

## **TABLES**

This page was intentionally left blank.

Table 1.–Inventory of minor tributary streams to the Thunder Bay River mainstem valley segments. Tributaries are indented to show the stream they flow into. Intermittent streams, unnamed streams, and streams less than one section (1 mi sq) in length were excluded from this inventory. Segment 5, Ninth Street Dam to mouth at Lake Huron is excluded because there are no tributaries to this reach.

Segment	Stream–tributary
Headwaters to Hillman Dam	Sheridan Creek
	Stanniger Creek
	Barger Creek
	Haymeadow Creek
	Smith Creek
	Crooked Creek
	Chadwick Creek
	Hunt Creek
	Fuller Creek
	Sage Creek
	Gilchrist Creek
	Boiling Springs Creek
	Greasey Creek
	Johnson Creek
	Nugent Creek
	Lockwood Lake Creek
	Edwards Creek
	Miller Creek
	Sucker Creek
	Hillman Dam to Confluence Upper South Branch
Little Brush Creek	
Anchor Creek	
Jewett Creek	
Upper South Branch confluence to Four Mile Dam	Upper South Branch Thunder Bay River
	Truax Creek
	Connon Creek
	Unnamed Creek
	Gaffney Creek
	Bean Creek
	Spratt Creek
	Morrison Creek
	Kingsbury Creek
	North Branch Thunder Bay River
Lower South Branch Thunder Bay River	
Fall Creek	
Four Mile Dam to Ninth Street Dam	Fletcher Creek

## Thunder Bay River Assessment

Table 2.—Inventory of major tributaries to the mainstem Thunder Bay River. Intermittent streams, unnamed streams, and streams that did not traverse at least one, 1-mile square USGS section were excluded from this inventory. Tributaries were indented to show the stream they flow into. Montmorency–Alpena County line to Quinn Creek and Fletcher Pond Dam to mainstem segments are excluded because there are no tributaries in these reaches.

Segment	Stream–tributary
Upper South Branch Thunder Bay River Headwaters to Fletcher Pond Dam	Marsh Creek Pike Creek Bullock Creek Cole Creek Webber Creek Turtle Creek
North Branch Thunder Bay River Headwaters to Montmorency–Alpena County Line	Long Lake Creek Grass Creek Unnamed Creeks
North Branch Thunder Bay River Quinn Creek to mainstem	Quinn Creek Unnamed Creek Erskine Creek
Lower South Branch Thunder Bay River Headwaters to Hubbard Lake Dam	West Branch River Comstock Creek Cold Creek Buff Creek Little North Creek Cabbage Creek Sucker Creek Pettis Creek Fish Creek Vincent Creek Stevens Creek Holcomb Creek North Branch Holcomb Creek
Lower South Branch Thunder Bay River Hubbard Lake dam to Wolf Creek	Poscoba Creek Bowden Creek Watson Creek Big Ravine Creek Scott Creek Simmons Creek High Banks Creek

Table 2.–Continued.

Segment	Stream–tributary
Lower South Branch Thunder Bay River Wolf Creek confluence to mainstem	Butterfield Creek King Creek Wolf Creek Robinson Creek
Wolf Creek–Headwaters to Lower South Branch	Evans Creek Beaver Creek Indian Creek Richmond Creek Pete Ryan Creek Rayburn Creek McGinn Creek Robb’s Creek Bruster Creek Putcomber Creek Little Wolf Creek Yoder Creek Mohr Creek Bear Creek Wildcat Creek Unnamed Creek Unnamed Creek Silver Creek Silver Brook Widner Creek Butterfield Creek Schmidt Creek Watson Creek

Thunder Bay River Assessment

Table 3.—Inventory of lakes 10 acres or more in the Thunder Bay River (TBR) watershed. Lakes are organized by river valley segment.

Segment	Lake	County	Latitude	Longitude	Acreage
TBR—Headwaters to Hillman Dam					
	Atlanta Pond	Montmorency	45.00048	84.15439	107
	Avery Lake	Montmorency	44.93611	84.19084	332
	Bass Lake, North	Montmorency	44.95418	84.22963	27
	Bass Lake, South	Montmorency	44.94918	84.23077	15
	Churchill Lake	Oscoda	44.81528	84.07639	14
	Crooked Lake	Montmorency	44.98023	84.14721	108
	Fifteen, Lake	Montmorency	44.98806	84.17751	90
	Fish Lake, East	Montmorency	44.86139	84.17306	17
	Fish Lake, West	Montmorency	44.85639	84.18667	11
	Fuller Lake	Montmorency	44.86556	84.17723	18
	Gaylanta Lake	Montmorency	44.97926	84.30251	161
	Harder Lake	Oscoda	44.83998	84.14573	19
	Hillman Pond	Montmorency	45.05222	83.96806	70
	Lockwood Lake	Montmorency	44.91389	84.00056	119
	McCormick Lake	Montmorency	44.95861	84.24864	107
	No Name	Montmorency	44.94556	84.01546	112
	No Name	Oscoda	44.81820	84.08456	21
	Rhoads Lake	Oscoda	44.82222	84.07223	39
	Sage Lakes	Montmorency	44.89262	84.14839	29
	Sportsmen Lake	Montmorency	45.04842	84.11887	37
	Sucker Lake	Montmorency	45.05222	83.96806	13
	Twin Lake	Montmorency	45.01139	84.13223	56
	Voyer Lake	Montmorency	45.03389	84.11417	31
TBR—Hillman Dam to Confluence Upper South Branch					
	Anchor Lake	Montmorency	45.12000	83.94639	18
	Avalon Lake	Montmorency	45.10389	83.95612	372
	Beaver Lake	Montmorency	45.10247	83.97299	31
	Brush Lake, Little	Montmorency	45.09667	84.07389	79
	Coopers Pond	Montmorency	45.09417	83.97223	12
	Dollar Lake	Montmorency	45.11444	83.96084	11
	Horseshoe Lake	Montmorency	45.11917	83.96167	42
TBR—Upper South Branch confluence to Four Mile Dam					
	Blue Lake	Alpena	45.11278	83.64334	10
	Four Mile Imp.	Alpena	45.09650	83.50730	98
	Lake Winyah	Alpena	45.10244	83.52038	1530
TBR—Four Mile Dam to Ninth Street Dam					
	Lake Besser	Alpena	45.07270	83.45630	392

Table 3.–Continued.

Segment	Lake	County	Latitude	Longitude	Acreage
Upper South Branch TBR–Headwaters to Fletcher Pond Dam					
	Bass Lake	Oscoda	44.82667	84.00112	52
	Black Lake	Oscoda	44.77222	83.99028	14
	Lake David	Oscoda	44.73778	83.92056	89
	Doller Lake	Oscoda	44.80944	83.99834	14
	Durkee Lake	Oscoda	44.76944	83.96945	38
	Fletcher Pond	Alpena	44.98278	83.84278	8970
	Indian Lake	Oscoda	44.76750	83.97862	57
	Island Lake	Oscoda	44.77778	83.98473	30
	Island Lake	Oscoda	44.72972	83.90945	80
	Island Lake	Oscoda	44.83028	83.99001	56
	Lost Lake, West	Oscoda	44.83893	83.94481	14
	No Name	Oscoda	44.77910	84.00900	31
	No Name	Oscoda	44.72841	83.90243	12
	No Name	Oscoda	44.73252	83.90337	11
	No Name	Oscoda	44.72957	83.89441	11
	Perch Lake	Oscoda	44.80028	83.97917	32
	Pike Lake #1	Oscoda	44.81397	83.98350	20
	Pike Lake #2	Oscoda	44.81000	83.98195	17
	Rienstein Lake	Oscoda	44.81139	83.89362	19
	Saddleback Lake NE	Oscoda	44.82083	83.99917	14
	Saddleback Lake SW	Oscoda	44.81854	84.00438	21
	Shamrock Lake	Oscoda	44.74306	83.93056	250
	Shear Lake	Oscoda	44.73750	83.94389	26
	Spring Lake	Oscoda	44.76889	83.98695	15
	Tote Road Lake	Oscoda	44.81000	84.00417	37
	Turtle Lake	Montmorency	44.89889	83.89251	830
	Ward Lake, Big	Oscoda	44.78167	83.96445	20
North Branch TBR–Headwaters to Montmorency/Alpena County line					
	Bedore Lake	Montmorency	45.13667	83.96973	38
	Cranberry Lake	Montmorency	45.14722	84.03501	28
	Ess Lake	Montmorency	45.11250	83.98334	114
	Grass Lake	Montmorency	45.12694	84.02501	413
	Long Lake	Montmorency	45.12778	83.97306	295
	No Name	Montmorency	45.15060	84.06132	14
	Rush Lake	Montmorency	45.11972	84.09639	384
North Branch TBR–Quinn Creek to mainstem					
	Duck Lake	Presque Isle	45.21500	83.63889	60
	No Name	Presque Isle	45.21173	83.73535	20
	Sunken Lake	Presque Isle	45.21194	83.71862	71

Table 3.–Continued.

Segment	Lake	County	Latitude	Longitude	Acreage
Lower South Branch TBR– Headwaters to Hubbard Lake Dam					
	Badger Lake	Alcona	44.77722	83.43778	89
	Bear Lake	Alcona	44.78806	83.49112	16
	Bucks Pond	Alcona	44.69794	83.69520	33
	Deer Lake	Alcona	44.78028	83.48223	50
	Hubbard Lake	Alcona	44.80417	83.55945	8850
	Lost Lake	Alcona	44.79639	83.45945	18
	No Name	Alcona	44.69079	83.58276	66
	No Name	Alcona	44.78683	83.44638	60
Lower South Branch TBR–Wolf Creek confluence to mainstem					
	Zim Lake	Alpena	45.06917	83.54084	12
Wolf Creek–Headwaters to Lower South Branch					
	Beaver Lake	Alpena	44.93778	83.79889	665
	Crooked Lake	Alcona	44.73556	83.86945	90
	McCollum Lake	Oscoda	44.77250	83.88945	224
	Meyer Lake	Alcona	44.72981	83.87630	29
	No Name	Alpena	44.94736	83.73618	17
	No Name	Oscoda	44.73339	83.89438	16
	Sand Lake	Alcona	44.73667	83.88195	48
	Silver Wolf Ranch Lake	Alcona	44.79891	83.76236	85



Table 4.—Archaeological sites within the Thunder Bay River drainage (B. Mead, Michigan Department of State, Archaeological Section, personal communication).

County Township(s)	Township coordinates	Prehistoric sites	Historic sites
Alcona			
Caledonia	T28N, R6E	2	
Caledonia	T28N, R7E	32	2
Alcona–Caledonia	T28N, R8E	15	3
Mitchell	T27N, R5E	3	
Hawes	T27N, R7E	11	
Mitchell	T27N, R9E		1
Alpena			
Maple Ridge	T32N, R7E	1	
Green, Wilson, Long Rapids	T31N, R6E	1	
Maple Ridge	T31N, R7E	3	1
Alpena	T31N, R8E	27	7
Wilson	T30N, R7E	5	
Alpena	T30N, R8E	2	
Montmorency			
Montmorency	T32N, R3E	3	
Montmorency	T32N, R4E		1
Briley	T31N, R2E		1
Hillman	T31N, R4E		1
Vienna	T30N, R1E		2
Briley	T30N, R2E	1	4
Avery	T30N, R3E		1
Rust	T30N, R4E		1
Albert	T29N, R2E	5	3
Loud	T29N, R3E		1
Rust	T29N, R4E	2	
Oscoda			
Comins	T27N, R4E	1	
Mentor	T26N, R4E		1
Presque Isle			
Bismarck	T33N, R4E		1
Posen	T33N, R6E	3	

Table 5.—Monthly mean, maximum, and minimum flows in cubic feet per second (ft<sup>3</sup>/s) (Blumer et al. 2005).

Station number (drainage area mi <sup>2</sup> ) and location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
04132500 (232)												
Mainstem Thunder Bay River near Hillman (M-32) 1945–73												
Mean	187	208	206	186	181	240	382	264	212	177	163	173
Maximum	311	296	333	262	242	422	595	422	353	270	292	223
Minimum	136	150	162	149	128	163	214	164	143	126	119	125
04133000 (171)												
Upper South Branch Thunder Bay River near Lachine (M-32) 1945–53												
Mean	97	58	89	95	116	120	35	89	120	151	183	134
Maximum	155	129	215	178	175	217	69	138	184	223	254	275
Minimum	25	15	5	28	42	27	5	4	60	97	112	74
041315001 (588)												
Mainstem Thunder Bay River near Bolton (3.8 miles upstream of confluence with the North Branch Thunder Bay River) 1945–80, 2002-04												
Mean	361	414	437	412	394	624	859	545	443	377	337	329
Maximum	620	651	754	892	709	1408	1632	1099	954	765	594	542
Minimum	242	202	198	256	225	305	360	254	189	202	193	152
04134000 (184)												
North Branch Thunder Bay River near Bolton 1945–80												
Mean	58	80	89	69	59	199	475	173	91	48	32	34
Maximum	262	249	256	245	129	599	970	402	336	211	255	136
Minimum	4	6	15	12	15	45	106	45	13	6	2	2
04134500 (146)												
Lower South Branch Thunder Bay River @ Hubbard Lake Outlet (1945–53)												
Mean	84	69	77	106	121	111	73	128	107	120	147	100
Maximum	124	105	140	177	197	199	227	238	181	184	219	164
Minimum	16.4	.38	29.8	26.5	19.8	2.53	.20	.15	31.2	64.9	105	44
04135000 (1,238)												
Mainstem Thunder Bay River near Alpena (1000 feet downstream of Thunder Bay Power Company Four Mile Dam) 1901–08 & 1979–93												
Mean	688	872	849	752	737	1495	2044	1166	802	543	500	546
Maximum	1652	1526	1342	1322	1380	2844	4391	2596	1474	872	1057	1231
Minimum	380	444	441	453	387	733	903	380	398	327	222	184

Table 6.—Mean annual discharge, drainage area in square miles, and exceedence flows at six USGS gauge sites in the Thunder Bay River watershed. All discharge data are expressed as cubic feet per second. Sites are arranged from upstream to downstream within the watershed. Data from United States Geological Survey.

Gauge site (station number)	Period of record	Drainage area	Mean annual discharge	Exceedence flows			Ratio of 10% and 90% exceedence flow
				10%	50%	90%	
Mainstem near Hillman (04132500)	1945–73	232	215	322	184	140	2.3
Upper South Branch near Lachine (04133000)	1945–53	171	108	228	98	12	19.0
Mainstem near Bolton (04133500)	1945–80, 2002–04	586	463	708	380	250	2.8
North Branch near Bolton (04134000)	1945–80	184	118	261	54	12	21.8
Lower South Branch at Hubbard Lake (04134500)	1945–54	146	104	192	95	8	24.0
Mainstem near Alpena (04135000)	1901–08 1979–93	1,238	913	1,640	697	340	4.8

Thunder Bay River Assessment

Table 7.—July and August water temperature (°F) of the Thunder Bay River (TBR) watershed (upstream to downstream direction) (MDNR, Fisheries Division, unpublished data).

Waterbody	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
Sheridan Creek	Scenic Rte. 3	Jul-03	56.9	49.4	53.4	54.5
		Aug-03	58.0	49.4	53.7	
Stanniger Creek	McCormick Lake Rd.	Jul-03	56.9	48.8	52.6	53.8
		Aug-03	58.0	49.4	53.2	
Haymeadow Creek	Reimann Rd.	Jul-03	74.7	58.6	66.9	70.3
		Aug-03	75.0	58.6	67.5	
Smith Creek	M-32	Jul-03	84.4	56.8	68.2	71.8
		Aug-03	81.8	56.8	68.5	
Crooked Creek	Above Crooked Lake	Jul-03	75.8	64.5	70.4	73.1
		Aug-03	73.3	65.3	70.3	
	South Airport Rd.	Jul-03	81.3	63.8	72.8	76.6
		Aug-03	80.6	67.3	73.9	
Fuller Creek	Tributary to Hunt Creek	Jul-00	64.1	54.7	60.2	62.5
Pine Ridge Creek	Tributary to Hunt Creek	Jul-00	56.3	47.4	50.2	51.7
Sage Creek	County Rd. 487	Jul-03	70.4	53.5	61.1	64.5
		Aug-03	69.8	52.4	61.7	
Hunt Creek	Mouth	Jul-99	70.8	55.3	63.0	64.4
	D-Bulkhead	Jul-00	57.9	51.1	53.8	55.7
	Z-Weir	Jul-00	60.9	53.9	56.8	58.7
	2.9 km up from Co Rd 612	Jul-00	65.1	54.5	59.1	60.7
Nugent Creek	Harwood Rd.	Jul-03	67.5	54.7	61.4	63.2
		Aug-03	67.5	55.2	61.1	
Gilchrist Creek	2.3 km up of Co Rd 612	Jul-00	63.5	57.0	60.1	62.4
		Jul-00	64.6	57.6	60.9	63.0
Edwards Creek	County Rd. 487	Jul-03	71.5	52.5	60.6	64.9
		Aug-03	69.7	48.9	61.9	
	M-33	Jul-03	75.6	62.9	68.4	70.8
		Aug-03	74.4	64.0	69.0	
Miller Creek	Power line off Miller Creek Rd.	Jul-00	66.4	58.9	62.3	64.8
Sucker Creek	Funk Rd.	Jul-03	81.9	59.1	68.8	71.7
		Aug-03	80.6	58.0	69.5	

Table 7.–Continued.

Waterbody	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
Mainstem TBR	30 m upstream of					
	Hunt Ck mouth	Jul-99	82.3	61.8	72.7	80.3
	Hall Rd.	Jul-99	80.1	59.8	70.0	78.4
	Ulshaffer Rd.	Jul-99	77.6	60.9	69.8	71.3
	Ford Bridge					
	(Hossler Rd.)	Jul-00	69.7	61.5	65.5	67.0
	Lake 15 Rd.	Jul-00	72.3	69.6	70.8	72.2
	¼ m down from					
	McCormick Lk	Jul-01	80.4	62.9	70.8	80.3
	Below					
	Atlanta Dam	Jul-03	80.2	61.9	70.3	73.7
		Aug-03	78.3	62.8	71.0	
	James Rd.	Jul-03	75.7	61.4	69.5	72.7
		Aug-03	76.4	63.8	70.3	
	M-65	Jul-03	78.7	63.7	71.1	74.5
		Aug-03	79.0	64.3	72.0	
Herron Rd.	Jul-03	79.9	63.4	71.0	74.4	
	Aug-03	78.0	63.4	71.9		
Brush Creek	Bertha Rd.	Jul-00	66.4	59.0	62.3	64.5
	Brush Creek					
	Truck Trail	Jul-03	69.5	50.8	59.0	61.7
		Aug-03	68.3	50.5	60.0	
	Voyer Lake Rd.	Jul-03	73.5	59.2	64.9	67.2
		Aug-03	69.3	56.7	63.8	
	Above Hillman					
	Impoundment	Jul-03	71.2	57.0	63.4	65.7
		Aug-03	70.0	55.1	63.5	
Anchor Creek	County Rd. 451	Jul-03	82.8	58.5	68.9	72.4
		Aug-03	86.4	56.6	69.4	
Weber Creek	Weber Creek Rd.	Jul-03	72.2	60.8	66.9	68.1
		Aug-03	69.5	61.4	66.4	
Upper South Branch TBR	Turtle Lake Rd.	Jul-00	72.5	54.3	62.9	72.2
		Jul-03	84.8	65.1	73.7	77.4
		Aug-03	83.5	65.1	74.7	
Bean Creek	Evens Rd.	Jul-03	75.6	57.4	65.2	68.5
		Aug-03	70.4	54.6	63.9	
		Jul-03	74.9	60.0	68.1	71.0
	M-32	Aug-03	74.0	58.3	68.5	
Quinn Creek	South Roders Rd.	Jul-03	77.0	58.7	67.5	70.1
		Aug-03	74.8	58.7	67.5	

Thunder Bay River Assessment

Table 7.–Continued.

