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crease with time (Kleerekoper et al. 1974; W. W. Reynolds unpublished data). The stress of infection, mediated by pyrogens, can increase the preferendum by several degrees (Reynolds et al. 1976a; Reynolds and Covert 1977; Reynolds 1977c), which somehow enhances survival from the infection (J. B. Covert and W. W. Reynolds unpublished data). Stress-enhanced thermoregulation might "fine-tune" the physiological responses of the organism, such as the immune response to infection or escape reactions from harmful stimuli. Fish maintained in laboratory temperature and photoperiod conditions comparable to those of the spawning season may also be in perpetual breeding condition (Banner and Hyatt 1975; Smith 1975), so their preferenda might reflect spawning optima.

Another possible interpretation of initially high laboratory preferenda involves initial overshoot during gravitation to the final preferendum (cf. Badenhuizen 1967; Beitinger and Magnuson 1976), a phenomenon not uncommon in physiological responses to temperature changes (Prosser 1965; Peterson and Anderson 1969; Reynolds 1977b). Alternatively, the laboratory responses may be considered to represent the pure species-specific temperature preferendum, since every effort is made to remove extraneous stimuli, while a multitude of nonthermal stimuli interfere in a complex fashion with thermal responses in nature, making thermal distributions in the field less predictable. In extended laboratory tests, fish might similarly begin to respond to nonthermal factors, modifying the observed thermal distributions. Nutrition level may have an effect. Perhaps more significantly, social interactions in groups of fish seem to increase following the initial exploratory phase in a novel environment (W. W. Reynolds unpublished data), and such social interactions have been shown to affect thermal distributions and behavior (Bacon et al. 1967; Regal 1971; Beitinger and Magnuson 1975), especially in the case of subordinate individuals whose behavior is interfered with by socially dominant individuals. A great deal of further work is needed to more fully clarify all of the above considerations.

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Compilation of Temperature Preference Data[1]

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COUTANT, C. C. 1977. Compilation of temperature preference data. J. Fish. Res. Board Can. 34: 739–745.

This report briefly summarizes current information from field and laboratory studies on temperature selection by fishes, with a tabulation of final temperature preferenda and upper and lower avoidance temperatures.

Key words: temperature, selection, preferendum, avoidance, preference, behavior, orientation

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On résume brièvement dans cet article les connaissances courantes acquises sur le terrain et en laboratoire sur le choix des températures par les poissons, avec tabulation des températures préférées finales et des températures d'évitement supérieures et inférieures.

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THIS paper summarizes information on temperatures selected by fishes in laboratory and field situations. Its primary purpose is to provide tabular data on three "endpoints" of temperature selection that have been found useful for setting temperature standards for water bodies and for describing and predicting the behavior of fishes near power station heated discharges (Table 1). These endpoints are the final preferendum and the upper and lower avoidance temperatures. A significant amount of additional data has been published since Coutant (1975) summarized reports through 1973.

Despite different study objectives and methods among the research reports summarized in Table 1, a pattern of temperature preference appears in the results for many species. Species specificity is clearly demonstrated with reasonable consistency among laboratory and field results. For some species, the tabular summary clarifies the need for research directed toward resolving contradictions. Discrepancies among results indicate where caution should be used in applying these data in impact assessments. Some tabulated values represent my own interpretation of the authors' data, which may differ from theirs. Certainly, the original papers should be fully understood before these data are used for power plant impact analyses or for other purposes.

Acknowledgments

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TABLE 1. Summary of available data on final preferendum and upper and lower avoidance temperatures of fish from field and laboratory studies. Numbers here may vary somewhat from the original author's interpretation. Sp = spring; W = winter; F = fall; Su = summer; YOY = young of the year.

