

DRAFT Pumpkinseed Sunfish (*Lepomis gibbosus*) Thermal Tolerance Analyses – Juvenile and Adult, Summer
 June 2016

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult pumpkinseed sunfish 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 pumpkinseed sunfish for various lines of evidence. These values are based upon a review of 9 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 pumpkinseed sunfish, EPA did not recommend a chronic thermal threshold. 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 32°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 Optimal Growth Studies – Constant Temperature	
Optimum	30
Upper Optimum	>30
Laboratory Temperature Preference Studies	
Average Preferences	10 – 33
Upper Preferences	22 – 34
Final Preferendum	27.7 – 31.1
Laboratory Upper Temperature Avoidance Studies	25 – 39
Thresholds from EPA and Colorado (MWAT)	28.7
Recommended Chronic Temperature Tolerance	31

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for pumpkinseed sunfish for various lines of evidence. These values are based upon a review of 5 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 (32°C) are to be included in the acute criterion development process. For pumpkinseed sunfish, UILT values for acclimation temperatures 30 – 35°C are utilized for criterion development. None of the CTM values were for acclimation temperatures close enough to 32°C for use in criterion development.

Table 2. Summary of Acute Temperature Tolerances

Category	Temperature Tolerances (°C)	Potential Acute Criteria (°C)
Laboratory Lethal Studies – UILT/UUILT		
UILT		
Acclim. = 5 – 10°C	26 – 30	
Acclim. = 10 – 15°C	30	
Acclim. = 15 – 20°C	30.5 – 31.7	
Acclim. = 20 – 25°C	30.2 – 34.5	
Acclim. = 25 – 30°C	31.9 – 35.3	
Acclim. = 30 – 35°C	33.5 – 37 ¹	31.5 - 35
Laboratory Lethal Studies – CTM		
Acclim. = 10°C	29.5 – 34.6	
Acclim. = 20°C	35.1 – 38.1	
Thresholds from Colorado		32.6
Recommended Acute Temperature Tolerance		33

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

A review of the available studies suggest that an appropriate acute criteria should fall between 31.5 and 35°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, no acute recommendation was provided by EPA for pumpkinseed sunfish. Based upon the available information, NDEP concluded that an acute thermal tolerance value of 33°C is appropriate.

References

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ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Pumpkinseed Sunfish, 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
Pessah and Powles (1974)	17 – 40 g		30		>30	Insufficient data were collected to identify if higher growth rates occur above 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
Cincotta and Stauffer (1984)	Unknown	6 - 36	17 - 32		22 - 34	Maximum temperatures occupied by test fish	31.1	
Evans (1977)	Adult	8 - 24	22.9 – 30.3					
Muller and Fry (1976)	1.2 – 7.7 g	8 - 30	22 – 28		24 – 31.5	Maximum temperatures occupied by test fish	28.5	
Peterson et al. (1974)	Juvenile	8 - 26	10 - 33					
Reutter and Herdendorf (1974)	Adult	Unknown					27.7	
Reynolds and Casterlin (1977)	Adult	Unknown	26	Mode of measurements	29	Upper temperature occupied by 90% of fish		

Table A-3. Chronic Temperature Tolerances – Laboratory Upper Temperature Avoidance Studies

Reference	Age or Size	Acclim. Temp. (°C)	Temperature (°C)	Comment
Cincotta and Stauffer (1984)	Unknown	18 - 36	33 - 39	
Evans (1977)	Young-of-year	20	31.4	
	Adult	8 - 24	25 -32.7	

Table A-4. Chronic Temperature Tolerances – EPA and Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	28.7	Recommended level as MWAT

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Pumpkinseed Sunfish, 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
Black (1953)	Adult	24	1-day	30.2			
Brett (1944)	Juvenile	25.5	1-day	34.5			
Evans (1977)	Young-of-year	8		26			
		16		30.5			
		20		31.7			
		24		34.2			
	Adult	12		27.7 – 28.5			
		20		31.6 – 32.9			
		28		31.9 – 35.3			
		32		33.5			
Hathaway (1927)	Juvenile	10	1-day	30			
		22.5	1-day	34			
		30	1-day	34.3			

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

Reference	Size or Age	Acclim. Temp. (°C)	Rate	Temperature (°C)	Endpoint
Becker and Genoway (1979)	Adult	10	1, 6, 18, 30, 60°C/hour	29.5 – 31.6	Loss of equilibrium
				30.5 – 34.6	Death
		20		35.1 – 36.6	Loss of equilibrium
				35.6 – 38.1	Death

Table B-3. Acute Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	32.6	Recommended level as DM

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