



New Water Temperature Criteria to Protect Colorado's Fisheries

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Why new temperature standards?

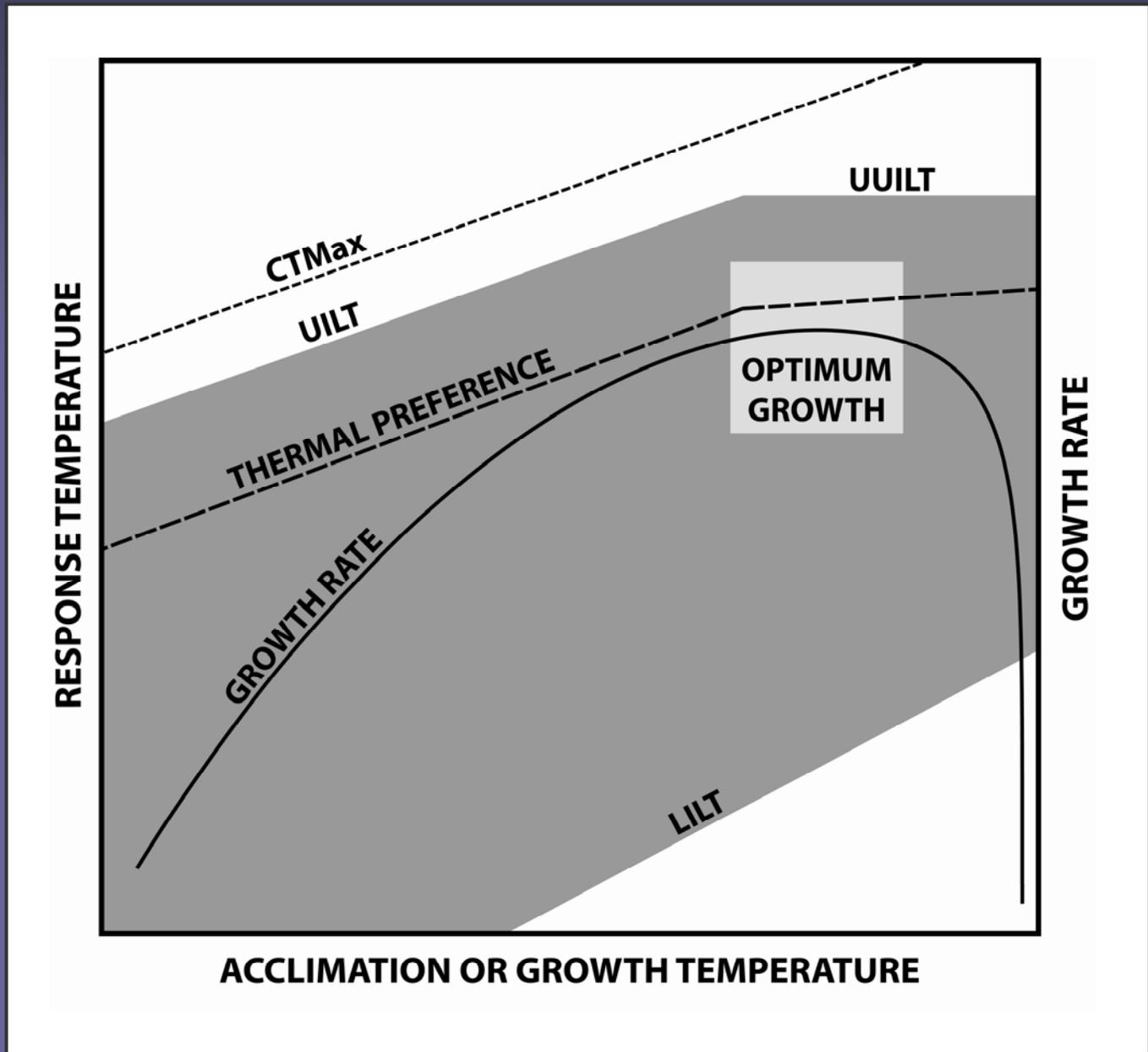
- 1978 standards were dated
- Standards were not enforceable
 - Lacking discernable scientific foundation
 - Lacking clear guidance for implementation

Why new temperature standards?