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
Alburnus alburnus (bleak)	Large	20			Lab	Alabaster and Downing 1966
Alosa chrysochloris (skipjack herring)	Large	29		22	Wabash R., Ind.	Gammon 1973
A. pseudoharengus (alewife)			18.8		Cayuga L., N.Y.	Galligan 1951
		22.0		8.0	L. Michigan	Wells 1968
	Adult (Sp)		21.3		Lab	Reutter and Herdendorf 1974
A. sapidissima (American shad)	Small	30			Connecticut R., Conn.	Marcy et al. 1972
Ambloplites rupestris (rock bass)			21.3		Wisconsin Lakes	Hile and Juday 1941
			20.7		S. Ontario streams	Ferguson 1958
			27–27.8[a]		L. Monona, Wis.	Neill 1971
			26.8–28.3[b]		L. Monona, Wis.	Neill 1971
	Small	29.0	26.2	25.5	Lab[a]	Neill 1971
	Small	29.5	28.8	26.0	Lab[b]	Neill 1971
	Adult (W)		21.6		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		20.5		Lab	Reutter and Herdendorf 1974
	Adult (F)		22.8		Lab	Reutter and Herdendorf 1974
Anchoa mitchilli (bay anchovy)	All	33	24.5–32.5		Galveston Bay, Tex.	Gallaway and Strawn 1974
Aplodinotus grunniens (freshwater drum)	Large		22.2		Norris Res., Tenn.	Dendy 1948
	Large	30		22	Wabash R., Ind.	Gammon 1973
	Small		29.5–30.3[a]		L. Monona, Wis.	Neill 1971
	Small		27.5–29[b]		L. Monona, Wis.	Neill 1971
	YOY (Su)		31.3		Lab	Reutter and Herdendorf 1974
	Adult (Su)		26.5		Lab	Reutter and Herdendorf 1974
	Adult (F)		19.6		Lab	Reutter and Herdendorf 1974
Arius felis (sea catfish)	All	37			Galveston Bay, Tex.	Gallaway and Strawn 1974
Atherinops sp[c] (silverside species)		28	25.2	22	California coast	Doudoroff 1938
Brevoortia patronis (gulf menhaden)	All	30			Galveston Bay, Tex.	Gallaway and Strawn 1974
Campostoma anomalum (stoneroller)	All	23.8			New R., Va.	Sauffer et al. 1975[a]
			26.8		Lab	Stauffer et al. 1975[a]
	Adult	33	29	24	Lab	Cherry et al. 1975
Carassius auratus (goldfish)	Small		28.1		Lab	Fry 1947
	Small	33	30		Lab	Roy and Johansen 1970
	Adult (W)		24.2		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		25.3		Lab	Reutter and Herdendorf 1974
	Adult (Su)		27.0		Lab	Reutter and Herdendorf 1974
	Adult (F)		24.0		Lab	Reutter and Herdendorf 1974
	Medium		27.9		Lab	Reynolds and Covert 1977
Carpoides carpio (river carpsucker)	Large	34.5		26	Wabash R., Ind.	Gammon 1973

TABLE 1 (*Continued*)