Waterbody	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean	
North Branch TBR	Thunder Bay Hwy	Jul-00	76.6	65.5	70.6	73.4	
		Hubert Rd.	Jul-03	78.1	59.2	69.7	73.2
		Aug-03	78.4	62.4	70.5		
	Traux Rd.	Jul-00	72.6	65.1	68.8	71.2	
		Jul-03	80.3	60.0	69.7	73.0	
		Aug-03	79.4	60.3	70.5		
	M-65	Jul-03	80.0	64.6	71.8	75.0	
		Aug-03	78.7	64.6	72.8		
	Cathro Rd.	Jul-03	77.7	63.1	70.5	73.5	
		Aug-03	77.0	62.5	71.0		
Fish Creek	Miller Rd.	Jul-03	65.2	48.5	56.3	57.6	
		Aug-03	64.9	48.2	56.3		
Pettis Creek	Miller Rd.	Jul-03	80.4	62.3	71.5	75.4	
		Aug-03	79.4	59.2	69.9		
Sucker Creek	Sucker Creek Rd. (Alcona County)	Jul-00	69.3	58.2	62.9	64.4	
Buff Creek	Richardson Rd.	Jul-03	74.2	56.8	65.2	67.5	
		Found dry on 08/19/2003					
Stevens Creek	Mt. Maria Rd.	Jul-03	59.4	50.2	54.4	56.2	
		Aug-03	61.4	51.0	55.5		
Shafer Creek	Hubbard Lake Rd.	Jul-03	70.8	58.9	64.5	66.7	
		Aug-03	69.9	57.8	64.2		
Holcomb Creek	Anderson Rd.	Jul-03	73.4	55.5	63.4	66.5	
		Aug-03	73.1	53.2	64.0		
Simmons Creek	Hubbard Lake Rd.	Jul-03	65.5	50.5	57.1	58.2	
		Aug-03	66.0	50.2	56.9		
Watson Creek	Ratz Rd.	Jul-03	58.1	48.9	53.2	54.9	
		Aug-03	59.2	50.0	54.0		
Big Ravine Creek	Upstream of confluence with Lower South Branch TBR	Jul-03	64.1	53.4	58.7	61.0	
		Aug-03	65.8	52.0	58.9		
Little Wolf Creek	Welch Rd.	Jul-03	66.3	52.2	60.1	61.8	
		Aug-03	65.4	61.3	59.5		
	Hubbard Lake Trail	Jul-03	74.6	55.5	64.2	66.6	
		Aug-03	73.7	55.7	64.0		

Table 7.–Continued.

Waterbody	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
Wildcat Creek	Hubbard Lake Trail	Jul-03	66.4	49.4	57.5	60.0
		Aug-03	65.5	51.4	58.0	
Beaver Creek	Silver Spring Bridge	Jul-00	68.3	59.2	63.5	65.6
		Jul-00	60.4	47.5	53.3	54.6
Indian Creek	Van Wagoner Rd.	Jul-00	60.4	47.5	53.3	54.6
McGinn Creek	M-65	Jul-00	63.8	53.7	58.3	60.3
Silver Creek	M-65	Jul-03	50.4	48.5	49.1	49.5
		Aug-03	49.3	48.5	48.9	
Wolf Creek	Goodrich Rd.	Jul-03	76.5	58.8	68.0	71.7
		Aug-03	77.2	59.1	68.5	
	Krueger Rd.	Jul-03	77.7	58.8	68.6	72.3
		Aug-03	78.4	59.7	68.8	
	Wolf Creek Rd.	Jul-03	79.6	59.4	69.1	73.2
		Aug-03	81.5	59.9	70.1	
Butterfield Creek	Goodrich Rd.	Jul-03	76.3	58.6	66.7	69.6
		Aug-03	69.7	59.1	65.7	
Schmitt Creek	Krueger Rd.	Jul-03	61.7	52.2	57.4	58.4
		Aug-03	61.7	52.2	57.1	
Evans Creek	Heron Rd.	Jul-03	69.2	55.7	63.0	65.0
		Aug-03	71.3	54.6	63.4	
King Creek	Taylor Hawks Rd.	Jul-03	70.5	56.9	63.9	65.3
		Jul-03	67.2	55.5	62.4	
	King Settlement Rd.	Jul-03	72.8	58.5	65.1	68.5
Aug-03	73.1	59.1	66.4			
Lower South Branch TBR	Hubbard Lake Rd.	Jul-00	83.1	59.6	70.6	73.5
Fall Creek	Benson Rd.	Jul-03	69.2	56.0	62.8	65.6

Thunder Bay River Assessment

Table 8.—Gradient of the Thunder Bay River (TBR) and its tributaries by river segment (Michigan Department of Natural Resources, Fisheries Division, unpublished data).

Reach	Gradient class	Miles	% of reach	Total miles
<b>Mainstem TBR</b>				
Headwaters to Hillman Dam	0–2.9 ft/mi	16.0	45.0	
	3.0–4.9 ft/mi	2.6	7.3	
	5.0–9.9 ft/mi	0.7	2.1	
	10.0–69.9 ft/mi	13.3	37.4	
	70.0–149.9 ft/mi	2.9	8.2	35.5
Hillman Dam to Upper South Branch TBR confluence	0–2.9 ft/mi	8.3	72.2	
	3.0–4.9 ft/mi	3.2	27.8	11.5
Upper South Branch confluence to Four Mile Dam	0–2.9 ft/mi	14.3	76.9	
	3.0–4.9 ft/mi	4.0	21.3	
	5.0–9.9 ft/mi	0.3	1.8	18.7
Four Mile Dam to Ninth Street Dam	0–2.9 ft/mi	1.8	27.6	
	5.0–9.9 ft/mi	2.7	43.1	
	10.0–69.9 ft/mi	1.9	29.3	6.3
Ninth Street Dam to Lake Huron	0–2.9 ft/mi	1.9	100.0	1.9
<b>Upper South Branch TBR</b>				
Headwaters to Upper South Dam	0–2.9 ft/mi	8.7	30.2	
	5.0–9.9 ft/mi	11.0	38.4	
	10.0–69.9 ft/mi	9.0	31.4	28.7
Upper South Dam to mainstem	0–2.9 ft/mi	3.3	73.4	
	5.0–9.9 ft/mi	1.2	26.6	4.5
<b>North Branch TBR</b>				
Headwaters to Montmorency/Alpena County line	0–2.9 ft/mi	3.5	12.7	
	3.0–4.9 ft/mi	15.5	57.1	
	5.0–9.9 ft/mi	7.5	27.7	
	10.0–69.9 ft/mi	0.7	2.5	27.2
Montmorency/Alpena County line to Quinn Creek	3.0–4.9 ft/mi	15.5	100.0	15.5
Quinn Creek to mainstem	0–2.9 ft/mi	13.2	63.8	
	3.0–4.9 ft/mi	5.1	24.6	
	5.0–9.9 ft/mi	1.5	7.1	
	10.0–69.9 ft/mi	0.9	4.5	20.7



Table 8.–Continued.

Reach	Gradient class	Miles	% of reach	Total miles
<b>Lower South Branch TBR</b>				
Headwaters to Hubbard Lake dam	0 - 2.9 ft/mi	8.2	65.0	12.6
	10.0 - 69.9 ft/mi	4.4	35.0	
Hubbard Lake dam to Wolf Creek confluence	0 - 2.9 ft/mi	6.2	72.4	8.5
	3.0 - 4.9 ft/mi	0.7	8.6	
	5.0 - 9.9 ft/mi	0.8	9.5	
	10.0 - 69.9 ft/mi	0.8	9.6	
Wolf Creek confluence to mainstem	0 - 2.9 ft/mi	10.5	77.1	13.6
	5.0 - 9.9 ft/mi	0.9	6.3	
	10.0 - 69.9 ft/mi	2.3	16.6	
<b>Wolf Creek</b>				
Headwaters Wolf Creek and Little WC to Lower South Branch TBR	0 - 2.9 ft/mi	13.5	42.0	32.2
	3.0 - 4.9 ft/mi	1.6	5.1	
	5.0 - 9.9 ft/mi	6.8	21.2	
	10.0 - 69.9 ft/mi	7.8	24.2	
	70.0 - 149.9 ft/mi	2.5	7.7	

Thunder Bay River Assessment

Table 9.–Gradient of the mainstem Thunder Bay River (Michigan Department of Natural Resources, Fisheries Division, unpublished data).

Gradient class	Length (mi)	% basin
0 - 2.9 ft/mi	42.8	57.8
10.0 - 69.9 ft/mi	15.1	20.5
3.0 - 4.9 ft/mi	9.7	13.1
5.0 - 9.9 ft/mi	3.5	4.7
70.0 - 149.9 ft/mi	2.9	3.9

Table 10.–Gradient of the entire Thunder Bay River watershed (Michigan Department of Natural Resources, Fisheries Division, unpublished data).

Gradient class	Length (mi)	% basin
0 - 2.9 ft/mi (low)	189.1	23.7
3.0 - 4.9 ft/mi (medium)	71.4	8.9
5.0 - 9.9 ft/mi (high)	141.4	17.7
10.0 - 69.9 ft/mi (very high)	303.5	38.0
70.0 - 149.9 ft/mi (chutes and pools)	82.8	10.4
> 150 ft/mi (falls, rapids)	11.1	1.4
Total	799.3	

Table 11.—Analysis of channel morphological data for the Thunder Bay River (TBR) and select tributaries. Stream width was calculated from measurements made by the United States Geological Survey and the Michigan Department of Natural Resources Fisheries Division. Status indicates whether site is outside of expected range; “W” is too wide and “N” is too narrow. Expected mean width, and upper and lower 95% widths were calculated using equations developed by Leopold and Maddock 1953 and Leopold and Wolman 1957:

$$\text{Lower 95\% width} = 10^{(0.662895+(0.471522*\log_{10}(Q)))}$$

$$\text{Mean width} = 10^{(0.741436+(0.498473*\log_{10}(Q)))}$$

$$\text{Upper 95\% width} = 10^{(0.819976+(0.525423*\log_{10}(Q)))}$$

	Date	Actual width	Discharge (ft <sup>3</sup> /s)	Lower bound	Expected mean width	Upper bound	Status
<b>TBR</b>							
at Ford Bridge	07/10/2000	24	23.67	20.5	26.7	34.8	
at Lake 15 Rd	07/10/2000	24	29.23	22.6	29.7	38.9	
above Hunt Cr.	07/03/2001	39.3	71.44	34.4	46.3	62.2	
at M33	07/02/2001	38.6	90.7	38.5	52.1	70.6	
at Hall Rd	07/03/2001	49.5	99.81	40.3	54.7	74.2	
at M32	07/02/2001	49	117.73	43.6	59.4	80.9	
at Ulshafer Rd	07/02/2001	43.7	125.07	44.8	61.2	83.5	N
at James Rd	07/02/2001	47.5	131.55	45.9	62.8	85.8	
at Co Rd 451	07/02/2001	79.3	180.44	53.3	73.5	101.3	
at M-65	06/29/2001	89	208.55	57.1	79.0	109.3	
near Bolton	06/27/2002	96	756	104.8	150.1	215.0	N
near Bolton	08/20/2002	91	232	60.0	83.3	115.6	
<b>N Br TBR</b>							
at Truax Rd	06/29/2001	33.1	5.9	10.6	13.4	16.8	W
at Thunder Bay Hwy	06/29/2001	46	8.01	12.3	15.6	19.7	W
at LaComb Rd	06/29/2001	39.5	10.31	13.8	17.6	22.5	W
<b>Lower S Br TBR</b>							
at Hubbard Lk Rd	07/12/2000	50	53.67	30.1	40.1	53.6	
at Indian Reserve Rd Campground	06/29/2001	97	66.37	33.3	44.6	59.9	W
<b>Upper S Br TBR</b>							
at M-32	07/02/2001	85.9	62.93	32.4	43.5	58.2	W
at Turtle Lake Rd	07/13/2000	39	51.12	29.4	39.2	52.2	
<b>Hunt Creek</b>							
at Co Rd 612	06/22/2001	14.5	24.68	20.9	27.3	35.6	N
at mouth	07/03/2001	25.3	33.24	24.0	31.6	41.6	
<b>Wolf Creek at Wolf Cr Rd</b>							
Quinn Creek at Rogers Rd	07/13/2000	14	0.06	1.2	1.4	1.5	W
Beaver Creek at Silver Sp Rd	07/13/2000	8	6.17	10.9	13.7	17.2	N
Gilchrist Creek at Co Rd 612	06/22/2001	18.7	36.14	25.0	33.0	43.5	N
Greasy Creek at Greasy Cr. Rd	06/20/2001	6.2	2.12	6.6	8.0	9.8	N
Sucker Creek at Sucker Cr Rd	07/11/2000	22.4	11.57	14.6	18.7	23.9	
<b>Miller Creek</b>							
at powerline	07/14/2000	6.7	1.42	5.4	6.6	7.9	
at Adams Trail	07/14/2000	13.7	5.77	10.5	13.2	16.6	
Haymeadow Creek at M-32	07/02/2001	14.9	3.77	8.6	10.7	13.3	W
Brush Creek at Adams Trail	07/14/2000	13.7	5.77	10.5	13.2	16.6	

Table 12.—Dams in the Thunder Bay River watershed, sorted by county. Date is the date of construction; location is provided by township (T.), range (R.), and section (Sec.); “Owner” indicates ownership as private, state, or local government; blanks indicate data are missing; an asterisk (\*) indicates the dam is classified a high or significant hazard (M. Mackay, MDNR, Spatial Information Resource Center).

County	Dam name	River reach	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Montmorency	Atlanta	Thunder Bay River	1920	30N	2E	12	Local	18	94	615
	Atlanta Sportsmen	Smith Creek	1980	31N	3E	30	State	7	10	28
	Avalon Lake	Coopers Pond–Trib.	1976	31N	4E	8	Private	2	372	300
	Avery Lake	Crooked Creek	1970	29N	2E	3	Local	7	322	1140
	Brandimore	N. Br. Thunder Bay River		32N	3E	22	Private	3	14	17
	Brush Ck.	Brush Creek	1930	31N	4E	23	Local	8	6	190
	Cooper’s Pond	Little Brush Creek	1941	31N	4E	8	Private	1	13	10
	Cranberry Lake	N. Br. Thunder Bay R.–Trib.	1955	32N	3E	23	State	4	60	72
	Crooked Lake	Crooked Creek	1949	30N	2E	13	Local	9	66	460
	Decheau Lake	Haymeadow Creek	1949	31N	2E	34	Private	3	36	96
	East Fish Lake	Fuller Creek	1962	29N	2E	34	State	5	16	32
	Fuller Ck. Pond	Fuller Creek	1949	29N	2E	34	State	5	15	30
	Grass Lake	Grass Creek	1937	32N	3E	25	Private	9	382	1495
	Hillman	Thunday Bay River	1895	31N	4E	23	Private	14	100	550
	Hopkinson	Grass Lake Outlet–Trib.		32N	4E	29	Private	4	10	–
	Alidon Lodge	Hunt Creek	1933	29N	3E	17	Private	4	2	–
	Lake Inez	Barger Creek	1974	30N	2E	7	Private	13	30	165
	Little Brush Lake	Brush Creek	1947	31N	3E	9		1	69	28
	Long Lake	Long Lake Outlet	1977	32N	4E	29	Private	1	300	120
	Long Lake Pond	Long Lake Creek	1960	32N	4E	29	Private	5	1	40
	Lower Hiawatha Lake	Brush Creek	1966	31N	3E	10	Private	6	7	17
	Marshall Pond	Hunt Ck.–Trib.	1930	29N	2E	35	Private	8	3	10
	McCormick Lake	Thunder Bay River	1930	30N	2E	30	Private	1	100	40
	Phipps	Hunt Creek	1944	29N	2E	25	Private	6	2	12
	Hunt Creek Lodge	Hunt Creek	1962	29N	2E	25	Private	3	5	6

Table 12.—Continued.

County	Dam name	River reach	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Montmorency—continued										
	Robert Silvensky*	Gilchrist Creek—Trib.	1972	30N	3E	36	Private	15	113	855
	Rush Lake	N. Br. Thunder Bay River	1956	32N	3E	21	Local	8	355	2250
	Sage Lake	Sage Creek	1960	29N	2E	24	State	6	48	96
	Section Z Bulkhead	Hunt Creek	1949	29N	2E	25	State	3.3	0.2	0.6
	Turtle Lake Fish Slats	S. Br. Thunder Bay River		29N	4E	14	Private	4	925	8
	Upper Hiawatha*	Brush Creek	1947	31N	3E	10	Private	6	20	50
Oscoda										
	Nawakwa	Bullock Creek	1940	28N	4E	4	Private	15	23	
	Paulovich	Marsh Creek—Trib.	1967	28N	4E	30	Private	13	2	12
	Reed Ranch	Upper S. Br. Thunder Bay R.	1938	27N	4E	11	Private	14	350	380
	Rhoads	Gilchrist Creek	1900	28N	3E	16	Private	8	22	100
	Woodland	Boiling Springs Creek	1931	28N	3E	16	Private	16	10	90
Alcona										
	B & G Ranch	Widner Creek	1972	28N	6E	12	Private		1	
	Badger Lake	Pettis Creek—Trib.	1960	28N	8E	35	Private	4	60	
	Bear Lake	Hubbard Lake—Trib.	1988	28N	8E	29	Private	4	60	98
	Belwin Lodge	Silver Brook		28N	5E	34	Private		2	
	Bucks Pond	Comstock Creek	1930	27N	6E	27	Private	9	68	300
	Buggs	Yoder Creek		27N	5E	22	Private		1	
	Clear Ck.	Silver Brook		28N	5E	33	Private		1	
	Crow Bar Ranch	Buster Creek	1970	28N	5E	28	Private		2	
	Dage	Little North Creek—Trib.	1932	28N	6E	24	Private	10	1	
	Deep Woods Ranch	Bear Creek		27N	5E	12	Private		1	
	Deer Haven Lodge	Bear Creek	1940	27N	5E	1	Private	2		
	Guaresino	Wildcat Creek—Trib.	1970	28N	6E	34	Private	5	1	1
	Hubbard Lake*	S. Br. Thunder Bay River	1890	28N	7E	4	Private	7	8800	34200

Table 12.–Continued.