- Goals for development of new standards
 - Biologically meaningful and defensible
 - Protect broad spectrum of Colorado aquatic habitats
 - Clear implementation procedure

Acute Criteria Development

- Intended to protect fish from short-term, lethal exposures
- Two principal experimental approaches
 - Critical Thermal Maximum (CTM): Fish subjected to uniform rates of temperature change until loss of equilibrium, spasm, or death
 - Upper Incipient Lethal Temperature (UILT): Instantaneous transfer of acclimated fish to higher fixed lethal temperatures



Acute Criteria Decisions

- Commission decided to use UUILT
 - UILT at “summer time” acclimation temperatures
 - CTM data used minus a “conversion factor”
 - Resulted in robust data set
- Margin of safety
 - UILT represents a 50% lethality level
 - EPA suggests 2°C below UUILT
 - Division created a “1/5th Rule”

Chronic Criteria Development

- Intended to protect aquatic life from sub-lethal exposures resulting in detrimental effects on long-term survival, growth, and reproduction
- Upper thermal optimum temperature target
- Surrogates
 - 1/3rd rule- uses optima and UILT data
 - Preference data and / or “converted” CTM used where necessary

Colorado Temperature Database

- Data on thermal requirements and tolerance for Colorado resident fish species compiled
- Data screening guidelines
- Laboratory vs. field studies
- >500 papers reviewed
 - Data from 158 papers utilized
 - Total species investigated = 73
 - Coldwater species with adequate data = 8
 - Warmwater species with adequate data = 43

Resultant Temperature Criteria

- Criteria developed for several “categories”
 - Headwater trout fisheries
 - Gold-medal / lower elevation coldwater fisheries
 - “Transitional” native warmwater fisheries
 - Warmwater fisheries
 - Lakes vs. streams
- Seasonal criteria developed to protect thermally sensitive reproductive functions

Parameter	Cold Water Biota	Warm Water Biota
Temperature (°C)	Rivers & Streams: June-Sept = 17.0 (chronic), 21.2 (acute)	Rivers & Streams: Mar-Nov = 28.7 (chronic), 31.3 (acute)
	Rivers & Streams: Oct –May = 9.0 (chronic), 13.0 (acute)	cs, Jd, od ^a = 24.2 (chronic), 29.0 (acute) rs ^b = 27.7 (chronic), 31.3 (acute) other ss ^c = 27.5 (chronic), 28.6 (acute)
	NS^e Rivers & Streams: Apr-Oct = 18.2 (chronic), 23.8 (acute)	Rivers & Streams: Dec-Feb = 14.3 (chronic), 15.2 (acute)
	NS^e Rivers & Streams: Nov-Mar = 9.0 (chronic), 13.0 (acute)	cs, Jd, od ^a = 12.1 (chronic), 14.5 (acute) rs ^b = 13.9 (chronic), 15.2 (acute) other ss ^c = 13.7 (chronic), 14.3 (acute)
	Lakes & Res: Apr-Dec = 17.0 (chronic), 21.2 (acute)	Lakes & Res: Apr-Dec = 26.5 (chronic), 29.3 (acute)
	Lakes & Res: Jan-Mar = 9.0 (chronic), 13.0 (acute)	Lakes & Res: Jan-Mar = 13.3 (chronic), 14.6 (acute)
	Large Lakes & Res^d: Apr-Dec = 18.2 (chronic), 23.8 (acute)	
	Large Lakes & Res^d: Jan-Mar = 9.0 (chronic), 13.0 (acute)	

^a “cs, jd, od” means common shiner, Johnny darter and orangethroat darter: these temperature criteria are to be applied only where any of these species are expected to occur at the site.