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
C. cyprinus (quillback)	Large	34.5		27.0	Wabash R., Ind.	Gammon 1973
	Adult (F)		22.1		Lab	Reutter and Herdendorf 1974
Catostomus catostomus (longnose sucker)			11.6		Moosehead L., Me.	Cooper and Fuller 1945
C. commersoni (white sucker)			20.6		Wisconsin Lakes	Hile and Juday 1941
			18.3		Moosehead L., Me.	Cooper and Fuller 1945
	Large		18.9–21.1		Horsetooth Res., Colo.	Horak and Tanner 1964
	Adult (F)		22.4		Lab	Reutter and Herdendorf 1974
Chromis chromis (damselfish)		26	20	8	Lab	Cabanac and Jeddi 1971
Coregonus artedii (cisco)	Large	20	10		L. Nipissing, Ont.	Fry 1937
	Large		7.2		Cayuga L., N.Y.	Galligan 1951
C. clupeaformis (lake whitefish)			11.9		Moosehead L., Me.	Cooper and Fuller 1945
	Small		12.7		Lab	Ferguson 1958
	Larvae		17		South Bay, Lake Huron, Ontario	Reckahn 1970
	Larvae					
	12.9 mm		12–16		Lab	Hoagman 1974
	17.8 mm	17	13.5	12	Lab	Hoagman 1974
	23.1 mm	19	15.5	14.5	Lab	Hoagman 1974
C. hoyi (bloater)	Large	10		6	L. Michigan	Wells 1968
C. lavaretus (n.c.n.)	Larvae					
	(60 days)		11–15.4		Lab	Mantelman 1958
	(100 days)		8–12		Lab	Mantelman 1958
Cottus bairdii (mottled sculpin)			16.5		S. Ontario streams	Ferguson 1958
C. cognatus (slimy sculpin)	Large	6		4	L. Michigan	Wells 1968
Crenichthys baileyi (White River killifish)			29.5		White R., Nev.	Deacon and Bradley 1971
Cyprinodon macularius (desert pupfish)	Adults	36.5	35.5–36.5		Salton Sea, Calif.	Barlow 1958
	Young		40		Quitobaquito, Ariz.	Lowe and Heath 1969
Cyprinus carpio (carp)	Large	34.5		27	Wabash R., Ind.	Gammon 1973
	Large		29.3–31.9[a]		L. Monona, Wis.	Neill 1971
	Large		28.2–30.7[b]		L. Monona, Wis.	Neill 1971
	Young	35	32	28	Lab	Pitt et al. 1956
	Young	33.5	31.9	30	Lab[a]	Neill 1971
	Young	32.3	32	29.5	Lab[b]	Neill 1971
	Adult (Sp)		27.4		Lab	Reutter and Herdendorf 1974
	Adult (Su)		29.7		Lab	Reutter and Herdendorf 1974
	Adult	> 31	29	24	Lab	Reynolds unpublished data
Cynoscion arenarius (sand seatrout)	All	40	29–32		Galveston Bay, Tex.	Gallaway and Strawn 1974
			35	30–35	Galveston Bay, Tex.	Copeland and Bechtel in Galloway and Strawn 1974
Dorosoma cepedianum (gizzard shad)	Large	30		23.5	Wabash R., Ind.	Gammon 1973
	Large		23.0		Norris Res., Tenn.	Dendy 1948
	Adult (F)		20.5		Lab	Reutter and Herdendorf 1974
Esox americanus vermiculatus (grass pickerel)	Small		26		Lab	Ferguson 1958
F. masquinongy (muskellunge)	Small		24		Lab	Ferguson 1958
E. niger (chain pickerel)	Medium	27	24	< 20	Lab	Reynolds unpublished data
Gadus morhua morhua (Atlantic cod)	Large	8.9	1.4–2.0	0.6	Field	Tatyankin 1972
			1–3		Field	Tatyankin 1972
		8–10			Field	Tatyankin 1972
			1.5–2		Field	Tatyankin 1972
		15	9	1.0	Lab	Tatyankin 1972
	Small	16–17			Lab	Bohle 1974
Gambusia affinis (mosquitofish)			31		Field and Lab	Winkler 1973
	Adults	29.5	27		Lab	Bacon et al. 1967
	15–19 mm	32			Lab	Bacon et al. 1967
	< 15 mm	35			Lab	Bacon et al. 1967
Gillichthys mirabilis (longjaw mudsucker)		23	22	9	Lab	deVlaming 1971
Girella nigricans (opaleye)	Transforming		28–31.2		California coast	Norris 1963
	55–60 mm		26–28.2		California coast	Norris 1963
		30	26		Lab	Duodoroff 1938
			26		Lab	Norris 1963
Heterodontus francisci (horn shark)	Young		24		Lab	Crawshaw and Hammel 1973

TABLE 1 (*Continued*)