County	Dam name	River reach	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Alcona–continued										
	Indian Ck. Club	Indian Creek	1935	28N	5E	3	Private	4	1	
	Little Wolf Ck.	Little Wolf Creek	1948	28N	6E	19	Private	10	80	320
	Lost Lake Woods Club	Pettis Creek–Trib.	1988	28N	8E	27	Private	4	10	18
	Ludwig	Hubbard Lake–Trib.		28N	8E	29	Private		2	
	Manion	Indian Creek	1935	28N	5E	2	Private	4	1	
	McGinn	McGinn Creek	1930	28N	5E	27	Private	5	4	16
	Norman	Little North Creek		28N	7E	31	Private		5	
	Pioneer Club	Cold Creek		27N	6E	13	Private		1	
	Redman Walker Club	Silver Creek	1952	27N	5E	3	Private	5	1	1
	Robbs Ck.	Robbs Creek		28N	5E	13	Private		1	
	Rocky R Ranch 1	Little Wolf Creek	1955	27N	5E	14	Private		1	
	Rocky R Ranch 2	Little Wolf Creek	1955	27N	5E	11	Private		2	
	Smith	Cabbage Creek		27N	7E	7	Private		1	
	Strangway	Little Wolf Creek–Trib.		27N	6E	7	Private		1	
	Three Bears Camo	Wildcat Creek		27N	6E	6	Private		3	
Alpena										
	Beaver Lake	Beaver Creek	1888	29N	5E	11	Private	3	665	900
	Chaput	Butterfield Creek–Trib.		30N	6E	32	Private		15	
	Fletcher Ck.	Fletcher Creek		31N	8E	16	Local		3	
	Four Mile*	Thunder Bay River	1902	31N	8E	7	Private	28	98	1000
	Herron	Bean Creek–Trib.		31N	6E	33	Private		2	
	James Farm Walleye Pond	Thunder Bay R.–Trib.	1984	31N	5E	23	State	8	5	22
	Ninth Street	Thunder Bay R.	1910	31N	8E	22	Private	17	392	2000
	Seven Mile*	Thunder Bay River	1924	31N	7E	12	Private	37	1530	6000
	Upper South	Upper S. Br. Thunder Bay R.	1930	30N	5E	2	Private	19	8970	45000

Table 13.—Mean August 2001 water temperatures (°F) and dissolved oxygen concentrations (mg/L) for various impounded areas of the Thunder Bay River watershed. Upstream readings were taken in lotic environments above the impounded reach, whereas downstream readings were taken directly below the dam. Temperature readings were every hour while dissolved oxygen readings were taken twice daily (Thunder Bay Power Company, unpublished data).

	Upstream August Mean (range)	Downstream August Mean (range)
Hillman Dam		
Temperature	68.0 (60.6-79.7)	71.8 (64.3-81.0)
Dissolved Oxygen	8.3	7.4
Upper South Dam (Fletcher)		
Temperature	66.2 (57.2-80.6)	75.8 (68.3-84.4)
Dissolved Oxygen	—	—
Hubbard Lake Dam		
Temperature	74.3 (63.4-88.5)	74.6 (68.4-82.9)
Dissolved Oxygen	—	—
Seven Mile Dam (Lake Winyah)		
Temperature	73.0 (66.0-83.2)	74.8 (70.2-81.6)
Dissolved Oxygen	7.1	7.9
Four Mile Dam		
Temperature	74.8 (70.2-82.0)	75.2 (71.0-82.2)
Dissolved Oxygen	7.9	7.6
Ninth Street Dam (Lake Besser)		
Temperature	75.3 (70.4-82.2)	74.8 (69.3-83.2)
Dissolved Oxygen	7.6	7.4

## Thunder Bay River Assessment

Table 14.—Estimated Chinook salmon and steelhead young-of-year (age-0) production, and lake sturgeon and walleye adult run size for various segments of the Thunder Bay River (TBR) watershed. Estimates were made assuming dam removal/fish passage and migration into the appropriate river segment. Estimates of salmon and trout were made for portions of each reach having suitable gradient > 4.6 ft/mi (5.0 ft/mi used for this table) based on data from (Newcomb and Coon 1997; Woldt 1998; Rutherford et al. 1997; and MDNR, Fisheries Division, unpublished data). Walleye adult run size was based on gradients > 3 ft/mi (Zorn and Sendek 2001) while adult lake sturgeon run size was based on relationships between river discharge, gradient (> 5 ft/mi), and fish abundance developed by G. Whelan (MDNR, Fisheries Division records) using data from published studies (Carl 1982; Seelbach 1986; Thuemler 1985; Auer 1995; Auer 1996) and unpublished data (R. O’Neal, MDNR, Fisheries Division, unpublished data).

Reach	Miles			YOY		Adult run	
	Total	>3 ft/mi	>5 ft/mi	Chinook <sup>a</sup>	summer steelhead <sup>b</sup>	lake sturgeon <sup>c</sup>	walleye <sup>d</sup>
Seven Mile Dam– Ninth St. Dam	9.3	4.6	4.6	300,246	–	2,300	30,355
Hillman Dam– Seven Mile Dam	30.2	7.4	0.3	15,778	–	75	48,833
Headwaters Mainstem– Hillman Dam	35.5	19.5	16.9	485,350	6,496	–	–
N. Br. TBR– Quinn Ck confluence–Mainstem	20.7	7.5	2.4	62,681	–	600	49,493
Upper South Dam– Mainstem	4.5	1.2	1.2	67,313	–	–	–
Hubbard Lake Dam–Mainstem	22.1	5.5	4.8	230,478	–	–	36,295
Wolf Creek Mainstem	32.2	18.7	17.1	389,336	6,507	–	–

### Assumptions made:

Mean annual flow 500-999 ft<sup>3</sup>/s = 500 lake sturgeon/mi (below Seven Mile Dam)

Mean annual flow < 500 ft<sup>3</sup>/s = 250 lake sturgeon/mi (above Seven Mile Dam)

<sup>a</sup> Chinook salmon YOY production estimates were based on density estimates for the Manistee River below Tippy Dam

<sup>b</sup> Summer steelhead YOY production estimates were based on density estimates (Newcomb and Coon 1997) from four lower Betsie River sites which are relatively near in size, discharge, and temperature to the upper mainstem TBR and Wolf Creek

<sup>c</sup> Lake sturgeon potential run size scaled down from estimates in Zorn and Sendek (2001) where mean annual flow > 1000 ft<sup>3</sup>/s = 1900 lake sturgeon/mi (for the Thunder Bay River: If 500-999 ft<sup>3</sup>/s, then 500 lake sturgeon/mile; If 200-500 ft<sup>3</sup>/s, then 250 lake sturgeon/mile)

<sup>d</sup> Adult walleye potential run size was based on estimates where 6,599 fish/mi could be attained at gradients > 3 ft/mi; data based on adult estimates at other large Michigan rivers



Table 15.—Number of fish collected in turbine passage studies at four hydroelectric facilities on the Thunder Bay River (number in parentheses indicates number of species). Table recreated from Navarro et al. 1996.

Common name	Hillman	Seven Mile	Four Mile	Ninth Street
northern brook lamprey	36	0	0	1
alewife, shad	0	0	0	3
trout spp.	38 (3)	7 (3)	10 (3)	8 (2)
rainbow smelt	0	18	14	69
central mudminnow	11	18	1	324
northern pike	53	89	8	3
minnows	4,595 (10)	915 (6)	140 (5)	3,426 (7)
white sucker	486	82	28	17,757
other suckers	0	0	0	29 (3)
bullheads	129 (3)	15,385 (3)	861 (3)	3,453 (3)
other catfish	0	0	0	29 (3)
burbot	107	10	6	2
banded killifish	2	0	0	35
brook stickleback	635	40	18	5
smallmouth bass	148	53	508	869
largemouth bass	110	55	10	75
rock bass	561	89	317	308
crappies	5 (2)	300	42	19 (2)
bluegill	254	135	144	289
pumpkinseed	96	36	124	245
other sunfish	7 (2)	0	2	1 (1)
walleye	32	138	262	161
yellow perch	56	83	74	23,471
blackside darter	2,125	603	84	68
logperch	16	99	30	95
other darters	179 (4)	7 (3)	0	18 (2)
sculpin	3	0	1	0
Total Species	41	31	29	40
Total Number	9,684	18,162	2,684	50,379

## Thunder Bay River Assessment

Table 16.—National Pollution Discharge Elimination System (NPDES) permits issued in the Thunder Bay River watershed in 2002.

County and permittee	Location
Alpena	
Alpena Wastewater Treatment Plant	Thunder Bay River
LP Corp.—Alpena	Lake Huron (Thunder Bay)
Lafarge Midwest	Lake Huron (Thunder Bay)
Montmorency	
Hillman Power Company	Thunder Bay River
Hillman Wastewater Sewage Lagoons	Brush Creek
Joey's Oil Company—Atlanta	Thunder Bay River

Table 17.—National Pollution Discharge Elimination System (NPDES) industrial storm water permits issued in the Thunder Bay River (TBR) watershed in 2002.

County and permittee	Receiving water
<b>Alpena</b>	
Alpena Wilbert Vault	Unnamed tributary to TBR
Ameri-Shred Industrial Corp.	Thunder Bay River
Bay Manufacturing Corp.	Thunder Bay River
BBi Enterprises, L.P.	Thunder Bay River
W G Benjey, Inc.	Thunder Bay River
Besser Co.	Thunder Bay River
Cheboygan Cement Products, Inc.	Unnamed tributary to TBR
Conveyer Systems, Inc.	Thunder Bay River
J D Philips Corp.	Thunder Bay River
Louisiana Pacific Corp.	Thunder Bay River
Floyd Minton Cedar Post Co.	Unnamed tributary to TBR
Nemroc, Inc.	Unnamed tributary to TBR
Nor-Tech Industrial Corp.	Thunder Bay River
P C I	Thunder Bay River
Panel Processing, Inc.	Thunder Bay River
Quest Industrial Corp.	Thunder Bay River
Ren-Tech Industrial Corp.—Alpena	Thunder Bay River
Ren-Tech Industrial Corp.—Hillman	Upper South Branch Thunder Bay River
Steel Craft Inc.	Thunder Bay River
Thunder Bay Manufacturing	Thunder Bay River
United Parcel Service—Alpena	Thunder Bay River
Via-Tech Corp.—Lachine	Bean Creek
<b>Montmorency</b>	
Gildners Concrete Products, Inc.	Anchor Creek
Wayne Wire Cloth—Hillman	Brush Creek Mill Pond
<b>Presque Isle</b>	
Prells Sawmill Inc.—Hawks	Quinn Creek
Standard Industrial Corp.	Duck Lake

Thunder Bay River Assessment

Table 18a.—Levels of six water chemistry parameters measured at 19 locations in the Thunder Bay River (TBR) watershed in July and August 2000 (Taft 2003). Unless indicated otherwise, sampling was done upstream of the road crossing. The letter “T” to the left of the values denotes the value reported is less than criteria of detection.

Collection site	Parameter (units)					
	Ammonia (mg N/L)	COD (mg/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus–Total (mg P/L)	TOC (mg/L)
North Branch TBR @ Co. Road 628	0.013	30	T 0.003	.59	0.012	11
North Branch TBR @ Hackensville Road	0.024	32	0.028	0.74	0.038	11
North Branch TBR @ M-65	0.039	34	0.029	0.80	0.022	13
North Branch TBR @ Cathro Road	0.029	38	0.020	0.73	0.021	12
TBR @ Ford Bridge	T 0.004	10	0.013	0.19	0.015	2.6
Haymeadow Creek @ M-32–M-33	0.056	18	0.030	0.37	0.031	5.9
Smith Creek downstream of M-32	0.055	32	0.015	0.70	0.040	10
TBR @ Eichorn Bridge	0.013	13	0.017	0.29	0.014	4.2
Sage Creek @ Co. Road 487	T 0.009	12	0.024	0.33	0.019	3.4
Gilchrist Creek @ Co. Road 612	T 0.004	5	0.021	0.16	0.011	2.8
TBR @ M-33	T 0.005	10	T 0.007	0.24	0.013	3.5
TBR @ M-32	T 0.005	14	T 0.008	0.22	0.014	3.2
Anchor Creek @ Hunt Road	0.063	38	0.033	0.88	0.039	14
Upper South Branch TBR @ Hunt Club	T 0.005	7	0.012	0.26	0.014	3.9
Upper South Branch TBR @ M-32	0.020	23	T 0.009	0.58	0.028	8.2
South Branch TBR @ Scott Road	0.011	15	T 0.008	0.30	0.008	5.2
Wolf Creek @ Beaver Lake Road	0.010	12	0.022	0.26	0.017	4.7
South Branch TBR @ Forest Campground	0.012	15	0.011	0.42	0.019	6.8
Fall Creek @ Hilks Road	0.034	52	0.021	0.99	0.021	21

Table 18b.—Levels of 34 water chemistry parameters from three index locations in the Thunder Bay River (TBR) watershed in September 2000 (Taft 2003). Unless indicated otherwise, sampling was done upstream of the road crossing. The letter “K” to the left of the value denotes not detected at concentration shown. A study conducted by the MDEQ laboratory indicates that results coded “HT” are sufficiently reliable for use in water chemistry monitoring. The letter “T” to the left of the values denotes the value reported is less than criteria of detection.

Parameter (Units)	Brush Creek	Mainstem TBR @ Ninth St	Mainstem TBR @ Second St
Alkalinity (mg CaCO <sub>3</sub> /L)	143	151	148
Aluminum (ug/L)	56	62	62
Barium (ug/L)	12	21	20
Calcium (mg/L)	48.8	44.7	44.6
Chloride (mg/L)	5	6	7
COD (mg/L)	9	12	15
Conductivity (umho/cm)	320	339	344
Hardness (mg/L)	167	176	175
Iron (ug/L)	120	110	72
Lead (ug/L)	K 1.0	K 1.0	9.4
Lithium (ug/L)	K 10	K 10	K 10
Magnesium (mg/L)	109	15.4	15.5
Manganese (ug/L)	8.3	16	19
Mercury (ug/L)	K 0.2	K 0.2	K 0.2
Molybdenum (ug/L)	K 25	K 25	K 25
Nickel (ug/L)	3.2	3.8	3.0
Nitrate+Nitrite (mg N/L)	0.039 HT	0.009 HT	0.016 HT
Nitrite (mg/L)	0.003	T 0.001	T 0.001
Nitrogen–Kjeldahl (mg N/L)	0.26 HT	0.39 HT	0.46 HT
Ortho Phosphate (mg P/L)	0.023	0.004	0.006
pH (pH)	8.18	8.15	8.15
Phosphorus–Total (mg P/L)	0.034 HT	0.021 HT	0.23 HT
Potassium (mg/L)	0.60	0.60	0.61
Selenium (ug/L)	K 1.0	K 1.0	K 1.0
Silver (ug/L)	K 0.5	K 0.5	K 0.5
Sodium (mg/L)	4.0	6.0	7.6
Solids–Suspended (mg/L)	7	9	4
Solids–Total Dissolved (mg/L)	210	220	220
Strontium (ug/L)	80	90	100
Sulfate (mg/L)	5	4	5
Thallium (ug/L)	K 2.0	K 2.0	K 2.0
TOC (mg/L)	4.2	5.5	5.8
Vanadium (ug/L)	K 10	K 10	K 10
Zinc (ug/L)	K 10	K 10	K 10

Thunder Bay River Assessment

Table 19.—Mean and range of concentrations; Rule 57 water quality values, or acceptable levels, and exceedance rates for mercury and selected trace metals in the Thunder Bay River at the Bagley St. Bridge, Alpena Township in 2000 and 2001 (adapted from Aiello 2002 and Aiello 2003).

	Mercury (ng/L)	Chromium (ug/L)	Copper (ug/L)	Lead (ug/L)
2000				
Rule 57 Water Quality Value @+	1.300	120.000	15.000	20.000
Mean Concentration +	0.463	0.090	0.367	0.091
Range of Concentrations	0.21–0.63	0.04–0.14	0.26–0.51	0.053–0.11
Exceedance Rate *	0 / 6	0 / 6	0 / 6	0 / 6
2001				
Rule 57 Water Quality Value @+	1.3	120.0	14.0	18.0
Mean Concentration +	0.585	0.058	0.254	0.110
Range of Concentrations	0.34–0.98	0–0.14	0–0.4	0.063–0.146
Exceedance Rate *	0 / 4	0 / 4	0 / 4	0 / 4

@ = With the exception of mercury, Rule 57 values are expressed as dissolved metal.

+ = Calculated value; not rounded to appropriate number of significant figures.

\* = Number of samples exceeding Rule 57 water quality values / number of samples analyzed.

Table 20.—Mercury concentrations in the Thunder Bay River at the Bagley St. Bridge, Alpena Township (site ID No. 040123). (MDEQ, SWQD, unpublished data). The Rule 57 water quality value, or acceptable level, for mercury is 1.3 ng/L or less.

Sample collection date	Mercury (ng/L)
6/24/1998	1.694
7/8/1998	2.113
7/20/1998	1.369
8/3/1998	2.822
8/10/1998	0.516
8/17/1998	0.469
8/31/1998	0.495
9/9/1998	0.496
9/14/1998	0.526
9/23/1998	0.978
9/28/1998	0.736
7/12/2000	0.4
8/2/2000	0.5
8/10/2000	0.63
8/21/2000	0.42
9/19/2000	0.21
11/27/2000	0.62
3/6/2001	0.34
6/20/2001	0.98
8/28/2001	0.38
10/24/2001	0.64

Thunder Bay River Assessment

Table 21.—Contaminated sites in the Thunder Bay River watershed and inner Thunder Bay Harbor by county, as of August 1, 2002 as determined by the Michigan Department of Environmental Quality, Environmental Response Division. Acronyms: BTEX = benzene, toluene, ethylbenzene, xylene; BTX = benzene, toluene, xylene; DCA = dichloroethane; 1,1 DCA = 1,1 dichloroethane; 1,2 DCA = 1,2 dichloroethane; cis-1,2 DCA = cis 1,2 dichloroethane; DCE = dichloroethylene; 1,1 DCE = 1,1 dichloroethylene; DDD = dichlorodiphenyldichloroethane; MEK = methyl ethyl ketone; MTBE = methyl(tert)butylether; PAH = polyaromatic hydrocarbon; PCB = polychlorinated biphenyls; PCE or PERC = perchloroethylene; PNAs = polynuclear aromatic hydrocarbons; TCA = trichloroethane; 1,1,1 TCE = isomer of previous; TCE = trichloroethylene.