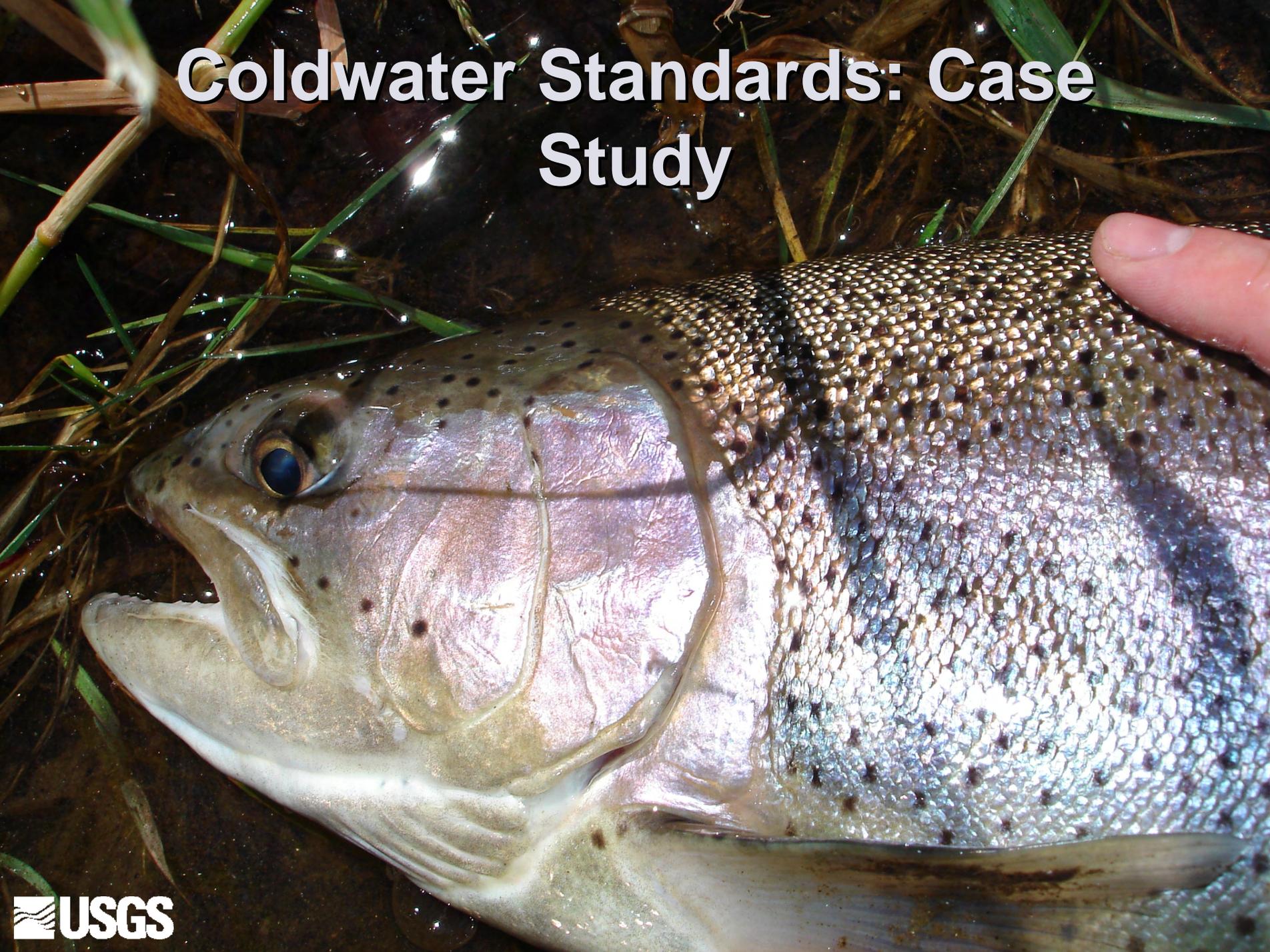
^b “rs” means razorback sucker: these temperature criteria are to be applied only where this species is expected to occur at the site.

^c “other ss” means brook stickleback, central stoneroller, creek chub, longnose dace, Northern redbelly dace, finescale dace and white sucker: these temperature criteria are to be applied only where any of these species are expected to occur at the site.

