

DRAFT Black Crappie (*Pomoxis nigromaculatus*) Thermal Tolerance Analyses – Juvenile and Adult, Summer
January 2016

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult black crappie 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 black crappie for various lines of evidence. These values are based upon a review of nine 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. EPA’s chronic value of 27°C falls within the range of potential criteria found in the literature, and is recommended as the chronic thermal tolerance level for adult/juvenile black crappie. 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.

Table 1. Summary of Chronic Temperature Tolerances

Category	Temperature (°C)
Laboratory Optimal Growth Studies – Constant Temperature	
Optimum	22 - 25
Upper Optimum	<30
Laboratory Temperature Preference Studies	
Average Preferences	24
Upper Preferences	23.4 – 26.7
Final Preferendum	21.7 – 24.6
Laboratory Upper Temperature Avoidance Studies	30 – 34
Temperature Preference Field Studies	16.5 – 30.6
Thresholds from EPA (MWAT)	27
Recommended Chronic Temperature Tolerance (MWAT)	27

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for black crappie for various lines of evidence. These values are based upon a review of two 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 (27°C) are to be included in the acute criterion development process. For black crappie, UILT values for acclimation temperatures of 24 to 29°C are utilized for criterion development. CTM values for acclimation temperatures of 24 to 30°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. = 24 - 29°C	31.5 – 35.1	29.5 – 33.1 ¹
Laboratory Lethal Studies – CTM		
Acclim. = 24 - 30°C	36 – 40	29.8 – 33.8 ²
Acclim. = 30 - 32°C	38 – 40	
Recommended Acute Temperature Tolerance (MDMT)		32

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

²CTM values reduced by 4.2°C to estimate quasi-UILT values. Quasi-UILT values then reduced by 2°C to provide 100% survival (see *Methodology*)

A review of laboratory studies suggests that an appropriate acute criterion should fall between 29.5 and 33.8°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 black crappie, Brungs and Jones did not provide a recommended acute value. Therefore, it is recommended that a value of 32°C (roughly in the middle of the identified range) be used for the protection of juvenile/adult black crappie.

References

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ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Black Crappie, Juvenile and Adult, Summer

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

Reference	Age or Size	Acclim. Temp. (°C)	Optimum Growth Temperature		Upper Optimum Growth Temperature	
			Temp. (°C)	Comment	Temp. (°C)	Comment
Hokanson and Kleiner (1977)	Juvenile	Unknown	22 - 25		<30	Zero growth at 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
Reutter and Herdendorf (1974)	Adult	20 - 26			23.4 - 26.7	Upper extent preferences based upon 1 stand. dev. above final preferendum	21.7 – 22.2	Summer and fall preference
Reutter and Herdendorf (1976)	Adult						21.7 – 24.6	Summer and fall preference
Reynolds and Casterlin (1977)	Adult	Unknown	24	Temperature most frequently occupied	25	Upper limit of temperatures occupied		

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

Reference	Age or Size	Acclim. Temp. (°C)	Temperature (°C)	Comment
Neill et al. (1972)	Juvenile	Unknown	24 – 34	Lower and upper limits of temperatures occupied by 1 fish ¹
Neill and Magnuson (1974)	Juvenile	Unknown	25.5 – 30	Median lower and upper limits of temperatures avoided by test fish

¹Results not available for the other 5 fish

Table A-4. Chronic Temperature Tolerances – Field Studies

Reference	Temperature (°C)	Comment
Eaton et al. (1995)	30.6	Based upon 95 th percentile of 5% highest weekly average temperatures
Marcy (1976)	16.5 – 27.3	Temperature range
	21.3	Mean temperature

Table A-5. Chronic Temperature Tolerances – EPA

Reference	Temperature (°C)	Comments
EPA (1977)	27	Recommended level as MWAT

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Black Crappie, 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
Baker and Heidinger (1996)	Mean size = 30.2 mm	24	1-d	33.8			
	Mean size = 45.6 mm			35.1			
	Mean size = 74.9 mm			31.5			
Hokanson and Kleiner (1977)	Juvenile	29	Unknown	33			

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

Reference	Size or Age	Acclim. Temp. (°C)	Rate	Temperature (°C)	Endpoint
Baker and Heidinger (1996)	Mean size = 30.2 mm	24	1°C/hour	38	100% mortality
		30		38.5	100% mortality
				32	39
	Mean size = 45.6 mm	24		39	100% mortality
		30		40	100% mortality
				32	40
	Mean size = 74.9 mm	24		36	100% mortality
		30		38	100% mortality
				32	39