County and common site name	Pollutant
<b>Alpena</b>	
Jerry Duby Excavating Glawe Equipment Co. (closed part 201)	Waste Oil
Abitibi-Price Corp. Fivenson Iron and Metal Co. (closed part 201)	BTEX Metals
Cathro Auto Parts	PNAs
Lee's Auto Parts	BTEX PNAs, Heavy Metals
Alpena Oil Company Waters St.	Petroleum Products
Alpena Third Ave.	Metals
Third Avenue Soil Piles	Metals
Tandem Transport	Diesel Fuel, Metals
Reynolds Residence Fuel Spill	Gasoline, Diesel Fuel
National Gypsum	Arsenic, Lead, Heavy Metals
1000 Highland Court	Fluorene, Fluoranthene
Alpena LF City of	Lead, Benzene, Zinc
Kurvan Bait Ship Former	BTX
Lancewicz Dump	Methylene Chloride, 1,2 DCE, 1,4 DCB, Pb, Cd, Ch, Arsenic
Maple Ridge Twp. Disposal	Domestic–Commercial
Phelps Collins ANG Base	TCE Carbon Tet. BTEX, 1,2 Dichlorobenzene, 1,3 Dichlorobenzene
Scheuner Construction Dump	PCE Lead, Phthalates Copper, Chromium Nickel
Homant Oil Company	BTEX
Tuttle Street	Fuel Oil
Alpena Manufacturing	Solvents, Cutting Oils
Alpena Oil Campbell Street	BTX
<b>Montmorency</b>	
Lowell St. Hillman Twp.	BTEX, PCE, TCE
Montmorency Oscoda LF	Lead Toluene Benzene, Methylene Chloride
Res Well Grosinski	BTEX, 1,2 DCA
Wayne Wire Cloth Hillman	PCE As Cd Pb DDT, TCA TCE PNAs, Chrysene
Hillman Farm Service	Lead, PNAs
Homant Oil Hillman Bulk Plant	Gasoline, Diesel Fuel
Essex Building (former)	PCE, Tetrachloroethane
Briley Twp. M33N Gas Contam.	BTX



Table 22.—Designated trout streams in the Thunder Bay River (TBR) watershed. All of the stream, from its source to the downstream limit, including tributaries, are designated trout waters, unless excepted.

Stream or segment name	Downstream limit
Thunder Bay River	Ninth Street Dam to mouth
Wolf Creek and all upstream tributaries	T30N, R7E, S32
Thunder Bay River	T31N, R4E, S33 (except portion between Atlanta Dam and Lake 15)
Brush Creek	T31N, R4E, S23
Unnamed Creek	T31N, R4E, S33
Unnamed Creek	T30N, R4E, S9
Miller Creek	T30N, R4E, S8
Edwards Creek	T30N, R4E, S18
Gilchrist Creek	T30 N, R3E, S24 (except Lockwood Lake Outlet, T29N, R3E, S11)
Unnamed Creek	T30N, R3E, S23
Hunt Creek	T30N, R3E, S34
Smith Creek	T30N, R3E, S7
Haymeadow Creek	T30N, R2E, S12
Barger Creek	T30N, R2E, S29
Upper South Branch TBR	T29N, R4E, S14
Stanniger Creek	T30N, R2E, S30
Sheridan Creek	T30N, R2E, S31
Avery Creek	T29N, R2E, S9
Unnamed Creek (tributary to Avery Lake)	T29N, R2E, S9
Shafer Creek	T28N, R8E, S30
Sucker Creek	T28N, R7E, S36
Vincent Creek	T27N, R8E, S9
Unnamed tributary to Hubbard Lake	T27N, R8E, S16
Pettis Creek	T27N, R8E, S23
Fish Creek	T27N, R8E, S23
West Branch River and all tributaries	T27N, R7E, S3

Thunder Bay River Assessment

Table 23.–Fishes in the Thunder Bay River watershed. Data from Bailey and Smith (1981), FERC (1996), Bailey et al. (2003), and Michigan Department of Natural Resources, Fisheries Division records. Species origin: N=native; C=colonized; and I=introduced. Thunder Bay status: P=recent observation; O=extirpated; U=historic record, or current status unknown.

Common name	Scientific name	Species origin	Thunder Bay River status
Lampreys	Petromyzontidae		
northern brook lamprey	<i>Ichthyomyzon fossor</i>	N	P
silver lamprey	<i>Ichthyomyzon unicuspis</i>	N	U
American brook lamprey	<i>Lampetra appendix</i>	N	U
sea lamprey	<i>Petromyzon marinus</i>	C	P
Sturgeons	Acipenseridae		
lake sturgeon (threatened)	<i>Acipenser fulvescens</i>	N	U
Gars	Lepisosteidae		
longnose gar	<i>Lepisosteus osseus</i>	N	P
Bowfins	Amiidae		
bowfin	<i>Amia calva</i>	N	P
Herrings	Clupeidae		
alewife	<i>Alosa pseudoharengus</i>	C	U
gizzard shad	<i>Dorosoma cepedianum</i>	C	U
Carp and minnows	Cyprinidae		
spotfin shiner	<i>Cyprinella spiloptera</i>	N	P
common carp	<i>Cyprinus carpio</i>	C	P
brassy minnow	<i>Hybognathus hankinsoni</i>	N	U
common shiner	<i>Luxilus cornutus</i>	N	P
northern pearl dace	<i>Margariscus nachtriebi</i>	N	U
hornyhead chub	<i>Nocomis biguttatus</i>	N	P
river chub	<i>Nocomis micropogon</i>	N	P
golden shiner	<i>Notemigonus crysoleucas</i>	N	P
pugnose shiner (special concern)	<i>Notropis anogenus</i>	N	U
emerald shiner	<i>Notropis atherinoides</i>	N	P
blackchin shiner	<i>Notropis heterodon</i>	N	U
blacknose shiner	<i>Notropis heterolepis</i>	N	U
spottail shiner	<i>Notropis hudsonius</i>	N	P
rosyface shiner	<i>Notropis rubellus</i>	N	P
sand shiner	<i>Notropis stramineus</i>	N	P
mimic shiner	<i>Notropis volucellus</i>	N	P
northern redbelly dace	<i>Phoxinus eos</i>	N	P
finescale dace	<i>Phoxinus neogaeus</i>	N	U
bluntnose minnow	<i>Pimephales notatus</i>	N	P
fathead minnow	<i>Pimephales promelas</i>	N	P
longnose dace	<i>Rhinichthys cataractae</i>	N	P
western blacknose dace	<i>Rhinichthys obtusus</i>	N	P
creek chub	<i>Semotilus atromaculatus</i>	N	P
Suckers	Catostomidae		
longnose sucker	<i>Catostomus catostomus</i>	N	P
white sucker	<i>Catostomus commersonii</i>	N	P
silver redhorse	<i>Moxostoma anisurum</i>	N	U
greater redhorse	<i>Moxostoma valenciennesi</i>	N	U

Table 23.–Continued.

Common name	Scientific name	Species origin	Thunder Bay River status
Bullhead catfishes	Ictaluridae		
black bullhead	<i>Ameiurus melas</i>	N	P
yellow bullhead	<i>Ameiurus natalis</i>	N	P
brown bullhead	<i>Ameiurus nebulosus</i>	N	P
channel catfish	<i>Ictalurus punctatus</i>	N	P
tadpole madtom	<i>Noturus gyrinus</i>	N	U
Pikes	Esocidae		
grass pickerel	<i>Esox americanus</i>	N	P
northern pike	<i>Esox lucius</i>	N	P
tiger muskellunge	<i>Esox lucius</i> x <i>E. masquinongy</i>	I	U
muskellunge	<i>Esox masquinongy</i>	N	P
Mudminnows	Umbridae		
central mudminnow	<i>Umbra limi</i>	N	P
Smelts	Osmeridae		
rainbow smelt	<i>Osmerus mordax</i>	C	P
Trouts	Salmonidae		
cisco (threatened)	<i>Coregonus artedi</i>	N	P
lake whitefish	<i>Coregonus clupeaformis</i>	N	P
pink salmon	<i>Oncorhynchus gorbuscha</i>	C	P
coho salmon	<i>Oncorhynchus kisutch</i>	I	P
rainbow trout	<i>Oncorhynchus mykiss</i>	I	P
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	I	P
round whitefish	<i>Prosopium cylindraceum</i>	N	U
Atlantic salmon	<i>Salmo salar</i>	I	U
brown trout	<i>Salmo trutta</i>	I	P
brook trout	<i>Salvelinus fontinalis</i>	N	P
lake trout	<i>Salvelinus namaycush</i>	N	P
splake	<i>Salvelinus fontinalis</i> x <i>S. namaycush</i>	I	P
Arctic grayling (extinct)	<i>Thymallus arcticus</i>	N	O
Cods	Lotidae		
burbot	<i>Lota lota</i>	N	P
Killifishes	Cyprinodontidae		
western banded killifish	<i>Fundulus diaphanus menona</i>	N	U
Sticklebacks	Gasterosteidae		
brook stickleback	<i>Culaea inconstans</i>	N	P
Sculpins	Cottidae		
mottled sculpin	<i>Cottus bairdii</i>	N	P
slimy sculpin	<i>Cottus cognatus</i>	N	P
Sunfishes	Centrarchidae		
rock bass	<i>Ambloplites rupestris</i>	N	P
green sunfish	<i>Lepomis cyanellus</i>	N	P
pumpkinseed	<i>Lepomis gibbosus</i>	N	P
bluegill	<i>Lepomis macrochirus</i>	N	P
northern longear sunfish	<i>Lepomis peltastes</i>	N	U
smallmouth bass	<i>Micropterus dolomieu</i>	N	P

Table 23.–Continued.

Common name	Scientific name	Species origin	Thunder Bay River status
largemouth bass	<i>Micropterus salmoides</i>	N	P
black crappie	<i>Pomoxis nigromaculatus</i>	N	P
Perches	Percidae		
rainbow darter	<i>Etheostoma caeruleum</i>	N	P
Iowa darter	<i>Etheostoma exile</i>	N	P
least darter	<i>Etheostoma microperca</i>	N	P
johnny darter	<i>Etheostoma nigrum</i>	N	P
ruffe	<i>Gymnocephalus cernuus</i>	C	P
yellow perch	<i>Perca flavescens</i>	N	P
northern logperch	<i>Percina caprodes semifasciata</i>	N	P
blackside darter	<i>Percina maculata</i>	N	P
walleye	<i>Sander vitreus</i>	N	P
Drums	Sciaenidae		
freshwater drum	<i>Aplodinotus grunniens</i>	N	P
Gobies	Gobiidae		
round goby	<i>Neogobius melanostomus</i>	C	P

Table 24.—Aquatic invertebrates in the Thunder Bay River and select tributaries (modified from Taft 2003). Data code: X=present, dash (–) indicates not collected.

Taxa	N. Br. Thunder Bay off Co. 628	N. Br. Thunder Bay M-65	N. Br. Thunder Bay Cathro Rd.	Thunder Bay River Ford Bridge	Smith Creek M-32	Thunder Bay River Eichorn Bridge	Sage Creek	Gilchrist Ck Co Rd 612	Thunder Bay River M-33	Thunder Bay River @ M-32	Upper S. Br. Thunder Bay Rv Turtle Lake	Up S. Br. Thunder Bay Rv M-32	S. Br. Thunder Bay Rv Scott Road	Wolf Creek Beaver Lake Road	S. Br. Thunder Bay Rv Forest Campgd
PORIFERA (sponges)	X	X	X	–	–	–	–	–	–	–	–	X	–	–	–
PLATYHELMINTHES (flatworms)															
Turbellaria	–	X	X	X	–	X	–	X	–	–	–	X	X	X	–
BRYOZOA (moss animals)	X	X	X	–	–	X	–	–	–	–	–	X	–	X	–
ANNELIDA (segmented worms)															
Hirudinea (leeches)	–	–	–	X	X	X	–	–	–	–	X	–	X	–	–
Oligochaeta (worms)	X	X	–	X	X	X	X	X	X	X	X	X	X	X	–
ARTHROPODA															
Arachnoidea															
Hydracarina	X	–	–	X	–	X	–	X	–	–	–	X	–	–	–
Crustacea															
Amphipoda (scuds)	–	X	X	–	X	X	X	–	X	–	X	X	X	X	X
Decapoda (crayfish)	X	X	X	X	X	X	–	X	X	X	X	X	X	X	X
Isopoda (sowbugs)	–	–	–	–	–	–	–	–	X	–	–	–	X	–	–
Insecta															
Ephemeroptera (mayflies)															
Baetiscidae	X	–	–	–	–	–	–	X	–	X	–	–	–	–	–
Baetidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caenidae	–	X	–	–	X	X	–	X	–	–	X	–	–	–	X
Ephemerellidae	X	–	–	–	–	–	X	X	X	X	X	–	X	X	–
Ephemeridae	X	–	–	–	–	X	X	–	–	X	X	–	–	X	–
Heptageniidae	X	X	X	X	X	X	X	X	X	X	X	X	–	X	X
Isonychiidae	–	–	X	–	–	X	–	X	–	–	X	–	–	X	–
Tricorythidae	–	–	–	X	–	–	X	–	–	–	X	–	–	–	–

Table 24.–Continued.

Taxa	N. Br. Thunder Bay off Co. 628	N. Br. Thunder Bay M-65	N. Br. Thunder Bay Cathro Rd.	Thunder Bay River Ford Bridge	Smith Creek M-32	Thunder Bay River Eichorn Bridge	Sage Creek	Gilchrist Ck Co Rd 612	Thunder Bay River M-33	Thunder Bay River @ M-32	Upper S. Br. Thunder Bay Rv Turtle Lake	Up S. Br. Thunder Bay Rv M-32	S. Br. Thunder Bay Rv Scott Road	Wolf Creek Beaver Lake Road	S. Br. Thunder Bay Rv Forest Campgd
Odonata															
Anisoptera (dragonflies)															
Aeshnidae	X	X	-	X	X	X	X	-	X	-	X	-	X	X	X
Cordulegastridae	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Gomphidae	X	X	-	X	X	-	-	X	-	X	X	X	-	X	X
Zygoptera (damselflies)															
Calopterygidae	-	X	X	X	X	X	X	X	X	-	X	-	-	X	X
Coenagrionidae	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Lestidae	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Plecoptera (stoneflies)															
Perlidae	X	-	X	-	-	X	-	-	X	X	X	-	X	X	X
Perlodida	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Pteronarcyidae	-	-	-	-	-	-	-	X	-	X	X	-	-	X	-
Hemiptera (true bugs)															
Belostomatidae	-	-	-	-	X	-	-	-	-	-	-	X	X	-	-
Corixidae	-	X	-	X	X	X	-	-	X	X	X	X	X	X	-
Gerridae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mesoveliidae	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Nepidae	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Veliidae	-	X	-	-	X	X	-	-	X	X	-	X	X	X	-
Megaloptera															
Corydalidae (dobson flies)	X	X	X	-	-	X	X	-	-	-	X	X	-	X	-
Sialidae (alder flies)	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Trichoptera (caddisflies)															
Brachycentridae	X	-	-	-	-	X	X	X	X	X	X	-	X	-	-
Glossosomatidae	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-

Table 24.–Continued.

Taxa	N. Br. Thunder Bay off Co. 628	N. Br. Thunder Bay M-65	N. Br. Thunder Bay Cathro Rd.	Thunder Bay River Ford Bridge	Smith Creek M-32	Thunder Bay River Eichorn Bridge	Sage Creek	Gilchrist Ck Co Rd 612	Thunder Bay River M-33	Thunder Bay River @ M-32	Upper S. Br. Thunder Bay Rv Turtle Lake	Up S. Br. Thunder Bay Rv M-32	S. Br. Thunder Bay Rv Scott Road	Wolf Creek Beaver Lake Road	S. Br. Thunder Bay Rv Forest Campgd
Helicopsychidae	X	-	X	-	-	X	-	-	-	-	X	X	X	X	-
Hydropsychidae	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X
Hydroptilidae	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Lepidostomatidae	-	-	-	-	-	X	-	-	X	X	X	-	-	-	-
Leptoceridae	X	X	-	X	-	-	-	-	-	X	X	-	X	-	-
Limnephilidae	X	X	X	X	-	X	X	X	-	X	X	X	X	X	X
Molannidae	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Philopotamidae	-	-	X	-	-	X	X	X	-	-	X	-	-	-	-
Phryganeidae	-	-	-	-	-	-	X	-	-	-	X	-	-	-	X
Polycentropodidae	-	-	-	X	-	-	-	X	X	X	X	-	-	-	X
Psychomyiidae	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Uenoidae	-	-	-	X	-	X	-	-	-	-	-	X	X	X	-
Coleoptera (beetles)															
Dryopidae	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Dytiscidae (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Elmidae	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gyrinidae (larvae)	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Gyrinidae (adults)	-	X	X	-	-	-	-	-	-	-	X	-	-	-	-
Haliplidae (larvae)	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-
Haliplidae (adults)	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X
Hydrophilidae (total)	-	X	-	X	X	-	X	X	X	-	-	X	X	-	-
Psephenidae (larvae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Diptera (flies)															
Athericidae	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidea	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 24.–Continued.