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
Hiodon alosoides (goldeye)	Large	28.5		22	Wabash R., Ind.	Gammon 1973
H. tergisus (mooneye)	Large	27		22	Wabash R., Ind.	Gammon 1973
Ictalurus natalis (yellow bullhead)	Adult (Su)		28.3		Lab	Reutter and Herdendorf 1974
I. nebulosus (brown bullhead)	Adult (W)		11.9		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		23.5		Lab	Reutter and Herdendorf 1974
	Adult (Su)		24.9		Lab	Reutter and Herdendorf 1974
	Adult (F)		23.6		Lab	Reutter and Herdendorf 1974
	93–193 mm		27.3		Lab	Richards 1974
	Adult		29–31		Lab	Crawshaw 1975[b]
I. punctatus (channel catfish)	Large	32		26	Wabash R., Ind.	Gammon 1973
	Large	34			White R., Ind.	Proffitt 1969
	Adult (Su)		25.2		Lab	Reutter and Herdendorf 1974
	Adult (F)		25.3		Lab	Reutter and Herdendorf 1974
		35	30.5	23	Lab	Cherry et al. 1975
Ictiobus sp. (buffalo species)	Large	34.5		27	Wabash R., Ind.	Gammon 1973
Leiostomus xanthurus (spot)	All	37.5			Galveston Bay, Tex.	Gallaway and Strawn 1974
Lepisosteus osseus (longnose gar)	Large		30–31.8		L. Monona, Wis.	Neill 1971
	Large	34.5		29	Wabash R., Ind.	Gammon 1973
	YOY (Su)		25.3		Lab	Reutter and Herdendorf 1974
	Adult (Su)		33.1		Lab	Reutter and Herdendorf 1974
L. platostomus (shortnose gar)	Large	34.5		27	Wabash R., Ind.	Gammon 1973
Lepomis cyanellus (green sunfish)	< 74 mm	30	27.3	24	Lab	Jones and Irwin 1965
	Adult	33	30.6	23	Lab	Cherry et al. 1975
	Small	30.3	28.2	26.5	Lab	Beitinger et al. 1975
L. gibbosus (pumpkinseed)	Large		28.5–32[a]		L. Monona, Wis.	Neill 1971
	Large		27–29[b]		L. Monona, Wis.	Neill 1971
	Small		31.5		Lab	Ferguson 1958
	Adult (Sp)		24.2		Lab	Reutter and Herdendorf 1974
	Adult (Su)		27.7		Lab	Reutter and Herdendorf 1974
	Large	> 31	26	< 22	Lab	Reynolds unpublished data
L. macrochirus (bluegill)			29.4–31.3		L. Monona, Wis.	Neill 1971
	53–99 mm		28.8–31.2[a]		L. Monona, Wis.	Neill 1971
	53–99 mm		27–29[b]		L. Monona, Wis.	Neill 1971
	100–193 mm		29.6–32.6[a]		L. Monona, Wis.	Neill 1971
	100–193 mm		27.2–29[b]		L. Monona, Wis	Neill 1971
			32.3		Lab	Ferguson 1958
	Young	32.1	30.2	28.5	Lab[a]	Neill 1971
	Young	32.5	31.5	28.5	Lab[b]	Neill 1971
	Young	33.1	31.2	29.3	Lab	Beittinger 1974
	Adult (W)		27.4		Lab	Reutter and Herdendorf 1974
	Adult	35	32	26	Lab	Cherry et al. 1975
	45–110 mm	33.0	32.3	26	Lab	Reynolds and Casterlin 1976[a]
	120–155 mm		30.5		Lab	Reynolds et al. 1976[a]
Leuresthes sardina (gulf grunion)	25–160 days old	37	32	< 20	Lab	Reynolds and Thomson 1974[a]
L. tenuis (Calif. grunion)	Adult	34	25	< 20	Lab	Reynolds et al. 1977[a]
Lota lota lacustris (burbot)	Small		21.2		Lab	Crossman et al. 1953 cited by Ferguson 1958
L. lota maculosa (burbot)			11.4		Moosehead L., Me.	Cooper and Fuller 1945
Melanogrammus aeglefinus (haddock)			5–6		Field	Tatyankin 1972
Membras martinica (rough silverside)	All	33			Galveston Bay, Tex.	Gallaway and Strawn 1974
Menidia beryllina (tidewater silverside)	All	34			Galveston Bay, Tex.	Gallaway and Strawn 1974
M. menidia (Atlantic silverside)		32			Lab	Meldrim 1970
Micropogon undulatus (Atlantic croaker)	All	38			Galveston Bay, Tex.	Gallaway and Strawn 1974
Micropterus dolomieui (smallmouth bass)			21.3		Nebish L., Wis.	Hile and Juday 1941
			21.4		S. Ontario streams	Ferguson 1958
	Small		28.0		Lab	Ferguson 1958
	YOY (W)		18.0		Lab	Barans and Tubb 1976
	YOY (Sp)		19–24		Lab	Barans and Tubb 1973

