

DRAFT Bonneville Cutthroat Trout (*Oncorhynchus clarkii utah*) and Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*) Thermal Tolerance Analyses – Juvenile and Adult, Summer
April 2016

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult Bonneville and Yellowstone cutthroat trout and their justification are discussed below. The analyses were performed for both subspecies combined as insufficient information was available to develop subspecies-specific recommendations. 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 Bonneville and Yellowstone cutthroat trout 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 Bonneville and Yellowstone cutthroat trout, EPA does not provide chronic thermal threshold recommendations.

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 17°C which is within the upper range of values reported in the literature, and is consistent with the Lahontan cutthroat trout chronic recommendation.

Table 1. Summary of Chronic Temperature Tolerances

Category	Temperature (°C)
Laboratory Optimal Growth Studies – Constant Temperature	
Optimum	13.4 – 17.2
Upper Optimum	18
Temperature Preference Field Studies	14.2 – 16.3
Thresholds from Colorado (MWAT)	17
Recommended Chronic Temperature Tolerance (MWAT)	17

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for Bonneville and Yellowstone cutthroat trout for various lines of evidence. These values are based upon a review of 4 papers, publications and other information, the details of which are summarized in Attachment B.

As discussed in the methodology document, only the UILT values for acclimation temperature near the recommended chronic criterion (17°C) are to be included in the acute criterion development process. For Bonneville and Yellowstone cutthroat trout, UILT values for acclimation temperatures of 15 to 20°C are utilized for criterion development. CTM values for acclimation temperatures of 18°C are also utilized for criterion development.

Table 2. Summary of Acute Temperature Tolerances

Category	Temperature Tolerances (°C)	Potential Acute Criteria (°C)
Laboratory Lethal Studies – UILT		
Acclim. = 10 – 15°C	24	
Acclim. = 15 – 20°C	23.7 – 24.2	21.7 – 22.2 ¹
Laboratory Lethal Studies – CTM		
Acclim. = 13.6°C	28.1 – 28.6	
Acclim. = 18°C	29.5 – 29.7	23.6 – 23.8 ²
Field Studies		22
Thresholds from Colorado		22.1
Recommended Acute Temperature Tolerance (MDMT)		22

¹UILT and UUILT values reduced by 2°C to provide 100% survival (See *Methodology*)

²CTM values reduced by 3.9°C to estimate quasi-UILT values, and reduced by 2°C to provide 100% survival (See *Methodology*)

A review of the available information suggests that an appropriate acute criteria should fall between 21.7 and 23.8°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 Bonneville and Yellowstone cutthroat trout, EPA did not provide acute thermal threshold recommendations. Based upon the available information, NDEP concluded that an acute thermal tolerance value of 22°C is appropriate. This value is within the range suggested by the literature and is consistent with the Lahontan cutthroat trout recommendation.

References

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ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Bonneville and Yellowstone Cutthroat Trout, 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
Myrick et al. (2012)	Juvenile	Unknown	14.7	Yellowstone cutthroat trout	18	Yellowstone cutthroat trout; Temperature at 80% optimum growth
Wagner et al. (1998)	Juvenile	N/A	13.4 – 17.2	Bonneville cutthroat trout; Tests were performed at 2 temperatures (13.4 and 17.2°C) with slightly higher growth found at 17.2°C.		

Table A-2. Chronic Temperature Tolerances – Field Studies

Reference	Temperature (°C)	Comment
Isaak and Hubert (2004)	12 - 14	Yellowstone cutthroat trout; Summer average temperature
	14.2 – 16.3	Yellowstone cutthroat trout; Estimated MWAT values using Standardization conversion discussed in <i>Methodology</i> document (MWAT = 1.05 x Jun-Aug Average + 1.6)

Table A-3. Chronic Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	17	Recommended level as MWAT; Based upon literature review for variety of cutthroat trout subspecies

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Bonneville and Yellowstone Cutthroat Trout, Juvenile and Adult, Summer

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Table B-1. Acute Temperature Tolerances – Laboratory Lethal Temperatures, UILT/UUILT

Reference	Size or Age	Acclim. Temp. (°C)	Test Duration	UILT		UUILT	
				Temp. (°C)	Comment	Temp. (°C)	Comment
Johnstone and Rahel (2003)	Juvenile	18	7-day	24.2	Bonneville cutthroat trout		
Wagner et al. (2001)	Juvenile	12.5	4-day	24	Bonneville, Snake, Yellowstone cutthroat trout		
		13.6		24			
		16		24			
		18		23.7			

Table B-2. Acute Temperature Tolerances – Laboratory Lethal Temperatures, Critical Thermal Maximum

Reference	Size or Age	Acclim. Temp. (°C)	Rate	Temperature (°C)	Endpoint
Wagner et al. (2001)	Juvenile	13.6	0.2°C/min	28.1	Loss of equilibrium
				28.6	Onset of spasms
		18		29.5	Loss of equilibrium
				29.7	Onset of spasms

Table B-3. Acute Temperature Tolerances – Field Studies

Reference	Temperature (°C)	Comments
Kelly (1993)	22	Summer temperatures exceeding 22°C excluded Yellowstone cutthroat trout from Alum Creek (Yellowstone National Park)

Table B-4. Acute Temperature Tolerances –Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	22.1	Recommended level as DM. Based upon literature review for variety of cutthroat trout subspecies

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