Taxa	N. Br. Thunder Bay off Co. 628	N. Br. Thunder Bay M-65	N. Br. Thunder Bay Cathro Rd.	Thunder Bay River Ford Bridge	Smith Creek M-32	Thunder Bay River Eichorn Bridge	Sage Creek	Gilchrist Ck Co Rd 612	Thunder Bay River M-33	Thunder Bay River @ M-32	Upper S. Br. Thunder Bay Rv Turtle Lake	Up S. Br. Thunder Bay Rv M-32	S. Br. Thunder Bay Rv Scott Road	Wolf Creek Beaver Lake Road	S. Br. Thunder Bay Rv Forest Campgd	
Culicidae	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	
Simuliidae	-	X	-	X	X	X	X	X	X	-	X	X	X	X	X	
Stratiomyidae	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	
Tabanidae	-	-	-	X	-	-	-	X	-	-	X	X	-	X	-	
MOLLUSCA																
Gastropoda (snails)																
Ancylidae (limpets)	X	X	-	X	X	X	-	-	-	X	-	-	-	-	-	X
Bithyniidae	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Hydrobiidae	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Lymnaeidae	-	-	X	-	X	-	-	-	-	-	-	X	X	-	-	-
Physidae	-	X	X	X	X	-	X	-	X	-	X	X	X	X	X	X
Planorbidae	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Plauronceridae	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Viviparidae	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-
Pelecypoda (bivalves)																
Dreissenidae	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
Pisidiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Sphaeriidae (clams)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unionidae (mussels)	X	X	X	-	X	X	-	-	-	-	-	X	X	X	X	X
Total Number of Taxa	25	29	27	29	25	34	25	25	23	24	41	31	34	31	26	
Macroinvertebrate Community Rating <sup>a</sup>	ACC	ACC	ACC	ACC	ACC	EXC	EXC	ACC	ACC	EXC	EXC	ACC	ACC	EXC	ACC	

<sup>a</sup> ACC=acceptable; EXC=excellent.



Table 25.—Natural features in the Thunder Bay River watershed. Status codes: E=endangered; T=threatened; C=candidate; PS=Partial Status, status in only a portion of the range; SC=Special Concern (rare, may become E or T in future). Blanks occur when none of the status categories apply. Michigan Department of Natural Resources, Natural Features Inventory, unpublished data.

Common name	Scientific name	State status	Federal status
Vertebrate			
lake sturgeon	<i>Acipenser fulvescens</i>	T	
Red-shouldered Hawk	<i>Buteo lineatus</i>	T	
wood turtle	<i>Clemmys insculpta</i>	SC	
Kirtland's Warbler	<i>Dendroica kirtlandii</i>	E	E
blanding's turtle	<i>Emydoidea blandingii</i>	SC	
Common Loon	<i>Gavia immer</i>	T	
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	PS
Migrant Loggerhead Shrike	<i>Lanius ludovicianus migrans</i>	E	
pugnose shiner	<i>Notropis anogenus</i>	SC	
Osprey	<i>Pandion haliaetus</i>	T	
eastern massasauga	<i>Sistrurus catenatus catenatus</i>	SC	C
Invertebrate			
secretive locust	<i>Appalachia arcana</i>	SC	
spike-lip crater	<i>Appalachina sayanus</i>	SC	
eastern flat-whorl	<i>Planogyra asteriscus</i>	SC	
grizzled skipper	<i>Pyrgus wyandot</i>	SC	
Vascular Plant			
prairie or pale agoseris	<i>Agoseris glauca</i>	T	
lake cress	<i>Armoracia lacustris</i>	T	
walking fern	<i>Asplenium rhizophyllum</i>	T	
western moonwort	<i>Botrychium hesperium</i>	T	
greenish-white sedge	<i>Carex albolutescens</i>	T	
Frank's sedge	<i>Carex frankii</i>	SC	
hill's thistle	<i>Cirsium hillii</i>	SC	
slender cliff-brake	<i>Cryptogramma stelleri</i>	SC	
ram's head lady's-slipper	<i>Cypripedium arietinum</i>	SC	
male fern	<i>Dryopteris filix-mas</i>	SC	
alleghany or sloe plum	<i>Prunus alleghaniensis var davisii</i>	SC	
satiny willow	<i>Salix pellita</i>	SC	
Plant community			
hardwood-conifer swamp			
southern floodplain forest			
Other features			
Great Blue Heron rookery			
esker			
karst			

Thunder Bay River Assessment

Table 26.—Amphibian and reptile species found in counties of the Thunder Bay River watershed (Harding and Holman 1992, Holman et al. 1989, and Harding and Holman 1990). Threatened (T) and Special Concern (SC) species are noted. P=Presque Isle, M=Montmorency, Alp=Alpena, Alc=Alcona, and O= Oscoda.

Common name	Scientific name	P	M	Alp	Alc	O
<b>Frogs and toads</b>						
eastern American toad	<i>Bufo americanus americanus</i>	X	X	X	X	X
coper's gray tree frog	<i>Hyla chrysoscelis</i>	X	X	X	X	X
eastern gray tree frog	<i>Hyla versicolor</i>	X	X	X	X	X
northern spring peeper	<i>Pseudacris crucifer crucifer</i>	X	X	X	X	X
western chorus frog	<i>Pseudacris triseriata triseriata</i>	X	X	X	X	X
bull frog	<i>Rana catesbeiana</i>	X	X	X	X	X
green frog	<i>Rana clamitans melanota</i>	X	X	X	X	X
pickerel frog	<i>Rana palustris</i>	X	X	X	X	X
northern leopard frog	<i>Rana pipiens</i>	X	X	X	X	X
wood frog	<i>Rana sylvatica</i>	X	X	X	X	X
<b>Salamanders</b>						
blue-spotted salamander	<i>Ambystoma laterale</i>	X	X	X	X	X
spotted salamander	<i>Ambystoma maculatum</i>	X	X	X	X	X
eastern tiger salamander	<i>Ambystoma tigrinum tigrinum</i>		X			X
four-toed salamander	<i>Hemidactylium scutatum</i>	X	X	X	X	X
mudpuppy	<i>Necturus maculosus maculosus</i>	X	X	X	X	X
eastern newt-central subspecies	<i>Notophthalmus viridescens louisianensis</i>	X	X	X	X	X
red-backed salamander	<i>Plethodon cinereus</i>	X	X	X	X	X
<b>Snakes and lizards</b>						
northern ringneck snake	<i>Diadophis punctatus edwardsi</i>	X	X	X	X	X
five-lined skink	<i>Eumeces fasciatus</i>	X	X	X	X	X
eastern hognose snake	<i>Heterodon Platyrrhinos</i>	X	X	X	X	X
eastern milk snake	<i>Lampropeltis tringulum triangulum</i>	X	X	X	X	X
northern water snake	<i>Nerodia sipedon sipedon</i>	X	X	X	X	X
eastern smooth green snake	<i>Opheodrys vernalis vernalis</i>	X	X	X	X	X
eastern massasauga rattlesnake (SC)	<i>Sistrurus catenatus catenatus</i>	X	X	X	X	X
brown snake	<i>Storeria dekayi</i>	X	X	X	X	X
northern red-bellied snake	<i>Storeria occipitomaculate occipitomaculate</i>	X	X	X	X	X
Butler's garter snake	<i>Thamnophis butleri</i>			X	X	X
northern ribbon snake	<i>Thamnophis sauritus septentrionalis</i>	X	X	X	X	X
eastern garter snake	<i>Thamnophis sirtalis sirtalis</i>	X	X	X	X	X
<b>Turtles</b>						
snapping turtle	<i>Chelydra serpentine</i>	X	X	X	X	X
painted turtle	<i>Chrysemys picta</i>	X	X	X	X	X
wood turtle (SC)	<i>Clemmys insculpta</i>	X	X	X	X	X
Blandings turtle (SC)	<i>Emydoidea blandingii</i>	X	X	X	X	X
common musk turtle	<i>Sternotherus odoratus</i>		X			

Table 27.—Breeding bird species associated with wetland habitats—Presque Isle, Montmorency, Alpena, Oscoda, and Alcona Counties, MI (Doepker et al. 2001).

Common name	Scientific name
Cooper's Hawk	<i>Accipiter cooperii</i>
Spotted Sandpiper	<i>Actitis macularia</i>
Northern Saw-whet Owl	<i>Aegolius acadicus</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Wood Duck	<i>Aix sponsa</i>
Henslow's Sparrow	<i>Ammodramus henslowii</i>
Green-winged Teal	<i>Anas crecca</i>
Blue-winged Teal	<i>Anas discors</i>
Mallard	<i>Anas platyrhynchos</i>
American Black Duck	<i>Anas rubripes</i>
Gadwall	<i>Anas strepera</i>
Ruby-throated Hummingbird	<i>Archilochus colubris</i>
Great Blue Heron	<i>Ardea herodias</i>
Long-eared Owl	<i>Asio otus</i>
Ring-necked Duck	<i>Aythya collaris</i>
Tufted Titmouse	<i>Baeolophus bicolor</i>
Upland Sandpiper	<i>Bartramia longicauda</i>
Cedar Waxwing	<i>Bombycilla cedrorum</i>
Ruffed Grouse	<i>Bonasa umbellus</i>
American Bittern	<i>Botaurus lentiginosus</i>
Canada Goose	<i>Branta canadensis</i>
Great Horned Owl	<i>Bubo virginianus</i>
Common Goldeneye	<i>Bucephala clangula</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Green Heron	<i>Butorides virescens</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
Pine Siskin	<i>Carduelis pinus</i>
Purple Finch	<i>Carpodacus purpureus</i>
Greater Egret	<i>Casmerodius albus</i>
Veery	<i>Catharus fuscescens</i>
Swainson's Thrush	<i>Catharus ustulatus</i>
Brown Creeper	<i>Certhia americana</i>
Belted Kingfisher	<i>Ceryle alcyon</i>
Piping Plover	<i>Charadrius melodus</i>
Killdeer	<i>Charadrius vociferus</i>
Black Tern	<i>Chlidonias niger</i>
Common Nighthawk	<i>Chordeiles minor</i>
Northern Harrier	<i>Circus cyaneus</i>
Marsh Wren	<i>Cistothorus palustris</i>
Sedge Wren	<i>Cistothorus platensis</i>
Evening Grosbeak	<i>Coccothraustes vespertinus</i>
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>
Olive-sided Flycatcher	<i>Contopus cooperi</i>
Common Raven	<i>Corvus corax</i>

Table 27.–Continued.

Common name	Scientific name
Yellow-rumped Warbler	<i>Dendroica coronata</i>
Yellow Warbler	<i>Dendroica petechia</i>
Cape May Warbler	<i>Dendroica tigrina</i>
Pileated Woodpecker	<i>Dryocopus pileatus</i>
Gray Catbird	<i>Dumetella carolinensis</i>
Alder Flycatcher	<i>Empidonax alnorum</i>
Willow Flycatcher	<i>Empidonax traillii</i>
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>
Merlin	<i>Falco columbarius</i>
American Coot	<i>Fulica americana</i>
Common Snipe	<i>Gallinago gallinago</i>
Common Moorhen	<i>Gallinula chloropus</i>
Common Loon	<i>Gavia immer</i>
Common Yellowthroats	<i>Geothlypis trichas</i>
Sandhill Crane	<i>Grus Canadensis</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Barn Swallow	<i>Hirundo rustica</i>
Wood Thrush	<i>Hylocichla mustelina</i>
Baltimore Oriole	<i>Icterus galbula</i>
Least Bittern	<i>Ixobrychus exilis</i>
Herring Gull	<i>Larus argentatus</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Red Crossbill	<i>Loxia curvirostra</i>
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>
Swamp Sparrow	<i>Melospiza georgiana</i>
Lincoln's Sparrow	<i>Melospiza lincolni</i>
Song Sparrow	<i>Melospiza melodia</i>
Common Merganser	<i>Mergus merganser</i>
Red-breasted Merganser	<i>Mergus serrator</i>
Black-and-white Warbler	<i>Mniotilta varia</i>
Great Crested Flycatcher	<i>Myiarchus crinitus</i>
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>
Connecticut Warbler	<i>Oporornis agilis</i>
Mourning Warbler	<i>Oporornis philadelphia</i>
Eastern Screech-owl	<i>Otus asio</i>
Osprey	<i>Pandion haliaetus</i>
Northern Parula	<i>Parula americana</i>
Savannah Sparrow	<i>Passerculus sandwichensis</i>
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>
Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>
Black-backed Woodpecker	<i>Picoides arcticus</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Hairy Woodpecker	<i>Picoides villosus</i>
Pied-billed Grebe	<i>Podilymbus podiceps</i>
Black-capped Chickadee	<i>Poecile atricapillus</i>

Table 27.–Continued.

Common name	Scientific name
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>
Sora	<i>Porzana carolina</i>
Purple Martin	<i>Progne subis</i>
Common Grackle	<i>Quiscalus quiscula</i>
Virginia Rail	<i>Rallus limicola</i>
Ruby-crowned Kinglet	<i>Regulus calendula</i>
Golden-crowned Kinglet	<i>Regulus satrapa</i>
Bank Swallow	<i>Riparia riparia</i>
American Woodcock	<i>Scolopax minor</i>
Northern Waterthrush	<i>Seiurus noveboracensis</i>
American Redstart	<i>Setophaga ruticilla</i>
Red-breasted Nuthatch	<i>Sitta canadensis</i>
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>
Caspian Tern	<i>Sterna caspia</i>
Common Tern	<i>Sterna hirundo</i>
Barred Owl	<i>Strix varia</i>
Tree Swallow	<i>Tachycineta bicolor</i>
Carolina Wren	<i>Thryothorus ludovicianus</i>
House Wren	<i>Troglodytes aedon</i>
Winter Wren	<i>Troglodytes troglodytes</i>
American Robin	<i>Turdus migratorius</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Nashville Warbler	<i>Vermivora ruficapilla</i>
Yellow-throated Vireo	<i>Vireo flavifrons</i>
Warbling Vireo	<i>Vireo gilvus</i>
Red-eyed Vireo	<i>Vireo olivaceus</i>
Philadelphia Vireo	<i>Vireo philadelphicus</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>

Table 28.–Mammals in the Thunder Bay River watershed (Kurta 1995). Threatened and special concern species are noted.

Common name	Scientific name
northern short-tailed shrew	<i>Blarina brevicauda</i>
coyote	<i>Canis latrans</i>
American beaver	<i>Castor canadensis</i>
elk	<i>Cervus elaphus</i>
southern red-backed vole	<i>Clethrionomys gapperi</i>
star-nosed mole	<i>Condylura cristata</i>
Virginia opossum	<i>Didelphis virginiana</i>
big brown bat	<i>Eptesicus fuscus</i>
common porcupine	<i>Erethizon dorsatum</i>
northern flying squirrel	<i>Glaucomys sabrinus</i>
southern flying squirrel	<i>Glaucomys volans</i>
silver-haired bat	<i>Lasionycteris noctivagans</i>
red bat	<i>Lasiurus borealis</i>
hoary bat	<i>Lasiurus cinereus</i>
snowshoe hare	<i>Lepus americanus</i>
northern river otter	<i>Lutra canadensis</i>
bobcat	<i>Lynx rufus</i>
woodchuck	<i>Marmota monax</i>
American marten (threatened)	<i>Martes Americana</i>
striped skunk	<i>Mephitis mephitis</i>
meadow vole	<i>Microtus pennsylvanicus</i>
woodland vole (special concern)	<i>Microtus pinetorum</i>
house mouse	<i>Mus musculus</i>
mink	<i>Mustela vison</i>
ermine	<i>Mustela erminea</i>
long-tailed weasel	<i>Mustela frenata</i>
little brown bat	<i>Myotis lucifugus</i>
northern bat	<i>Myotis septentrionalis</i>
woodland jumping mouse	<i>Napaeozapus insignis</i>
white-tailed deer	<i>Odocoileus virginianus</i>
muskrat	<i>Ondatra zibethicus</i>
white-footed mouse	<i>Peromyscus leucopus</i>
deer mouse	<i>Peromyscus maniculatus</i>
common raccoon	<i>Procyon lotor</i>
Norway rat	<i>Rattus norvegicus</i>
eastern mole	<i>Scalopus aquaticus</i>
eastern gray squirrel	<i>Sciurus carolinensis</i>
eastern fox squirrel	<i>Sciurus niger</i>
masked shrew	<i>Sorex cinereus</i>
pygmy shrew	<i>Sorex hoyi</i>
water shrew	<i>Sorex palustris</i>
thirteen-lined ground squirrel	<i>Spermophilus tridecemlineatus</i>
eastern cottontail	<i>Sylvilagus floridanus</i>
southern bog lemming	<i>Synaptomys cooperi</i>
eastern chipmunk	<i>Tamias striatus</i>
red squirrel	<i>Tamiasciurus hudsonicus</i>
American badger	<i>Taxidea taxus</i>
common gray fox	<i>Urocyon cinereoargenteus</i>
black bear	<i>Ursus americanus</i>
red fox	<i>Vulpes vulpes</i>
meadow jumping mouse	<i>Zapus hudsonius</i>

Table 29.—Fish stocking, by county, in the Thunder Bay River watershed, 1937–2002. Data from Michigan Department of Natural Resources Fisheries Division records. Includes known private fish stockings and rearing marsh plants. Asterisk (\*) indicates an ongoing division program while a (\*\*) indicates a DNR research study.

County	Location	Species	Years	Number stocked in period
Montmorency	Atlanta Pond	largemouth bass	75	2,352
		walleye	38, 86	210,000
	Avalon Lake	bluegill	37–42	111,800
		brook trout	49, 86	5,860
		lake trout	51–53, 55–57, 61–63	21,500
		largemouth bass	37–38, 40, 42	5,200
		rainbow trout	43, 44–61, 70–71, 73–74, 81–87, 89	278,175
		smallmouth bass	37–42	7,435
		splake*	65–66, 68–69, 83–88, 90–04	426,065
		steelhead	75	10,000
		walleye	37–39	1,210,000
		yellow perch	38–39, 41	71,890
	Avery Lake	bluegill	33–35, 37–45	117,900
		largemouth bass	33, 38, 40, 43–45	4,750
		rainbow trout	73–74	10,000
		smallmouth bass	38–42	4,077
		steelhead	75	5,106
		walleye	35–37, 39–40, 82, 86, 89, 91, 94, 96, 98	2,175,000
		yellow perch	33, 35, 39, 41	33,000
	Beaver Lake	bluegill	38–40	9,000
	Brush Creek	brook trout	38–41, 44, 46–47, 50–65	83,860
	Crooked Lake	bluegill	39–41	30,000
		largemouth bass	38, 40, 42	1,800
		rainbow trout	43–46	14,570
		smallmouth bass	39–41	1,358
		walleye*	38, 77–78, 81, 86, 89, 91, 95, 97, 99, 03	176,000
	Decheau Lake	bluegill	42–44	12,000
		largemouth bass	44	600
		smallmouth bass	42	500
	East Fish Lake	Arctic grayling**	87, 91	63,760
		brook trout**	40–42, 53–54, 57–65, 72, 82	21,133
		rainbow trout**	58–65, 77–81, 92	9,550
		steelhead**	92	535
	Ess Lake	bluegill	37–42	35,000
		largemouth bass	38, 40, 42	1,300
		rainbow trout	43–46, 57–66, 68–72	90,478
		smallmouth bass	39–40	1,022
		walleye*	37, 39, 64, 74–76, 85–86, 90–91, 93, 96, 98, 01–02, 04	209,168
		yellow perch	39	5,000

Thunder Bay River Assessment

Table 29.–Continued.

