of the American Fisheries Society 135:1433-1440.

Colorado Water Quality Control Division. 2007. Colorado temperature database.

Kappenman, K. M., E.S. Cureton, J. Ilgen, M. Toner, W.C. Fraser, and G.A. Kindschi. 2012. Thermal requirements of the bonytail (*Gila elegans*): application to propagation and thermal-regime management of rivers of the Colorado River basin. The Southwestern Naturalist 57(4):421-429.

ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Bonytail chub, Juvenile and Adult, Summer

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Table A-1. Chronic Temperature Tolerances – Laboratory Optimal Growth Studies

Reference	Age or Size	Acclim. Temp. (°C)	Optimum Growth Temperature		Upper Optimum Growth Temperature	
			Temp. (°C)	Comment	Temp. (°C)	Comment
Kappenman et al. (2012)	Juvenile	18	25.2 – 25.9	Regression analyses for growth based on total length and weight = 25.2 to 25.9°C, respectively. Maximum weight gain observed in the study occurred at 24°C.	30	Mean gain in weight was highest at 24°C, which differed significantly from treatments ≤20°C, but was not statistically different from 22-30°C.

Table A-2. Chronic Temperature Tolerances – Laboratory Preference Studies

Reference	Age or Size	Acclim. Temp. (°C)	Average Preference Temperature		Upper Preference Temperature		Final Preferendum	
			Temp. (°C)	Comment	Temp. (°C)	Comment	Temp. (°C)	Comment
Bulkey et al. (1981)	2.5 – 5 cm	14	17.9		21.2	Mean preference + 1 standard deviation	24.2	
		20	22.5		27.3			
		26	25.1		29.8			

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Bonytail chub, Juvenile and Adult, Summer

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Table B-1. Acute Temperature Tolerances – Laboratory Lethal Temperatures, Critical Thermal Maximum

Reference	Size or Age	Acclim. Temp. (°C)	Rate	Temperature (°C)	Endpoint
Carveth et al. (2006)	Juvenile	25	0.3°C/min (18°C/hour)	37.2	Initial loss of equilibrium
				38.7	Death
		30		39.0	Initial loss of equilibrium
				40.2	Death

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Table B-3. Acute Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	36.1	Recommended level as DM

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