

# DRAFT Redear Sunfish (*Lepomis microlophus*) Thermal Tolerance Analyses – Juvenile and Adult, Summer

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## Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult redear 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 redear sunfish 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 redear sunfish, EPA did not recommend a chronic thermal threshold for redear sunfish. Based upon the available information, NDEP recommends a chronic value of 29°C which is within the upper range of the tolerances. 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**

<b>Category</b>	<b>Temperature (°C)</b>
Laboratory Temperature Preference Studies	
Average Preferences	22.5 – 28.7
Upper Preferences	27.4 – 33.4
Other Information	23.9
<b>Recommended Chronic Temperature Tolerance (MWAT)</b>	<b>29</b>

## Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for redear sunfish for various lines of evidence. These values are based upon a review of 2 papers, the details of which are summarized in Attachment B. As discussed in the methodology document, only the CTM values for acclimation temperature near the recommended chronic criterion (29°C) are to be included in the acute criterion development process. For striped bass, CTM values for acclimation temperatures 34°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. = 10°C	30.8 – 34.1	
Acclim. = 34°C	37.4	31.2 <sup>1</sup>
<b>Recommended Acute Temperature Tolerance (MDMT)</b>		<b>31</b>

<sup>1</sup>CTM values reduced by 3.8°C to estimate quasi-UILT values, and reduced by 2°C to provide 100% survival (See *Methodology*)

A review of laboratory studies suggests that an appropriate acute criterion should be around 31.2°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 redear sunfish, EPA did not recommend an acute thermal threshold for striped bass. Based upon the available information, NDEP concluded that an acute thermal tolerance value of 31°C is appropriate. This value is consistent with the CTM study results and is slightly higher than the chronic threshold of 29°C.

## 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.

Hill, L.G., G.D. Schnell and J. Pigg. 1975. Thermal acclimation and temperature selection in sunfishes (*Lepomis centrarchidae*). *The Southwestern Naturalist*. Vol. 20, No. 2, pp. 177-184.

Lutterschmidt, W.I. and V.H. Hutchison. 1997. The critical thermal maximum: data to support the onset of spasms as the definitive end point. *Can. J. Zool.* 75: 1553-1560.

Reutter, J.M and C.E. Herdendorf. 1976. Thermal discharge from a nuclear power plant: predicted effects on Lake Erie Fish. *Ohio J. Sci.* 76, no. 1: 39-45.

Rounsefell, G.A. and W.H. Everhart. 1953. *Fishery science, its methods and applications*. John Wiley and Sons, New York. Cited in: Twomey, K.A., G. Gebhart, and P.C. Nelson. 1984. *Habitat Suitability Index Models and Instream Flow Suitability Curves: Redear Sunfish*. US Fish and Wildlife Service.

**ATTACHMENT A**

**Detailed Summary of Chronic Thermal Tolerance Values for Redear Sunfish, 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
Hill et al. (1975)	Yearlings	16 - 26	22.5 – 28.7	Average preferences	27.4 – 33.4	1 standard deviation above average		

**Table A-2. Chronic Temperature Tolerances – Other Information**

Reference	Age or Size	Temperature (°C)	Comment
Rounsefell and Everhart (1953)	Unknown	23.9	Best growth reported to occur at 23.9°C. Uncertain if finding based upon laboratory or field study

**ATTACHMENT B**

**Detailed Summary of Acute Thermal Tolerance Values for Spotted Bass, 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
Lutterschmidt and Hutchison (1997)	Not reported <sup>1</sup>	10	1°C/min (60°C/hour)	30.8	Loss of righting response
				34.1	Onset of spasms
Reutter and Herdendorf (1976)	Adult	34	Not reported	37.4	Loss of equilibrium

<sup>1</sup>Collected by seining streams and reservoirs in Oklahoma

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