County Location	Species	Years	Number stocked in period
Montmorency–continued			
Fuller Creek	Arctic grayling**	40	4,000
	brook trout**	43, 53, 57, 65	1,420
	rainbow trout**	64–65	600
Fuller Creek Pond	Arctic grayling**	40, 41, 87	3,300
	brook trout**	54, 59, 62–65, 77, 82	9,784
	brown trout**	65	200
	rainbow trout**	59, 62–65	2,470
Gaylanta Lake	largemouth bass	60	1,000
	northern pike	61, 81, 83, 85, 87, 89, 91	9,700
Gilchrist Creek	brook trout**	38–44, 46–65	146,725
	rainbow trout**	38–41, 45, 47–52, 90–91	180,621
Haymeadow Creek	brook trout	46, 51–65	9,900
Hillman Pond	largemouth bass	71	16
	walleye	86, 93	20,254
Hunt Creek	brook trout**	38–40, 49–51, 53–55, 57, 59–60	119,976
	rainbow trout**	39, 52	6,680
	steelhead**	98–03	960
Lake Fifteen	bluegill	40	5,000
	brown trout*	77–04	89,195
	rainbow smelt	54	6,400
	rainbow trout	50, 73–74	163,000
	steelhead	75	5,106
Little Brush Lake	largemouth bass	54–55	4,000
Long Lake	bluegill	38, 40–45	20,800
	largemouth bass	38, 40, 44–45	3,000
	rainbow trout	53–74, 76–78, 80–01	373,991
	smallmouth bass	39–42	3,000
	steelhead	79	17,300
	walleye	38, 75	200,600
McCormick Lake	yellow perch	41	5,000
	brook trout	55, 58, 64	40,000
	brown trout*	80–04	97,563
	rainbow trout	38–45, 48, 51, 56–67	244,800
Middle Fish Lake	splake	68–71	17,937
	brook trout**	61–63, 65	210
	brown trout**	61–64	200
Miller Creek	rainbow trout**	61–65	280
	brook trout	38	3,840
Rush Lake	bluegill	38–45	87,100
	brook trout	49	3,225
	largemouth bass	38, 40, 44–45	4,200
	northern pike	64	2,000
	smallmouth bass	38–42	3,210
	walleye	38–40, 42–44	2,400,000
	yellow perch	41	5,000
Sage Creek	brook trout	44	500



Table 29.–Continued.

County Location	Species	Years	Number stocked in period
Montmorency–continued			
Sage Lake	brook trout	64, 76–78, 82–88, 90–93	39,200
	largemouth bass	76–77	4,000
	rainbow trout	63–66, 68–69, 73, 80–86	33,450
	steelhead	75, 79	4,536
	yellow perch	41	2,000
Schoolhouse Lake	brook trout	43	588
Sheridan Creek	brook trout	38, 52	7,280
Stanniger Creek	brook trout	52	6,000
Sucker Lake	brook trout	48–51	8,875
Suttons Pond	Arctic grayling**	41	200
Thunder Bay River	brook trout	38–40, 45, 58–65	43,220
	brown trout	50, 56, 58, 64–65, 72–73	7,600
	rainbow trout	46–64, 73	112,600
	steelhead	72	13,817
Twin Lakes	bluegill	38, 40–41, 43, 60	20,100
	largemouth bass	38, 60	1,500
	smallmouth bass	39	500
	walleye	38, 40	440,000
Voyer Lake	largemouth bass	52	1,000
	smallmouth bass	52	1,000
	walleye	84–86, 89–90	47,074
Voyer Lk Inlet Pd.	rainbow trout	47–48, 50–51	16,000
West Fish Lake	bluegill**	40	3,000
	brook trout**	61–63, 65	729
	brown trout**	61–63, 65	560
	largemouth bass**	49	500
	rainbow trout**	61–63, 65	560
	redeer sunfish**	54, 56	3,000
Up. S. Br. Thunder Bay River	trout species	various years	–
Oscoda			
Bass Lake	bluegill	37–42	51,000
	largemouth bass	37–38, 43	1,250
	walleye	37–38	1,000,000
Churchill Lake	walleye	37	400,000
Crystal Lake	rainbow trout	51	9,100
Indian Lake	bluegill	40	5,000
Island Lake	bluegill	37–41	73,500
	largemouth bass	37–38, 43	3,000
	smallmouth bass	39	400
	walleye	38	640,000
Lake David	largemouth bass	39	500
	rainbow trout	40	500
	rock bass	40	24
	smallmouth bass	39, 40	512
	yellow perch	38	5,000

Thunder Bay River Assessment

Table 29.–Continued.

County Location	Species	Years	Number stocked in period
Oscoda–continued			
McCollum Lake	bluegill	37–42, 44–45	109,000
	largemouth bass	41, 44–45	7,000
	northern pike	61–63, 71–75, 77–78, 80, 82–83, 86–87, 89	39,606
	smallmouth bass	37–41, 43–44	1,857
	walleye	37, 64, 69, 88	385,538
	yellow perch	37–39, 42	33,300
Rhoads Lake	bluegill	39	5,000
	rainbow trout	43	455
Rudd Lake	bluegill	52	1,500
	largemouth bass	52	200
Saddleback Lake	bluegill	37–38, 40–41, 80	22,060
	largemouth bass	37–38, 43, 78	1,300
Second Lake	bluegill	40	3,500
	largemouth bass	54	1,500
Shamrock Lake	bluegill	35	1,000
	largemouth bass	35, 38	2,000
	northern pike	35, 37	4,000
	smallmouth bass	34, 36	1,300
	yellow perch	38	200
Up. S. Br. Thunder Bay River	trout species	various years	–
Toteroad Lake	bluegill	40–41	7,000
	largemouth bass	43	250
	yellow perch	39	5,000
Trout Lake	brook trout	51	8,013
Alcona			
Badger Lake	largemouth bass	51	840
Bucks Lake	bluegill	54	2,500
	largemouth bass	54	200
Buff Creek	brook trout	37–53	47,385
	brown trout	48–49	950
	rainbow trout	49	150
Comstock Creek	brook trout	38–42, 49, 51	17,100
	brown trout	48–49	350
	rainbow trout	49	150
Crooked Lake	bluegill	37–39, 41–45	73,000
	largemouth bass	41, 44–45	3,500
	northern pike	62–63	100
	smallmouth bass	37–44	3,792
	walleye	37, 40, 90	256,189
	yellow perch	37–39, 42	25,700
Durkee Lake	rainbow trout	04	360
Fish Creek	brook trout	40–42	6,250

Table 29.–Continued.

County Location	Species	Years	Number stocked in period
Alcona–continued			
Hubbard Lake	brown trout	82	10,682
	catfish	38	17
	lake trout	37–42, 44–46, 54–57	452,900
	northern pike	38, 80, 83, 99, 01, 02	152,198
	rainbow trout	44–47, 49–58, 68–69, 04	234,030
	shiners	38	31,200
	tiger muskellunge	78, 80, 82, 85	45,000
	walleye	37–40, 42, 77–78, 80–86, 88–89, 91	4,394,751
	yellow perch	37–39, 42, 87, 93, 99, 01	254,864
	Little North Creek	brook trout	44–46
Little Wolf Creek	brook trout	48	600
	brown trout	48–51	4,400
McGinn Creek	rainbow trout	44, 48	2,800
	brook trout	47–51	11,250
	rainbow trout	49	300
Silver Creek	brook trout	49–54	10,350
Silver Wolf Lake	rainbow trout	51	7,500
Spruce Creek	brook trout	51	2,500
Sucker Creek	brook trout	38–48	28,970
	rainbow trout	45–47, 49–50	1,900
W.Br. River	brown trout	48	700
	rainbow trout	49, 51–53	1,500
Widner Creek	brook trout	44–46	250
Wildcat Creek	brook trout	51	1,500
Yoder Creek	brook trout	44	50
	rainbow trout	48	1,000
Presque Isle			
N. Br. Thunder Bay River	brown trout	38, 59–60, 62–65	19,500
	rainbow trout	41–43, 62, 64	13,350
Quinn Creek	brook trout	41	1,300
	brown trout	50	300
Sunken Lake	bluegill	38–39, 42, 44–45	35,000
	largemouth bass	39–41, 45	2,969
	walleye	62	60
Alpena			
Bean Creek	brown trout	38	1,100
	rainbow trout	38	1,000

Thunder Bay River Assessment

Table 29.–Continued.

County Location	Species	Years	Number stocked in period
Alpena–continued			
Beaver Lake	bluegill	35–45	100,000
	largemouth bass	35–45	100,000
	northern pike*	79–98, 00–02	155,700
	rainbow trout	73–77	61,632
	smallmouth bass	35–45	4,907
	steelhead	75	15,012
	sunfish	35–45	550
	tiger muskellunge	78–79, 82, 84, 86, 88, 90	12,600
	walleye*	86, 92, 94, 96, 98, 00, 02, 04	286,100
	yellow perch	35–45	23,485
Four Mile Impoundment	largemouth bass	38, 49	15,600
	walleye	37–38, 89–91, 93, 95	561,000
Lower S. Br. Thunder Bay River	brown trout	38–41, 52–54,	36,770
	rainbow trout	42–44, 52–57	43,500
	walleye	86	150,000
Ninth Street Impoundment N. Br. Thunder Bay River	walleye	38, 86, 90, 93, 95, 97	386,046
	brown trout	42–43, 58–65	53,350
	rainbow trout	39, 42–43, 62	5,965
Lake Winyah	northern pike	42, 90–91	20,007
	walleye	86, 90–91, 93, 95, 97, 99	297,799
Sucker Creek	brook trout	38–48	35,970
	rainbow trout	46–47, 49–50	1,800
Thunder Bay River (Hillman Dam– 7 Mile Impoundment)	largemouth bass	49	2,250
	northern pike	42	20
	rainbow trout	41	12,800
	walleye**	83–94, 96–98, 00–03	961,147
Thunder Bay River (7 Mile dam–9 <sup>th</sup> St. Imp.)	bluegill	49	10,000
	northern pike	42	29
	rainbow trout	49–65	91,700
Thunder Bay River (below 9 <sup>th</sup> St. dam)	brown trout	61, 74, 78–79, 85	185,428
	Chinook salmon	68–73, 79	406,043
	coho salmon	68–71	450,125
	rainbow trout	59–65, 71, 78, 85	55,806
	steelhead*	69–70, 72–78, 80–02	601,441
Upper S. Br. Thunder Bay River Wolf Creek	brook trout	72–73	1,200
	brown trout	38–39, 45–49, 52–54	52,594
	rainbow trout	38–48, 52–60	76,420

Table 30.—Fletcher Pond historical creel statistics and catch, growth, and population information for northern pike (Laarman 1976, Schneider and Lockwood 1979, Ryckman and Lockwood 1985, and Lockwood 2000). Asterisk (\*) indicates 1948–65 creel censuses for both open water and winter; <sup>(a)</sup> indicates data is based on harvest in both creel and non-creel years; <sup>(b)</sup> indicates growth rates are compared to the statewide average growth for northern pike; <sup>(c)</sup> indicates winter creel estimate (January through March); and <sup>(d)</sup> indicates open water creel estimate (May through September).

Year	Regulations	Fishing pressure (hrs)	Fishing pressure/acre	Harvest			Mean length <sup>a</sup> (in)	Growth index <sup>b</sup> (number aged)	Population estimate
				winter	summer	total			
1948*	14" size; 5/day spear in winter	258,373	28.9	14,504	34,470	48,974	19.8	+0.3 (224)	
1954*	14" size; 5/day spear in winter							-1.6 (85)	
1955*	14" size; 5/day spear in winter	245,412	27.4	23,500	15,280	38,780		-1.8 (995)	
1956*	14" size; 5/day spear in winter	196,530	21.9	19,500	17,930	37,430	17.5	-2.6 (580)	97,000
1959*	14" size; 5/day spear in winter							-1.4 (19)	
1961*	20" size; 5/day spear in winter	77,950	8.7	1,200	980	2,180	23.4	-2.3 (97)	
1962*	20" size; 5/day spear in winter	99,008	11.0	1,210	581	1,791		-5.1 (88)	
1963*	14" size; 10/day no spear in winter	241,529	26.9	18,426	27,256	45,682	17.1	-4.9 (311)	
1964*	14" size; 10/day no spear in winter	269,817	30.1	10,258	18,800	29,058	17.4	-5.2 (200)	
1965*	14" size; 10/day no spear in winter	435,256	48.5	10,430	114,600	125,030	17.3	-5.4 (330)	
1966	14" size; 10/day no spear in winter						18.5	-3.3 (112)	

Table 30.–Continued.

Year	Regulations	Fishing pressure (hrs)	Fishing pressure/acre	Harvest			Mean length <sup>a</sup> (in)	Growth index <sup>b</sup> (number aged)	Population estimate
				winter	summer	total			
1967	20" size; 5/day no spear in winter						19.5	-3.0 (93)	
1968	20" size; 5/day no spear in winter						19.6	-2.0 (119)	
1983	No size limit; 5/day no spear in winter						21.9	0.0 (89)	
1984	No size limit; 5/day no spear in winter							+1.1 (80)	
1989	20" size; 5/day no spear in winter							+1.4 (24)	
1990	20" size; 5/day no spear in winter							+2.8 (33)	
1992	20" size; 5/day no spear in winter							+4.0 (15)	
1993	24" size; 5/day no spear in winter							+3.8 (51)	
1995	24" size; 5/day no spear in winter	15,114 <sup>c</sup>		1,126 <sup>c</sup>					
1997	24" size; 5/day no spear in winter	171,521 <sup>d</sup>			3,332 <sup>d</sup>				

## REFERENCES

- Abbe, T.B., and D.R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. *Regul. Rivers* 12: 201-221.
- Aeillo, C. 2002. Michigan water chemistry trend monitoring 2000 report. MDEQ Report Number MI/DEQ/SWQ-02/092, Lansing.
- Aeillo, C. 2003. Michigan water chemistry trend monitoring, 2001 report. MDEQ Report Number MI/DEQ/WD-03/085, Lansing.
- Aiello, C., and J. Smith. 2002. Michigan water chemistry trend monitoring, 1998-1999 report. Michigan Department of Environmental Quality, Report Number Michigan/Department of Environmental Quality/Surface Water Quality-02/025, Lansing.
- Albert, D.A., S.R. Denton, and B.V. Barnes. 1986. Regional landscape ecosystems of Michigan. School of Natural Resources, University of Michigan, Ann Arbor.
- Allan, J.D. 1981. Determinants of diet of brook trout (*Salvelinus fontinalis*) in a mountain stream. *Canadian Journal of Fisheries and Aquatic Sciences*. 38:184-192.
- Allan, J.D. 1995. *Stream ecology: Structure and function of running waters*. Chapman and Hall, London.
- Alexander, G.R., J.L. Fenske, and D.W. Smith. 1995. A fisheries management guide to stream protection and restoration. Michigan Department of Natural Resources, Fisheries Division, Special Report 15, Ann Arbor.
- Alexander, G.R., and E.A. Hansen. 1983. Effects of sand bedload sediment on a brook trout population. Michigan Department of Natural Resources, Fisheries Division, Research Report 1906, Ann Arbor.
- Alexander, G.R., and E.A. Hansen. 1986. Sand bed load in a brook trout stream. *North American Journal of Fisheries Management* 6:9-23.
- Alexander, G.R., and D.S. Shetter. 1957. The eighteenth annual intensive creel census, Hunt Creek Trout Research Station, 1956. Michigan Department of Natural Resources, Fisheries Division, Research Report 1508, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1958. The nineteenth annual intensive creel census, Hunt Creek Trout Research Station, 1957. Michigan Department of Natural Resources, Fisheries Division, Research Report 1537, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1959. The twentieth annual intensive creel census, Hunt Creek Trout Research Station, 1958. Michigan Department of Natural Resources, Fisheries Division, Research Report 1565, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1960. The twenty-first annual intensive creel census, Hunt Creek Trout Research Station, 1959 trout season. Michigan Department of Natural Resources, Fisheries Division, Research Report 1606, Ann Arbor.

## Thunder Bay River Assessment

- Alexander, G.R., and D.S. Shetter. 1961a. Seasonal mortality and growth of hatchery-reared brook and rainbow trout in East Fish Lake, Montmorency County, Michigan, 1958-59. Michigan Academy of Arts and Letters 46:317-328.
- Alexander, G. R., and D. S. Shetter. 1961b. The twenty-second annual intensive creel census, Hunt Creek Trout Research Station, 1960 trout season. Michigan Department of Natural Resources, Fisheries Division, Research Report 1619, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1962. The twenty-third annual intensive creel census, Hunt Creek Trout Research Station, 1961. Michigan Department of Natural Resources, Fisheries Division, Research Report 1641, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1963. The twenty-fourth annual intensive creel census at the Hunt Creek Trout Research Station, 1962. Michigan Department of Natural Resources, Fisheries Division, Research Report 1673, Ann Arbor.
- Alexander, G.R., and D.S. Shetter. 1969. Trout production and angling success from matched plantings of brook trout and rainbow trout in East Fish Lake, Michigan. Journal of Wildlife Management 33 (3) 682-692.
- Alexander, G.R., O.H. Williams, O.M. Corbett, and D.S. Shetter. 1964. The twenty-fifth annual intensive creel census at the Hunt Creek Trout Research Station, 1963. Michigan Department of Natural Resources, Fisheries Division, Research Report 1702, Ann Arbor.
- Allison, L.N., and H. Kilpela. 1943. A fisheries survey of Ess Lake, Montmorency County. Michigan Department of Natural Resources, Fisheries Division, Research Report 894, Ann Arbor.
- Anonymous. 1996. Mercury pollution prevention in Michigan. Michigan Department of Environmental Quality, Office of the Great Lakes, Lansing.
- Anonymous. 1997. A guide to public rights on Michigan waters. Michigan Department of Natural Resources, Law Enforcement Division, Report Number 9, Lansing.
- Anonymous. 2000. Michigan stream classification: 1967 system. Chapter 20 in Schneider, James C. (ed.). Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Division, Special Report 25, Ann Arbor.
- Anonymous. 2002. Interdepartmental approach to harmful aquatic nuisance species, report to the Michigan Legislature, MDNR-MDEQ, October, 2002, Lansing.
- Auer, N.A. 1995. Life history strategies of lake sturgeon, *Acipenser fulvescens*, in the Sturgeon River-Southern Lake Superior Ecosystem. Doctoral dissertation. Michigan Technological University, Houghton.
- Auer, N.A. 1996. Response of spawning lake sturgeons to change in hydroelectric facility operations. Transactions of the American Fisheries Society 125:66-77.
- Austin, M.B., T.R. Leibfried, K.M. Korroch, L.P. Gregory, A.J. Selwert, J.D. Duguay, and L.S. Peltz. 2000. Land use and land cover in 1800 [Electronic spatial data coverage]. Michigan Natural Features Inventory, Lansing.