TABLE 1 (*Continued*)

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
	YOY (Su)		31		Lab	Barans and Tubb 1973
	YOY (F)		24–27		Lab	Barans and Tubb 1973
	YOY (F)		26.6		Lab	Reutter and Herdendorf 1974
	YOY	35	31.1	25	Lab	Reynolds and Casterlin 1976[a]
	Adult (W)		12–13		Lab	Barans and Tubb 1973
	Adult (Sp)		15–16		Lab	Barans and Tubb 1973
	Adult (Su)		30.0		Lab	Barans and Tubb 1973
	Adult (F)		21–23		Lab	Barans and Tubb 1973
		33	31.3	26	Lab	Cherry et al. 1975
M. punctulatus (spotted bass)	Large		24.4		Norris Res., Tenn.	Dendy 1948
	Large	27		22	Wabash R., Ind.	Gammon 1973
		34	32.5	27	Lab	Cherry et al. 1975
M. salmoides (largemouth bass)	Large		26.6–27.7		Norris Res., Tenn.	Dendy 1948
	Large	30	27–30		Par Pond, S.C.	Clugston 1973
	72–99 mm		29.3–30.9		L. Monona, Wis.	Neill 1971
	100–408 mm		29.3–32[a]		L. Monona, Wis.	Neill 1971
	100–408 mm		26.5–29.1[b]		L. Monona, Wis.	Neill 1971
	Adult	29	27	25.5	Small Tenn. Lakes	Coutant 1975
	Small		30–32		Lab	Ferguson 1958
	Small	30.7	29	27.5	Lab	Neill 1971
	Adult	30			Pond C., Savannah R. Plant, S.C.	Siler and Clugston 1975
	110–160 mm YOY		30.1		Lab	Reynolds et al. 1976[a]
	110–150 mm YOY	34	30	21	Lab	Reynolds and Casterlin 1976[a]
	50–460 g		30.2		Lab	Reynolds et al. 1976[b]
Moapa coriacea (Moapa dace)			29.5		White R., Nev.	Deacon and Bradley 1971
Morone americana (white perch)	Small	35	32		Lab	Meldrim and Gift 1971
M. chrysops (white bass)	Large	29			Wabash R., Ind.	Gammon 1973
	YOY (W)		10–13		Lab	Barans and Tubb 1973
	YOY (Sp)		16–18		Lab	Barans and Tubb 1973
	YOY (Su)		31.0		Lab	Barans and Tubb 1973
	YOY (F)		28.0		Lab	Barans and Tubb 1973
	YOY (Su)		27.8		Lab	Reutter and Herdendorf 1975
	Adult (W)		12–17		Lab	Barans and Tubb 1973
	Adult (Sp)		12–17		Lab	Barans and Tubb 1973
