

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

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult razorback sucker 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 razorback sucker for various lines of evidence. These values are based upon a review of 4 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 razorback sucker, 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. Therefore, NDEP recommends a chronic value of 29°C which is within the upper range of the tolerances taken from the literature.

Table 1. Summary of Chronic Temperature Tolerances

Category	Temperature (°C)
Laboratory Temperature Preference Studies	
Average Preferences	17.1 – 30
Upper Preferences	25 - 32
Final Preferendum	22.9 – 24.8
Laboratory Upper Temperature Avoidance Studies	27.4 – 31.6
Temperature Preference Field Studies	
Typical	18 – 22
Range	12 - 30
Threshold from Colorado (MWAT)	27.7
Recommended Chronic Temperature Tolerance (MWAT)	29

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for razorback sucker for various lines of evidence. These values are based upon a review of one paper, 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 razorback sucker, 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	36.7 – 40.3	31.3 – 34.9 ¹
Threshold from Colorado (MDMT)		35.1
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 31.3 and 34.9°C. 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 razorback sucker, EPA did not provide a recommended acute threshold. Based upon the available data, the recommended acute threshold for razorback sucker 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.
- Bulkley, R.V. and R. Pimentel. 1983. Temperature Preference and Avoidance by Adult Razorback Suckers. Transactions of the American Fisheries Society 112:601–607
- 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.
- Mueller, G., P.C. Marsh, G. Knowles, and T. Wolters. 2000. Distribution, movements, and habitat use of razorback sucker (*Xyrauchen texanus*) in a lower Colorado River reservoir, Arizona-Nevada. Western North American Naturalist, 180-187.

ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Razorback Sucker, Juvenile and Adult, Summer

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Table A-1. 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)		8	26	Modes of pooled data	26 - 32	Upper range of individual modes	23 - 24	
		14	29 - 30					
		20	24 - 27					
		26	22 - 24					
Bulkey and Pimental (1983)	Adult	8	17.1 - 25	Mean of Modes	25 - 31	Mean of modes + 1 standard deviation	22.9 - 24.8	
		14	23.5 - 29					
		20	22.3 - 22.7					
		26	22.3 - 23.1					

Table A-2. Chronic Temperature Tolerances – Laboratory Upper Temperature Avoidance Studies

Reference	Age or Size	Acclim. Temp. (°C)	Temperature (°C)	Comment
Bulkey and Pimental (1983)	Adult	8 - 26	27.4 - 31.6	Bulkey and Pimental concluded that razorback suckers will probably avoid temperatures much above 29°C if lower temperatures are available.

Table A-3. Chronic Temperature Tolerances – Field Studies

Reference	Temperature (°C)	Comment
Mueller et al. (2000)	18 – 22	Adults were detected throughout the available thermal gradient (12°–30°C), but during summer typically had body temperatures between 18° and 22°C.
	12 – 30	

Table A-4. Chronic Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	27.7	Recommended level as MWAT

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Razorback sucker, 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)	36.7	Initial loss of equilibrium
				39.1	Death
		30		39.1	Initial loss of equilibrium
				40.3	Death

Table B-2. Acute Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	35.1	Recommended level as DM