- Bailey, R.M., W.C. Latta, and G.R. Smith. 2003. An atlas of Michigan fishes with keys and Illustrations for their identification. Museum of Zoology, University of Michigan, Ann Arbor. Data were acquired through a digital transfer of ArcGIS coverage Version 8.2 from original source.
- Bailey, R.M., and G.R. Smith. 1981. Origin and geography of the fish fauna of the Laurentian Great Lakes basin. *Canadian Journal of Fish and Aquatic Science* 38:1539-1561.
- Becker, G.C. 1983. *Fishes of Wisconsin*. University of Wisconsin Press. Madison.
- Bedient, P.B., and W.C. Huber. 1992. *Hydrology and floodplain analysis*. Addison-Wesley Publishing Company, Reading, Massachusetts.
- Bell, C.E., and B. Kynard. 1985. Mortality of adult American shad passing through a 17-megawatt Kaplan turbine at a low-head hydroelectric dam. *North American Journal of Fisheries Management* 5:33-38.
- Bell, M.C., and A.C. Delacy. 1972. A compendium on the survival of fish passing through spillways and conduits. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.
- Beschta, R.L., and W.S. Platts. 1986. Morphological features of small streams: significance and function. *Water Resources Bulletin* 22: 369-379.
- Bilby, R.E., and P.A. Bisson. 1998. Function and distribution of large woody debris. Pages 324-346 *in* River ecology and management. Edited by R.J. Naiman and R.E. Bilby. Springer-Verlag, New York.
- Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. Pages 143-190 *in* Streamside management: forestry and fishery interactions. Edited by E.O. Salo and T.W. Cundy. College of Forest Resources, University of Washington, Institute of Forest Resources Contrib. No. 57. Seattle.
- Blumer, S.P., T.E. Behrendt, J.M. Ellis, R.J. Minnerick, R.L. LeuVoy, and C.R. Whited. 2005 *Water Resources Data, Michigan, water year 2004: U.S. Geological Survey Water-Data Report MI 04-01*, 496p.
- Booth, D.B. 1991. Urbanization and the natural drainage system - impacts, solutions, and prognoses. *The Northwest Environmental Journal* 7:93-118.
- Borgeson, D.P. 1974. Michigan sport fishing regulations. *in* Michigan Fisheries Centennial Report 1873-1973. Michigan Department of Natural Resources, Fisheries Division, Management Report 6, Ann Arbor.
- Borgeson, D.J. 1996. Fletcher Floodwaters creel survey winter 1995. Michigan Department of Natural Resources, Report to Fisheries Division Files, Gaylord.
- Bovee, K.D., T. Newcomb, and T.G. Coon. 1994. Relations between habitat variability and population dynamics of bass in the Huron River, Michigan. U.S. Department of the Interior, National Biological Survey, Washington D. C., Biological Report 21, Washington.
- Brewer, R., G.A. McPeck, and R.J. Adams, Jr. 1991. *The atlas of breeding birds of Michigan*. Michigan State University Press, East Lansing.

## Thunder Bay River Assessment

- Brooker, M.P. 1981. The impact of impoundments on the downstream fisheries and general ecology of rivers. *Advances in Applied Biology* 6: 91-152.
- Cada, G.F. 1990. A review of studies relating to the effects of propeller-type turbine passage on fish early life stages. *North American Journal of Fisheries Management* 10:418-426.
- Carl, L.M. 1982. Natural reproduction of coho salmon and salmon in some Michigan streams. *North American Journal of Fisheries Management* 2(4):375-380.
- Carlander, K.D. 1969. *Handbook of freshwater fishery biology, volume 1*. The Iowa State University Press, Ames.
- Clapp, D.F. 1988. Movement, habitat use, and daily activity patterns of trophy brown trout in the South Branch of the Au Sable River, Michigan. Michigan Department of Natural Resources, Fisheries Division, Research Report 1907, Ann Arbor.
- Cleland, C.E. 1966. The prehistoric animal ecology and ethnozoology of the upper Great Lakes Region [PhD dissertation]. University of Michigan, Ann Arbor.
- Comer, P.J. 1996. Wetland trends in Michigan since 1800: a preliminary assessment. Michigan Natural Features Inventory, Report 1996-03, Lansing.
- Coon, T.C. 1987. Responses of benthic riffle fishes to variation in stream discharge and temperature. Pages 77-85 in W. J. Mathews and D. C. Heins, editors. *Community and evolutionary ecology of North American stream fishes*. University of Oklahoma Press, Norman.
- Coope, G.F, M. Quigley, J.S. Richards, N. Ringler, and G.E. Burgoyne, Jr. 1974. Au Sable River watershed project biological report (1971-1973). Michigan Department of Natural Resources, Fisheries Division, Management Report 7, Ann Arbor.
- Coscarelli, M., and E. Bankard. 1999. Aquatic nuisance species handbook for government officials. Michigan Department of Environmental Quality, Office of the Great Lakes. Lansing.
- Creaser, C.W., and E.P. Creaser. 1935. The grayling in Michigan. *Papers of the Michigan Academy of Science, Arts, and Letters* 20:599-608.
- Creel, W. and J. Wuycheck. 2002. Clean Water Act Section 303(d) list: Michigan submittal for year 2002. MDEQ Report Number MDEQ/SWQ-02/013, Lansing.
- Cwalinski, T.A. 2003. Hubbard Lake: Alcona County. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resource Report 2003-1, Ann Arbor.
- DePhilip, M.M. 2001. Daily and seasonal movements of large brown trout and walleye in an impounded reach of the Au Sable River, Michigan. Michigan Department of Natural Resources, Fisheries Division, Research Report 2056, Ann Arbor.
- Dewberry, T.C. 1992. Protecting the biodiversity of riverine and riparian ecosystems: the national river public land policy development project. *Transactions of the 57th North American Wildlife and Natural Resources Conference*. pp. 424-432.
- Diana, J. 1987. Simulation of mechanisms causing stunting in northern pike populations. *Transactions of the American Fisheries Society* 116: 612-617.

- Diana, J.S. 1995. Biology and ecology of fishes. Biological Sciences Press, Carmel, Indiana.
- Dodd, H.R. 1999. The effects of low-head lamprey barrier dams on stream habitat and fish communities in tributaries of the Great Lakes. Mater's thesis, Michigan State University., East Lansing.
- Doepker, R.V., L.E. Thomasma, and S.A. Thomasma. 2001. MIWildHab – Michigan Wildlife Habitats [computer program]. Michigan Department of Natural Resources, Wildlife Division, Lansing, MI and Two by Two Wildlife Consulting, Grand Rapids.
- Dorr, J.S. Jr., and D.F. Eschman. 1970. Geology of Michigan. The University of Michigan Press, Ann Arbor.
- Doyle, M.W., and E.H. Stanley, M.A. Luebke, and J.M. Harbor. 2000. Dam removal: physical, biological, and societal considerations. American Society of Civil Engineers Joint Conference on Water Resources Planning and Management Symposium, Minneapolis, MN, July 30 – August 2.
- Eaton, J.G., J.H. McCormick, B.E. Goodno, D.G. O'Brien, H.G. Stegany, M. Hondzo, and R.M. Scheller. 1995. A field information-based system for estimating fish temperature tolerances. Fisheries 15(4): 10-18.
- Ebel, W.J. 1969. Supersaturation of nitrogen in the Columbia River and its effect on salmon and steelhead trout. U.S. Fish and Wildlife Service Fishery Bulletin 68:1-11, Washington.
- Edwards, E.A., G. Gebhart, and O.E. Maughan. 1983. Habitat suitability index models: smallmouth bass. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.6), Washington.
- Edwards, E.A., D.A. Kriger, M. Bacteller, and O.E. Maughan. 1982. Habitat suitability index models: black crappie. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.6), Washington.
- EPRI (Electric Power Research Institute). 1992. Fish entrainment and turbine mortality review and guidelines. EPRI, TR-101231, Palo Alto, California.
- Farrand, W.R. 1988. The glacial lakes around Michigan. Michigan Department of Natural Resources, Geological Survey Division, Bulletin 4, Lansing.
- FERC (Federal Energy Regulatory Commission). 1996. Thunder Bay River Projects Nos. 2404 & 2419, FERC FEIS-0102, Washington.
- Fetterolf, C.J. Robinson, M. Newton, J. Seeburger, and B. Mills. 1965. Biological surveys of Thunder Bay and Thunder Bay River, Alpena, Michigan, 1957 and 1965. Michigan Water Resources Commission. Lansing.
- Fraley, J.J. 1979. Effects of elevated stream temperatures below a shallow reservoir on cold water macroinvertebrate fauna. Pages 257-272 in J.V. Ward and J.A. Stanford. Editors. The ecology of regulated streams. Plenum Press, New York. Pp. 257-272.
- Gauthier, D.A. 1982. Alcona, the community pioneers. Alpena County George N. Fletcher Library, Alpena, Michigan.

- Gibson, A.J.F., and R.A. Myers. 2002. A logistic regression model for estimating turbine mortality at hydroelectric generating stations. *Transactions of the American Fisheries Society* 131:623-633.
- Hallock, C. 1873. The Michigan grayling. *Forest and Stream* 1(18): 280.
- Haltiner, R.E. 1986. *The town that wouldn't die*. Village Press Inc., Traverse City, Michigan.
- Handley, C.O., Jr. 1953. Marine mammals in Michigan Pleistocene beaches. *Journal of Mammalogy* 34:252-253.
- Harding, J.H., and J.A. Holman. 1990. Michigan turtles and lizards. Michigan State University Cooperative Extension Service Bulletin E-2234.
- Harding, J.H., and J.A. Holman. 1992. Michigan frogs, toads, and salamanders. Michigan State University Cooperative Extension Service Bulletin E-2350. East Lansing.
- Hart, S., M. Klepinger, H. Wandell, D. Garling, and L. Wolfson. 2000. *Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes*. Michigan Department of Environmental Quality, Lansing.
- Hay-Chmielewski, E.M., P.W. Seelbach, G.E. Whelan, and D.B. Jester Jr. 1995. Huron River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 16. Ann Arbor.
- Hay-Chmielewski, E.M., and G.E. Whelan. 1997. Lake sturgeon rehabilitation strategy. Michigan Department of Natural Resources, Fisheries Division, Special Report 18. Ann Arbor.
- Hazard, A.S., L.A. Woodbury, and R.W. Eschmeyer. 1937. A survey of the waters in the Lost Lake Woods Club with recommendations for the improvement of fishing. Michigan Department of Conservation, Fisheries Division, Fisheries Research Report 40b, Ann Arbor.
- Heede, B.H. 1980. Stream dynamics: an overview for land managers. United States Department of Agriculture, Forest Service General Technical Report RM-72, Fort Collins, Colorado.
- Holden, P.B. 1979. Ecology of riverine fishes in regulated stream systems with emphasis on the Colorado River. Pages 57-74 in Ward, J.V., Stanford, J.A. (editors). *The Ecology of Regulated Streams*. Plenum: New York; 57-74.
- Holman, J.A., J.H. Harding, M.M. Hensley, and G.R. Dudderar. 1993. Michigan snakes. Michigan State University Cooperative Extension Service Bulletin E-2000. East Lansing.
- Hubbs, C.L., J.R. Greeley, and C.M. Tarzwell. 1932. Methods for the improvement of Michigan trout streams. Michigan Department of Conservation, Fisheries Division, Research Bulletin 1, Ann Arbor.
- Hubbs, C.L., and K.F. Lagler. 1947. *Fishes of the Great Lakes region*. The University of Michigan Press, Ann Arbor.
- Hubert, W.A., D.D. Douglas, and H.A. Rhodes. 1993. Variation in the summer diet of age-0 brown trout in a regulated mountain stream. *Hydrobiologia* 259:179-185.
- Hynes, H.B.N. 1970. *The ecology of running waters*. Liverpool University Press, Liverpool, England.

- Illies, J. 1962. Die bedeutung der strömung für die biozönose in rithron und potamon. Schweiz. Z. Hydrol. 24:433-435.
- Inskip, P.D. 1982. Habitat suitability index models: northern pike. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.17), Washington.
- Kanehl, P.D., J. Lyons, and J.E. Nelson. 1997. Changes in the habitat and fish community of the Milwaukee River, Wisconsin, following removal of the Woolen Mills Dam. North American Journal of Fisheries Management 17: 387-400.
- Kao, D.T. 1985. New hydroturbine design for improved water quality and reduced fish mortality. Pages 403-408 in F.W. Olson, R.G. White, and R.H. Hamre, editors. Symposium on small hydropower and fisheries. American Fisheries Society, Western Division and Bioengineering Section, Bethesda, Maryland.
- Kidder, J.S. 1985. Research needs for fish protection at small-scale hydroelectric installations. Pages 257-260 in F.W. Olson, R.G. White, and R.H. Hamre, editors. Symposium on small hydropower and fisheries. American Fisheries Society, Western Division and Bioengineering Section, Bethesda, Maryland.
- Kinney, J. 1999. Au Sable River impoundments fisheries assessments. Michigan Department of Natural Resources and U.S. Forest Service, Huron-Manistee National Forests. Unpublished manuscript dated, December 1999.
- Klomp, K.D. 1998. An initial evaluation of the habitat and fisheries resources associated with a dam removal in a Michigan cold water stream. Master's thesis, Michigan State University, East Lansing.
- Knighton, D. 1984. Fluvial forms and process. Edward Arnold Ltd, London.
- Kruger, K.M., W.W. Taylor, and J.R. Ryckman. 1985. Angler use and harvest in the Pere Marquette River near Baldwin, Michigan. Michigan Academician 17:317-330.
- Kurta, A. 1995. Mammals of the Great Lakes region. University of Michigan Press, Ann Arbor.
- Laarman, P.W. 1976. The sport fisheries of the twenty largest inland lakes in Michigan. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1843, Ann Arbor.
- Lavis, D.S., A.H. Hallett, E.M. Koon, and T.C. McAuley. 2003. History of and advances in barriers as an alternative method to suppress sea lampreys in the Great Lakes. Journal of Great Lakes Research 29 (Suppl. 1): 362-372.
- Law, J.W., and D.A. Law. 1975. Home was Alpena. Village Press, Alpena, Michigan.
- Leopold, L.B. 1968. Hydrology for urban land planning – a guidebook on the hydrologic effects of urban land use. United States Geological Survey Professional Paper 252, Washington.
- Leopold, L.B., M.G. Wolman, and J. P. Miller. 1964. Fluvial processes in geomorphology. W. H. Freeman and Company, San Francisco, California.
- Leopold, L.B., and M.G. Wolman. 1957. River channel patterns: Braided, meandering and straight. United States Geological Survey Professional Paper 282b pp. 33-85, Washington.

## Thunder Bay River Assessment

- Leopold, L.B., and T. Maddock. 1953. The hydraulic geometry of stream channels and some physiographic implications. United States Geological Survey Professional Paper 252, Washington.
- Lessard, J. 2001. Temperature effects of dams on cold water fish and macroinvertebrate communities in Michigan. Michigan Department of Natural Resources, Fisheries Division, Research Report 2058, Ann Arbor.
- Ligon, F.K., W.E. Dietrich, and W.J. Trush. 1995. Downstream ecological effects of dams. *BioScience* 45(3):183-192.
- Lockwood, R.N. 2000. Sportfishing angler surveys on Michigan inland waters, 1993-99. Michigan Department of Natural Resources, Fisheries Division, Technical Report 2000-3, Ann Arbor.
- Madison, G., and R.N. Lockwood. 2004. Manistique River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 31, Ann Arbor.
- Mather, F. 1874. The Michigan grayling and its habit. *Forest and Stream* 2(11):164-165.
- McFadden, J.T., G.R. Alexander, and D.S. Shetter. 1967. Numerical changes and population regulation in brook trout *Salvelinus fontinalis*. *Journal of the Fisheries Research Board of Canada* 24:1425-1459.
- McMahon, T.E. 1982. Habitat suitability index models: creek chub. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.56), Washington.
- McMahon, T.E., and P.C. Nelson. 1984. Habitat suitability index models: walleye. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.56), Washington.
- McPherron, A. 1967. The Juntunen site and the late woodland prehistory of the Upper Great Lakes Area. Museum of Anthropology, University of Michigan, Anthropological Paper No. 30. University of Michigan, Ann Arbor.
- Meek, F.B. 1976. Michigan's timber battleground: a history of Clare County 1674-1900. County Bicentennial Historical Committee, Clare County, Michigan.
- Michigan Department of Community Health. 1998. Michigan Department of Community Health Fish Consumption Advisory. Available: <http://www.mdch.state.mi.us/pha/fishadvi/htm> (October 12, 1998).
- Michigan Department of Community Health. 2002. 2002 Michigan family fish consumption guide. Available: [http://www.michigan.gov/documents/Fishing\\_Advisory\\_2002\\_26575\\_7.pdf](http://www.michigan.gov/documents/Fishing_Advisory_2002_26575_7.pdf) (September 2002).
- Michigan Department of Environmental Quality, Geological Survey Division and Michigan Department of Natural Resources, Land and Mineral Services Division (MDEQ-GSD; MDNR-LMSD). 2002. Oil and gas well spatial data. Lansing.
- Michigan Department of Environmental Quality, Water Division (MDEQ-WD). 1997. Procedure 51. Qualitative biological and habitat survey protocols, wadable streams and rivers. Lansing.
- Michigan Geographic Data Library. 2002. Spatial data coverages. Michigan Department of Information Technology. Available: <http://www.mcgi.state.mi.us/mgdl/>. (November 2002).