	Adult (Su)		28–30		Lab	Barans and Tubb 1973
	Adult (F)		16–17		Lab	Barans and Tubb 1973
M. mississippiensis (yellow bass)	Large		27.5–29.8[a]		L. Monona, Wis.	Neill 1971
	Large		27–28.7[b]		L. Monona, Wis.	Neill 1971
M. saxatilis	Small	34.4			Lab	Meldrim 1970, Meldrim and Gift 1971
(striped bass)	3 yr old	24	22	21	Small Tenn. Lakes	Coutant and Carroll unpublished data
Moxostoma sp. (redhorse species)	Large	26		22	Wabash R., Ind.	Gammon 1973
Myoxocephalus quadricornis (fourhorn sculpin)	Large	4.5		4	L. Michigan	Wells 1968
		10			Field	Westin 1970
Nocomis leptocephalus (bluehead chub)	Adult	17	15.0	10	Lab	Cherry et al. 1975
Notemigonus crysoleucas (golden shiner)	Adult (W)		16.8		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		23.7		Lab	Reutter and Herdendorf 1974
	Adult (Su)		22.3		Lab	Reutter and Herdendorf 1974
	Adult (F)		21.0		Lab	Reutter and Herdendorf 1974
Notropis atherinoides (emerald shiner)	YOY (W)		10–12		Lab	Barans and Tubb 1973
	YOY (Sp)		13–15		Lab	Barans and Tubb 1973
	YOY (S)		22–23		Lab	Barans and Tubb 1973
	YOY (F)		13–14		Lab	Barans and Tubb 1973
	Adult (W)		5–6		Lab	Barans and Tubb 1973
	Adult (Sp)		16.0		Lab	Barans and Tubb 1973
	Adult (S)		22–24		Lab	Barans and Tubb 1973
	Adult (F)		15–16		Lab	Barans and Tubb 1973
	Adult (W)		9.3		Lab	Reutter and Herdendorf 1974
N. hudsonius (spottail shiner)	Large	>22		13	L. Michigan	Wells 1968
	Adult (W)		10.2		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		14.3		Lab	Reutter and Herdendorf 1974
N. rubellus (rosyface shiner)	Adult	31	26.8	21	Lab	Cherry et al. 1975
N. spilopterus (spotfin shiner)	Adult	35	29.5	26	Lab	Cherry et al. 1975
Notorus flavus (stonecat)	Adult (W)		5.5		Lab	Reutter and Herdendorf 1974
	Adult (F)		25.1		Lab	Reutter and Herdendorf 1974