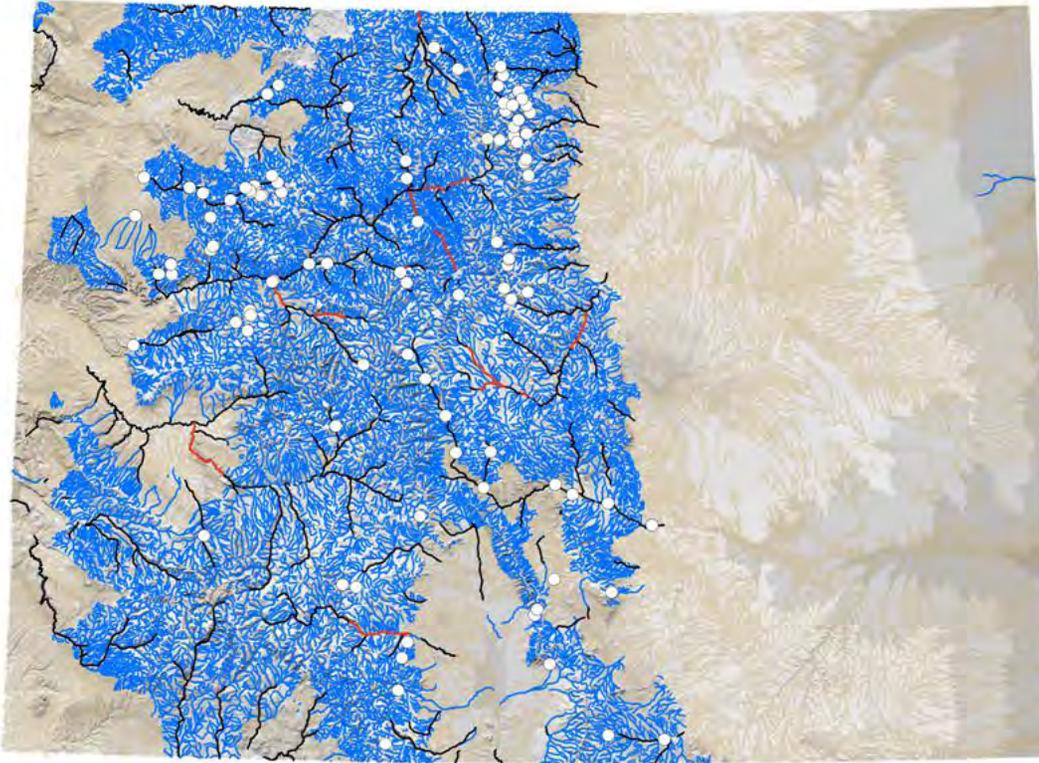
^d Temperature criteria are to be applied only on lakes and reservoirs that are equal to or larger than 100 acres in surface area.

^e “NS” means “not sensitive”: these criteria are to be applied where cutthroat trout and brook trout are not expected to occur at the site.

Coldwater Standards: Case Study

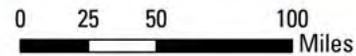


Common Name	Scientific Name	Chronic	Acute	# of studies
Cutthroat Trout	<i>Oncorhynchus clarki</i>	17.0	22.1	7
Rainbow Trout	<i>Oncorhynchus mykiss</i>	18.2	23.8	16
Brook Trout	<i>Salvelinus fontinalis</i>	18.3	21.7	12
Sockeye Salmon	<i>Oncorhynchus nerka</i>	19.0	22.9	2
Brown Trout	<i>Salmo trutta</i>	19.6	24.6	8
Arctic Grayling	<i>Thymallus arcticus</i>	No data	21.0	1
Longnose Sucker	<i>Catostomus catostomus</i>	No data	24.9	1
Mottled Sculpin	<i>Cottus bairdi</i>	No data	27.9	1
Lake Trout	<i>Salvelinus namaycush</i>	No data	No data	3
Mountain Whitefish	<i>Prosopium williamsoni</i>	No data	No data	1