- Michigan Society of Planning Officials. 1995. Patterns on the land: our choices-our future. Final Report of the Michigan Society of Planning Officials Trend Future Project. Rochester.
- Michigan State College. 1941. Michigan Log Marks bulletin 4, East Lansing.
- Mistak, J.L. 2000. Dam removal effects on fisheries resources, habitat, and summer diet of trout in the Pine River, Manistee County, Michigan. Master's thesis. Michigan State University, East Lansing.
- Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Co., Anchorage.
- Mundie, J.H. 1991. Overview of effects of Pacific coast river regulation on salmonids and the opportunities for mitigation. pp 1-11 *in* J. Colt and R.J. White, editors. Fisheries Bioengineering symposium. American Fisheries Society, Symposium 10, Bethesda, Maryland.
- Navarro, J.E., and D.J. McCauley. 1993. Fish escapement from two storage reservoirs in Michigan. *Rivers* 4:36-47.
- Navarro, J.E., D.J. McCauley, and A.R. Blystra. 1996. Turbine passage at four low-head hydroelectric facilities in northeast Michigan. *North American Journal of Fisheries Management* 16:182-191.
- NEMCOG (Northeast Michigan Council of Governments). 1985. Fletcher's Floodwaters visitors market survey, Gaylord, Michigan.
- NEMCOG (Northeast Michigan Council of Governments). 2001. Fletcher Creek watershed study. Available: [http://www.alpena.mi.us/docs/FCWS/fcws\\_main.htm](http://www.alpena.mi.us/docs/FCWS/fcws_main.htm). [February 2003].
- NEMCOG (Northeast Michigan Council of Governments). 2002. Thunder Bay River Watershed Initiative, Gaylord, Michigan.
- Newcomb, T.J., and T.G. Coon. 1997. Environmental variability and survival of steelhead parr in a thermally diverse watershed. Michigan Department of Natural Resources, Fisheries Division, Research Report 2046, Ann Arbor.
- Nuhfer, A.J. 1992. Evaluation of the reintroduction of the arctic grayling, into Michigan lakes and streams. Michigan Department of Natural Resources, Fisheries Division, Research Report 1985, Ann Arbor.
- Nuhfer, A. 2002. Evaluation of brown trout and steelhead competitive interactions in Hunt Creek, Michigan. Michigan Department of Natural Resources, United States Fish and Wildlife Service, Sport Fish Restoration, Study Performance Report F-35, Study 654, Ann Arbor.
- Nuhfer, A.J., R.D. Clark Jr., and G.R. Alexander. 1994. Recruitment of brown trout in the South Branch of the Au Sable River, Michigan, in relation to streamflow and winter severity. Michigan Department of Natural Resources, Fisheries Division, Research Report 2006, Ann Arbor.
- Oatka. 1888. Grayling fishing on the Au Sable. *American Angler* 14(2):19-20.
- O'Neal, R.P. 1997. Muskegon River watershed assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 19, Ann Arbor.
- Oliver, D.D. 1903. Centennial History of Alpena County, Michigan. Enterprise Printers, Mt. Pleasant.

- Osborne, L.L., and M.J. Wiley. 1988. Empirical relationships between land use/cover and stream water quality in an agricultural watershed. *Journal of Environmental Management* 26:9-27.
- Petts, G.E. 1984. *Impounded rivers*. John Wiley and Sons, Chichester, England.
- Pflieger, W.L. 1975. *The fishes of Missouri*. Missouri Department of Conservation. Jefferson City.
- Poff, N.L., and J.D. Allan. 1995. Functional organization of stream fish assemblages in relation to hydrological variability. *Ecology* 76(2):606-627.
- Prescott, R.E. 1934. *Historical tales of the Huron shore region and rhymes*. Alcona County Herald Publishing, Lincoln, Michigan.
- Purkey, T.H. 2003. *Soil survey of Montmorency County, Michigan*. U.S. Department of Agriculture, Washington D.C., U.S. Government Printing Office. 534 p. 56 soil maps.
- Rader, R.B. 1997. A functional classification of the drift: traits that influence invertebrate availability to salmonids. *Canadian Journal of Fisheries and Aquatic Sciences* 54:1211-1234.
- Raleigh, R.F. 1982. *Habitat suitability index models: brook trout*. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.24), Washington.
- Raleigh, R.F., and P.C. Nelson. 1985. *Habitat suitability index models and instream flow suitability curves: pink salmon*. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.109), Washington.
- Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986b. *Habitat suitability index models and instream flow suitability curves: brown Trout*. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.124), Washington.
- Raleigh, R.F., W.J. Miller and S.C. Nelson. 1986a. *Habitat suitability index models and instream flow suitability curves: Chinook salmon*. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.122), Washington.
- Regal, G.E. 1992. *Range of movement and daily activity of wild brown trout in the South Branch Au Sable River, Michigan*. Michigan Department of Natural Resources, Fisheries Division, Research Report number 1988, Ann Arbor.
- Reynolds, D.E. 1974. *Lake and Stream Improvement*. in *Michigan Fisheries Centennial Report 1873-1973*. Michigan Department of Natural Resources, Fisheries Division, Management Report 6, Ann Arbor.
- Rutherford, E., S. Thorrold, A. Woldt, D. Swank, and N. Godby. 1997. *Abundance, production, and harvest of salmonids in the Manistee, Muskegon, and Au Sable rivers*. Michigan Department of Natural Resources, Fisheries Division, 1996-97 progress report for Project # 231663, Ann Arbor.
- Ryckman, J.R., and R.N. Lockwood. 1985. *On-site creel surveys in Michigan*. Michigan Department of Natural Resources, Fisheries Division, Research Report 1922, Ann Arbor.
- Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. *BioScience* 41(10):704-712.
- Schneider, James C. (ed.) 2000. *Manual of fisheries survey methods II: with periodic updates*. Michigan Department of Natural Resources, Fisheries Division, Special Report 25, Ann Arbor.



- Schneider, J.C., and J.H. Leach. 1977. Walleye (*Stizostedion vitreum vitreum*) fluctuations in the Great Lakes and possible causes, 1800-1975. *Journal of Fisheries Research Board of Canada* 34: 1878-1889.
- Schneider, J.C., and R.N. Lockwood. 1979. Effects of regulations on the fisheries of Michigan lakes, 1946-65. Michigan Department of Natural Resources, Fisheries Division, Research Report 1872, Ann Arbor.
- Schoeneman, D.E., R.T. Pressey, and C.O. Junge. 1961. Mortalities of downstream migrant salmon at McNary Dam. *Transactions of the American Fisheries Society* 90:58-72.
- Science Applications International Corporation. 1993. Revised Lake Michigan lakewide management plan for toxic pollutants. Produced for United States Environmental Protection Agency, Chicago.
- Scott, W.B., and E.J. Crossman. 1998. *Freshwater fishes of Canada*. Galt House Publications Ltd., Oakville, Ontario.
- Seelbach, P.W. 1986. Population biology of steelhead in the Little Manistee River, Michigan. Doctoral dissertation. University of Michigan, Ann Arbor.
- Seelbach, P.W., M.J. Wiley, J.C. Kotanchik, and M.E. Baker. 1997. A landscape-based ecological classification system for river valley segments in Lower Michigan. Michigan Department of Natural Resources, Fisheries Division, Research Report 2036, Ann Arbor.
- Serns, S.L. 1982. Relationship of walleye fingerling density and electrofishing catch per effort in Northern Wisconsin lakes. *North American Journal of Fisheries Management* 2: 38-44.
- Sheehan, R.J., and J.L. Rasmussen. 1993. Large rivers. Pages 445-468 in C. C. Kohler and W. A. Hubert, editors. *Inland fisheries management in North America*. American Fisheries Society, Bethesda, Maryland.
- Shetter, D.S. 1939. Investigation of Thunder Bay River between Four-Mile Dam and Alpena. Michigan Department of Conservation, Fisheries Division, Research Report 550, Ann Arbor.
- Shetter, D.S. 1968. The effects of certain angling regulations on stream trout populations. Symposium on Salmon and Trout in Streams, H.R. MacMillan Lectures in Fisheries pp. 333-353. University of British Columbia, Vancouver.
- Shetter, D.S., W.C. Latta, M.G. Galbraith, J.W. Merna, and G.P. Cooper. 1964. Returns on hatchery trout in Michigan. Michigan Department of Natural Resources, Fisheries Division, Research Report 1691, Ann Arbor.
- Stanley, E., M.W. Doyle. 2002. A geomorphic perspective on nutrient retention following dam removal. *BioScience* 52 (8): 693-701.
- Stanley, E., M.A. Luebke, M.W. Doyle. 2002. Short-term changes in channel form and macroinvertebrate communities following low-head dam removal. *Journal of North American Benthological Society*. 21(1):172-187.
- Starrett, W.C. 1951. Some factors affecting the abundance of minnows in the Des Moines River, Iowa. *Ecology* 32(1):13-27.

## Thunder Bay River Assessment

- Strange, E.M., P.B. Moyle, and T.C. Foin. 1992. Interactions between stochastic and deterministic processes in stream fish community assembly. *Environmental Biology of Fishes* 36:1-15.
- Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982. Habitat suitability index models: largemouth bass. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.16), Washington.
- Taft, W. 2003. Biological survey of the Thunder Bay River watershed; Montmorency, Presque Isle, and Alpena counties, Michigan, June, August, and September 2000. Michigan Department of Environmental Quality, Michigan Department of Environmental Quality, Water Division-03/037, Lansing.
- Tanner, H.H. 1987. Atlas of Great Lakes Indian history. University of Oklahoma Press, Norman.
- Taylor, R.E., and B. Kynard. 1985. Mortality of juvenile American shad and blueback herring passed through a low-head Kaplan hydropower turbine. *Transactions of the American Fisheries Society* 114:430-435.
- The Academy of Natural Sciences. 2002. Ecological studies of dam removal cases. Available: <http://www.acnatsci.org/research/pcer/institute.html> (November 2002).
- The Heinz Center. 2002. Dam Removal. Available: [http://www.heinzctr.org/NEW\\_WEB/PDF/Dam\\_removal\\_full\\_report.pdf](http://www.heinzctr.org/NEW_WEB/PDF/Dam_removal_full_report.pdf). (March 2003).
- The Nature Conservancy, Freshwater Initiative. 2000. GIS tools for aquatic macrohabitat classification. Available: <http://www.freshwaters.org/info/large.shtml>. (November 2002).
- Thuemler, T.F. 1985. The lake sturgeon, *Acipenser fulvescens*, in the Menominee River, Wisconsin-Michigan. Pages 73-78 in F.P. Binkowski and S.I. Doroshov, editors. *North American sturgeons: biology and aquaculture potential*. Dr. W. Junk Publishers, Dordrecht, Netherlands.
- Thunder Bay River Watershed Council of Northeast Michigan. 2003. By-laws of the Thunder Bay River Watershed Council of Northeast Michigan, Revised, Alpena.
- Toffaleti, C., and J.A. Bobrin. 1991. Nonpoint pollution in the Ann Arbor-Ypsilanti area: A preliminary control strategy for the Huron River Watershed. Washtenaw County Drain Commissioner, Ann Arbor, Michigan.
- Trautman, M.B. 1942. Fish distribution and abundance correlated with stream gradient as a consideration in stocking programs. Pages 211-223 in *Transactions of the Seventh North American Wildlife Conference*, Washington.
- Trautman, M.B. 1981. *The fishes of Ohio*. Ohio State University Press, Columbus.
- Trelfa, F. Thunder Bay Region, Book 8. Trelfa Collection, Alpena County George N. Fletcher Library, Alpena, Michigan.
- Trial, J.G., J.G. Stanley, M. Batcheller, G. Gebhart, O.E. Maughan, P.C. Nelson, R.F. Raleigh, and J.W. Terrell. 1983. Habitat suitability index models: blacknose dace. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.41), Washington.

- Tschaplinski, P.J., and G.F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. *Canadian Journal of Fisheries and Aquatic Sciences* 40:452-461.
- Turbak, S.C., D.R. Reichle, and C.R. Shriner. 1981. Analysis of environmental issues related to small scale hydroelectric development. IV: Fish mortality resulting from turbine passage. Oak Ridge National Laboratory, Publication 1597, Oak Ridge, Tennessee.
- Twomey, K.A., K.L. Williamson, P.C. Nelson, and C. Armour. 1984. Habitat suitability index models and instream flow suitability curves: white sucker. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.64), Washington.
- Tyler, J.A., and E.S. Rutherford. 2002. Modeling dam effects on fish populations in Great Lakes tributaries. Available: <http://salar.wpi.edu/salmod/introduction.htm#> (November 2002).
- United States Department of Agriculture, Forest Service. 1986. Huron-Manistee National Forest, Land and Resource Management Plan. Cadillac, Michigan.
- United States Department of Agriculture, Forest Service, and Natural Resources Conservation Service (USDA and NRCS). 1993. Thunder Bay River basin report: the river basin planning process.
- United States Geological Survey (USGS). 1993. Water Quality Samples for Michigan. USGS. Available: [http://nwis.waterdata.usgs.gov/mi/nwis/qwdata?search\\_site\\_no=04135000&search\\_site\\_no\\_match\\_type=exact&sort\\_key=site\\_no&group\\_key=NONE&sitefile\\_output\\_format=html\\_table&column\\_name=agency\\_cd&column\\_name=site\\_no&column\\_name=station\\_nm&column\\_name=lat\\_va&column\\_name=long\\_va&column\\_name=state\\_cd&column\\_name=county\\_cd&column\\_name=alt\\_va&column\\_name=huc\\_cd&format=qw\\_sample\\_por\\_table&begin\\_date=&end\\_date=&inventory\\_output=0&rdb\\_inventory\\_output=file&date\\_format=YYYY-MM-DD&rdb\\_compression=file&qw\\_sample\\_wide=0&list\\_of\\_search\\_criteria=search\\_site\\_no](http://nwis.waterdata.usgs.gov/mi/nwis/qwdata?search_site_no=04135000&search_site_no_match_type=exact&sort_key=site_no&group_key=NONE&sitefile_output_format=html_table&column_name=agency_cd&column_name=site_no&column_name=station_nm&column_name=lat_va&column_name=long_va&column_name=state_cd&column_name=county_cd&column_name=alt_va&column_name=huc_cd&format=qw_sample_por_table&begin_date=&end_date=&inventory_output=0&rdb_inventory_output=file&date_format=YYYY-MM-DD&rdb_compression=file&qw_sample_wide=0&list_of_search_criteria=search_site_no) (October 2005).
- United States Geological Survey (USGS). 1994. National mapping program – land use and land cover from 1983. Sioux Falls, South Dakota.
- United States Geological Survey (USGS). 2005. Streamflow measurements for Michigan. USGS. Available: [http://nwis.waterdata.usgs.gov/mi/nwis/measurements/?site\\_no=04133501](http://nwis.waterdata.usgs.gov/mi/nwis/measurements/?site_no=04133501). (October 2005).
- United States Geological Survey Water Resources Division Michigan District (USGS). Effects of removing the dam on the Muskegon River at Big Rapids. Available: <http://mi.water.usgs.gov/splan5/sp09500/bgrap.php> (November 2002).
- Vincent, R.E. 1962. Biogeographical and ecological factors contributing to the decline of Arctic grayling, *Thymallus arcticus* Pallus, in Michigan and Montana. Doctoral dissertation. University of Michigan, Ann Arbor.
- Vogel, D.A., K.R. Marine, and J.G. Smith. 1988. Fish passage action program for Red Bluff Diversion Dam. United States Fish and Wildlife Service Report FR1/FAO-88-19, Red Bluff, California.
- Wakefield, L. 1995. Ghost towns of Michigan, volume II, Thunder Bay Press, Holt.

## Thunder Bay River Assessment

- Ward, J.V., and J.A. Stanford. 1983a. The serial discontinuity concept of lotic ecosystems. Pages 29-42 in T.D. Fontaine and S.M. Bartell, editors, *Dynamics of Lotic Systems*, Ann Arbor Science, Ann Arbor, Michigan.
- Ward, J.V., and J.A. Stanford. 1987. The ecology of regulated streams: Past accomplishments and directions for future research. Pages 391-409 in J.F. Craig and J.B. Kemper, editors, *Regulated Streams Advances in Ecology*. Plenum Press, New York, New York.
- Waters, T.E. 1995. *Sediment in streams: Sources, biological effects and control*. American Fisheries Society, Bethesda, Maryland.
- Wehrly, K.E., M.J. Wiley, and P.W. Seelbach. 2003. Classifying regional variation in thermal regime based on stream fish community patterns. *Transactions of the American fisheries Society* 132:18-38.
- Wesley, J.K., and J.E. Duffy. 1999. St. Joseph River assessment, Michigan Department of Natural Resources, Fisheries Division, Special Report 24, Ann Arbor.
- Whirling Disease Foundation. 2002. Whirling disease news 6(1). Whirling Disease Foundation. Bozeman, Montana.
- Wiley, M.J., S.L. Kohler, and P.W. Seelbach. 1997. Reconciling landscape and local views of aquatic communities: lessons from Michigan trout streams. *Freshwater Biology* 37:133-148.
- Wiley, M.J. and P.W. Seelbach. 1997. An introduction to rivers. Michigan Rivers Inventory Project, Michigan Department of Natural Resources, Fisheries Division, Special Report 20, Ann Arbor.
- Williams, O.H., G.R. Alexander, and D.S. Shetter. 1966. The twenty-sixth annual intensive creel census at the Hunt Creek Research Station, 1964. Michigan Department of Conservation, Fisheries Division, Research Report 1717, Ann Arbor.
- Williams, T.E. 2004. Soil survey of Alpena County, Michigan. U.S. Department of Agriculture, Washington D.C., U.S. Government Printing Office. 543 p. 72 soil maps.
- Wilson, M. 1991. Biological survey of the Lower South Branch, Thunder Bay River, Alpena County, Michigan, July 31, 1990. Michigan Department of Environmental Quality, Report Number Michigan/Department of Natural Resources/Surface Water Quality-91/005, Lansing.
- Wing, M.G., and A. Skaugset. 2002. Relationships of channel characteristics, land ownership, and land use patterns to large woody debris in western Oregon streams. *Canadian Journal of Fisheries and Aquatic Sciences* 59: 796-807.
- Woldt, A.P. 1998. Production of juvenile steelhead in two northern Lake Michigan tributaries. Master's thesis, University of Michigan, Ann Arbor.
- Wolf, S., and J. Wuycheck. 2002. Water quality and pollution control in Michigan: 2002 Section 305(b) report. Michigan Department of Environmental Quality Report Number Michigan/Department of Environmental Quality/Surface Water Quality-02/024, Lansing.
- Wood, C.A. 1993. Implementation and evaluation of the water budget. *Fisheries* 18(11):6-17.

- Ziegler, R.L. 1988. Stream resource utilization of sympatric and allopatric juvenile brown (*Salmo trutta*) and steelhead trout (*Salmo gairdneri*). Michigan Department of Natural Resources, Fisheries Division, Research Report 1957, Ann Arbor.
- Ziegler, W. and J.C. Schneider. 2000. Guidelines for evaluating walleye and muskie recruitment. Chapter 23 in Schneider, James C. (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Division, Special Report 25, Ann Arbor.
- Zorn, T.G., P.W. Seelbach, and M.J. Wiley. 1997. Patterns in the distributions of stream fishes in Michigan's Lower Peninsula. Michigan Department of Natural Resources, Fisheries Division, Research Report 2035, Ann Arbor.
- Zorn, T.G., P.W. Seelbach, and M.J. Wiley. 2002. Distributions of stream fishes and their relationship to stream size and hydrology in Michigan's Lower Peninsula. Transactions of the American Fisheries Society 131:70-85.
- Zorn, T.G., and S.P. Sendek. 2001. Au Sable River Assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 26. Ann Arbor.



Above: Log drive atop the Thunder Bay River below the Four Mile Dam. Photo courtesy of Brian McNeill, Alpena, Michigan.

---