TABLE 1 (*Continued*)

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
Oncorhynchus gorbuscha (pink salmon)	Small		11.7		Lab	Brett 1952
	Newly emerged		11.7–12.8		Lab	Hurley and Woodall 1968
	50 days		9.3		Lab	Hurley and Woodall 1968
O. keta (chum salmon)	Small		14.1		Lab	Brett 1952
O. kisutch (coho salmon)	Adult (Sp)		11.4		Lab	Reutter and Herdendorf 1974
	Adult		16.6		L. Michigan	Spigarelli 1975
O. nerka (sockeye salmon)					Cultus L., B.C.	Foerster 1937
			10.6–12.8		Horsetooth Res., Colo.	Horak and Tanner 1964
		21			Okanagan R., Wash.	Hajor and Mighel 1966
	Small		14.5		Lab	Brett 1952
O. tshawytscha (chinook salmon)	Small		11.7		Lab	Brett 1952
	Adult		17.3		L. Michigan	Spigarelli 1975
Osmerus mordax (rainbow smelt)			6.6–8.3		Cayuga L., N.Y.	Galligan 1951
		14		6	L. Michigan	Wells 1968
			12.8		L. Champlain, N.Y.	Greene 1930
Perca flavescens (yellow perch)	Small		12.2		Muskellunge L., Wis.	Hile and Juday 1941
	Large		20.2		Muskellunge L., Wis.	Hile and Juday 1941
			20.2		Silver L., Wis.	Hile and Juday 1941
			21.0		Nebish L., Wis.	Hile and Juday 1941
			20.8		Trout L., Wis.	Hile and Juday 1941
			19.7		L. Nipising, Ont.	Ferguson 1958
			21.2		L. Opeongo, Ont.	Ferguson 1958
			21.0		Costello L., Ont.	Ferguson 1958
				11	L. Michigan	Wells 1968
	Small		21.0		Lab	Ferguson 1958
	Small		24.2		Lab	Ferguson 1958
	Small	26.5	23.3	20.2	Lab[a]	Neill 1971
	Small	25	22.5	19.5	Lab[b]	Neill 1971
	Small		23.3		Lab	McCauley and Read 1973
	Adults		20.1		Lab	McCauley and Read 1973
	YOY (W)		10–13		Lab	Barans and Tubb 1973
	YOY (Sp)		18.0		Lab	Barans and Tubb 1973
	YOY (S)		25–27		Lab	Barans and Tubb 1973
	YOY (F)		28.0		Lab	Barans and Tubb 1973
	Adult (W)		7–12		Lab	Barans and Tubb 1973
	Adult (Sp)		13–16		Lab	Barans and Tubb 1973
	Adult (S)		27.0		Lab	Barans and Tubb 1973
	Adult (F)		22–25		Lab	Barans and Tubb 1973
	Adult (W)		14.1		Lab	Reutter and Herdendorf 1974
	Adult (S)		20.9		Lab	Reutter and Herdendorf 1974
	Adult (F)		19.9		Lab	Reutter and Herdendorf 1974
P. fluviatilis (Eurasian perch)		28.5			Polish lakes	Horoszewicz 1973
Percopsis omiscomaycus (trout-perch)	Adult	16		10	L. Michigan	Wells 1968
Pimephales promelas (fathead minnow)			28.5		Lab	Opuszynski 1971
	Adult	32	29	25	Lab	Cherry et al. 1975
	< 74 mm	28	23.4		Lab	Jones and Irwin 1965
P. notatus (bluntnose minnow)	Adult	31	29	21	Lab	Cherry et al. 1975
Pleuronectes platessa (plaice)	15–23 cm		16–17		Lab	Zahn 1963
Poecilia reticulata (guppy)	Adult male		28.2		Lab	Ruff and Zippel 1966
	Adult female		27.6		Lab	Ruff and Zippel 1966
	Adult		29		Lab	Ogilvie and Fryer 1971
Polydactylus octonemus (Atlantic threadfin)		33.5			Galveston Bay, Tex.	Gallaway and Strawn 1974
Pomoxis annularis (white crapple)	Large	27		22	Wabash R., Ind.	Gammon 1973
	Adult (W)		19.8		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		18.3		Lab	Reutter and Herdendorf 1974
	Adult (F)		10.4		Lab	Reutter and Herdendorf 1974
P. nigromaculatus (black crapple)	Large		27.8–29.8[a]		L. Monona, Wis.	Neill 1971
	Large		27–28.2[b]		L. Monona, Wis.	Neill 1971
	Small	30		26.5	Lab[a]	Neill 1971
	Small	29.5		25.5	Lab[b]	Neill 1971
	Adult (W)		20.5		Lab	Reutter and Herdendorf 1974
	Adult (Sp)		21.0		Lab	Reutter and Herdendorf 1974
	Adult (Su)		21.7		Lab	Reutter and Herdendorf 1974
	Adult (F)		22.2		Lab	Reutter and Herdendorf 1974
	Medium	26	24	20	Lab	Reynolds unpublished data
Prosopium cylindraceum (round whitefish)			17.5		Moosehead L.	Cooper and Fuller 1945

TABLE 1 (*Concluded*)