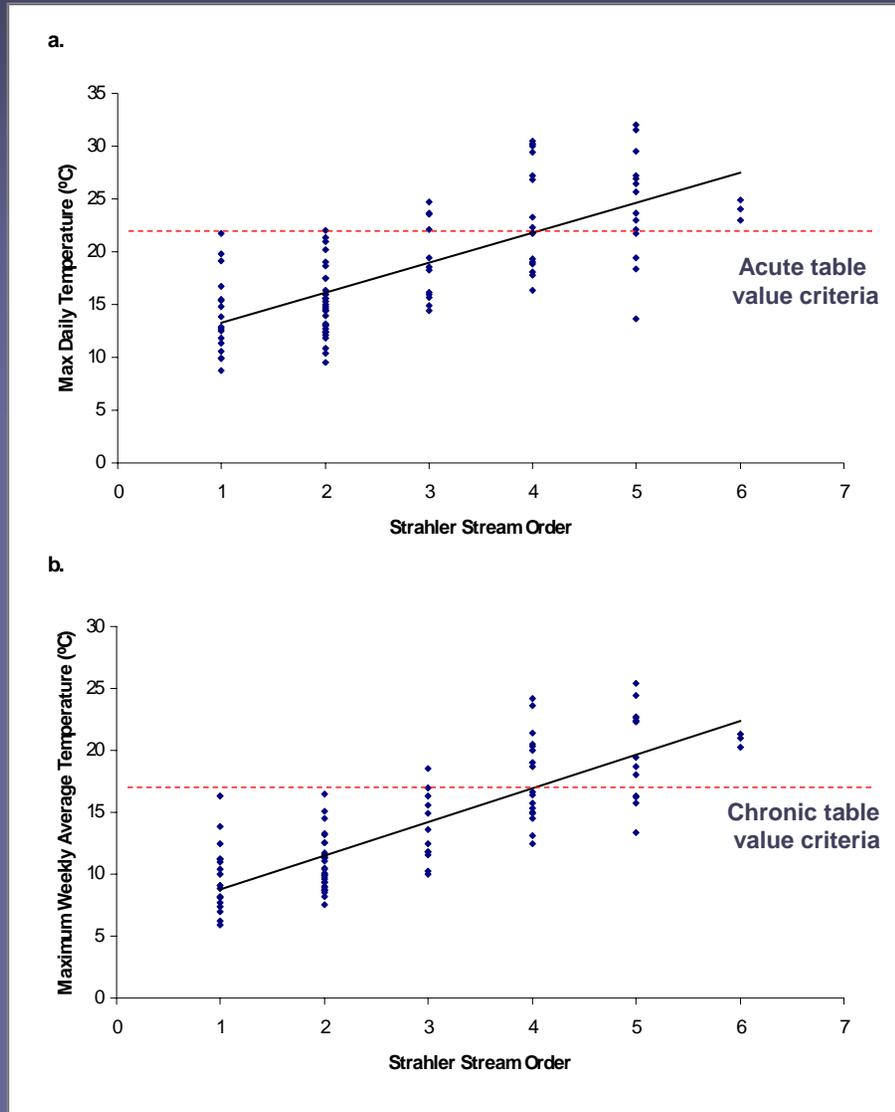


Legend:

-  1st - 3rd Order Coldwater Streams (Default TVS)
-  4th Order and Greater Coldwater Streams ("Not Sensitive" TVS)
-  "Gold Medal" Coldwater Streams
-  Warmwater Streams
-  Coldwater Thermistor Locations



GIS data courtesy of the Colorado Water Quality Control Division and the Colorado Division of Wildlife
Thermistor data set includes temperature data from USGS, USFS, USFWS, Dr. Amy Harig, and Dr. Mark Coleman.



Future of Colorado temperature standards

- Seasonal acute and chronic “ceilings” may not be enough to fully protect resource
- Natural diel variability in temperature
- Thermal shock
 - Abrupt thermal change can cause lethal and sublethal consequences (McCullough 1999)
 - Lack of relevant scientific literature
 - Anticipated confusion over implementation

Detailed account



Acknowledgements

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Questions?