Species	Size or age	Temp (°C) Upper avoidance	Final preferendum	Lower avoidance	Location	Reference
Pylodictus olivaris (flathead catfish)	Large	32		27	Wabash R., Ind.	Gammon 1973
Rhodeus sericeus (bitterling)	Adult		25		Lab	Zahn 1963
Rutilus rutilus (roach)			27		River Trent. UK	Alabaster and Downing 1966
					Lab	Alabaster and Downing 1966
	5–20 cm	25			Polish lakes	Horoszewicz 1973
		28.5				
Salmo gairdneri (rainbow trout)	Adult		18.9–21.1		Horsetooth Res., Colo.	Horak and Tanner 1964
	Red fingerlings		22		Lab	Javaid and Anderson 1967[a,b]
	Starved fingerlings		18		Lab	Javaid and Anderson 1967[a,b]
	Fingerlings	22–22	18–19	14	Lab	McCauley and Pond 1971
	Adult		13		Lab	Garside and Tait 1958
	Adult		16.5		L. Michigan	Spigarelli 1975
		19	18	13	Lab	Cherry et al. 1975
S. irideus (European rainbow trout)	Alevins	22	16–17	9	Lab	Mantelman 1958
	Fingerlings		14–15		Lab	Mantelman 1958
S. salar (Atlantic salmon)		14			Newfoundland lakes	Leggett and Power 1969
	Young		14		Lab	Fisher and Elson 1950
	Young		16		Lab	Mantelman 1958
	Underyearling		6–8		Lab	Ogilvie and Anderson 1965
	Young, fed		18		Lab	Javaid and Anderson 1967[a,b]
	Young, starved		20		Lab	Javaid and Anderson 1967[a,b]
S. salar sebago (landlocked Atl. salmon)			16.2		Moosehead L., Me.	Cooper and Fuller 1945
S. trutta (brown trout)			12		L. Oredon, France	James 1931
		20			Lab	Alabaster and Downing 1966
	Young		17.6		Lab	Ferguson 1958
	Adult		13.8		L. Michigan	Spigarelli 1975
Salvelinus fontinalis (brook trout)			19		Field	Creaser 1930
			20.3		Moosehead L., Me.	Cooper and Fuller 1945
			20.0		Redrock L. ,Ont.	Baldwin 1948
		20			Field studies	Smith and Saunders 1958
	Adult		15.7		S. Ontario streams	Ferguson 1958
	Adult		14.8		L. Michigan	Spigarelli 1975
	Small		16		Lab	Graham 1949
	Small, fall	20	16		Lab	Sullivan and Fisher 1953, 1954
	Small, winter		8–12		Lab	Sullivan and Fisher 1953, 1954
	Small, fed		18		Lab	Javaid and Anderson 1967[a,b]
		20	18	14	Lab	Cherry et al. 1975
	Small, starved		16		Lab	Javaid and Anderson 1967[a,b]
	Young		16		Lab	Peterson 1973
S. namaycush (lake trout)			14		White L., Ont.	Kennedy 1941
		13			Moosehead L., Me.	Cooper and Fuller 1945
		11			Lac La Ronge, NWT	Rawson 1956
			10		Louisa and Redrock L., Ont.	Martin 1952
			15.5		Cayuga L., N.Y.	Galligan 1951 (in Ferguson 1958)
	Young	15	11.7		Lab	McCauley and Tait 1970
	Young	14	11.5		Lab	Goddard et al. 1974
	Adult		11.8		L. Michigan	Spigarelli 1975
S. fontinalis × *S. namaycush* (splake)	Young		13.1		Jack and Sproule L., Ont.	Ferguson 1958
			12.0		Lab	Ferguson 1958
Scardinius erythrophthalmus (rudd)		28.5			Polish lakes	Horoszewicz 1973
Scorpaena scorfa (scorpionfish)		26	20	8	Lab	Cabanac and Jeddi 1971
Stizostedion canadense (sauger)	Large		19.2		Norris Res., Tenn.	Dendy 1948
	Large	28		22	Wabash R., Ind.	Gammon 1973
S. v. vitreum (walleye)	Large		20.6		Trout Lake, Wis.	Hile and Juday 1941
	Large		23.2		Norris Res.. Tenn.	Dendy 1948
Thymallus thymallus (grayling)		18			Lab	Alabaster and Downing 1966
Tilapia mossambica (Mozambique mouthbrooder)		33.5	28.5		Lab	Badenhuizen 1967
T. nilotica			28–29.5		Lab	Beamish 1970
Tinca tinca (tench)		26			Lab	Alabaster and Downing 1956

[a]Day; [b]Night; [c]May be other genera as well. See Reynolds et al. 1977a.