

**Minnesota Lake ID:** 16-0049

**Area:** 256 acres

**Watershed Area:** 891 acres

**Ecoregion:** Northern Lakes and Forests (NLF)

**Trophic State:** Oligotrophic

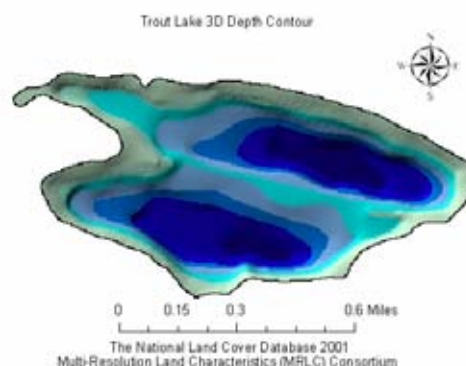
**Maximum Depth:** 77 feet

**Mean Depth:** 35 feet

**Mixing Status:** Thermally Stratified (Dimictic)



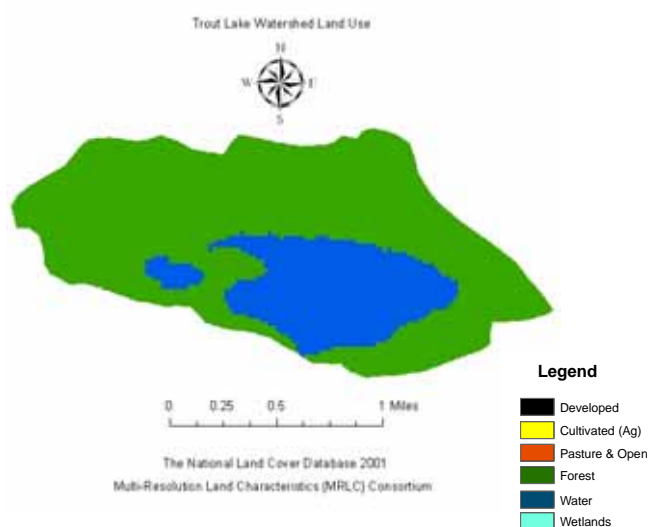
**Figure 1. Watershed land use map**



**Figure 2. Bathymetry map**

**Table 1. Trout Lake land use composition as compared to typical range for NLF ecoregion reference lakes**

Land use	Land use percentage	NLF typical percentage
Developed	<1	0 – 7
Cultivated (Ag)	0	<1
Pasture & Open	0	0 – 6
Forest	76	54 – 87
Water & Wetland	24	14 - 31
Feedlots (#)	0	



**Table 2. Trout Lake 2003 and 2006 data as compared to typical range for NLF ecoregion reference lakes**  
**Data from Minnesota Department of Health (MDH) laboratory**

Parameter	MPCA 2003 assessment	Cook County 2006 assessment	MPCA 2008 assessment	NLF Range
Number of reference lakes				32
Total Phosphorus (µg/L)	5.6	6.6	7.3	14 – 27
Chlorophyll mean (µg/L)	1.0	1.0	2.1	4 – 10
Secchi Disk (feet)	22.4	18.8	16.3	8 -15
Secchi Disk (meters)	6.8	5.7	4.9	2.4 – 4.6
Total Kjeldahl Nitrogen (mg/L)	0.3		.29	0.4 – 0.75
Alkalinity (mg/L)	16.5		14.6	40 – 140
Color (Pt-Co U)	7.5		8	10 – 35
pH (SU)	8.3		6.5	7.2 – 8.3
Chloride (mg/L)	1.0		<1	0.6 – 1.2
Total Suspended Solids (mg/L)	1.2		1	<1 – 2
Total Suspended Inorganic Solids (mg/L)	1.2		< 1	<1 - 2
Conductivity (umhos/cm)	38.8		37	50 – 250
TN:TP ratio	54:1		39:1	25:1 - 35:1

µg/L = micrograms per liter	Pt-Co-U = Platinum Cobalt Units
mg/L = milligrams per liter	SU = Standard Units
umhos/cm = micromhos per centimeter	

**Figure 3. Trout Lake July 2008 and July 1986 dissolved oxygen (DO) and temperature profiles**

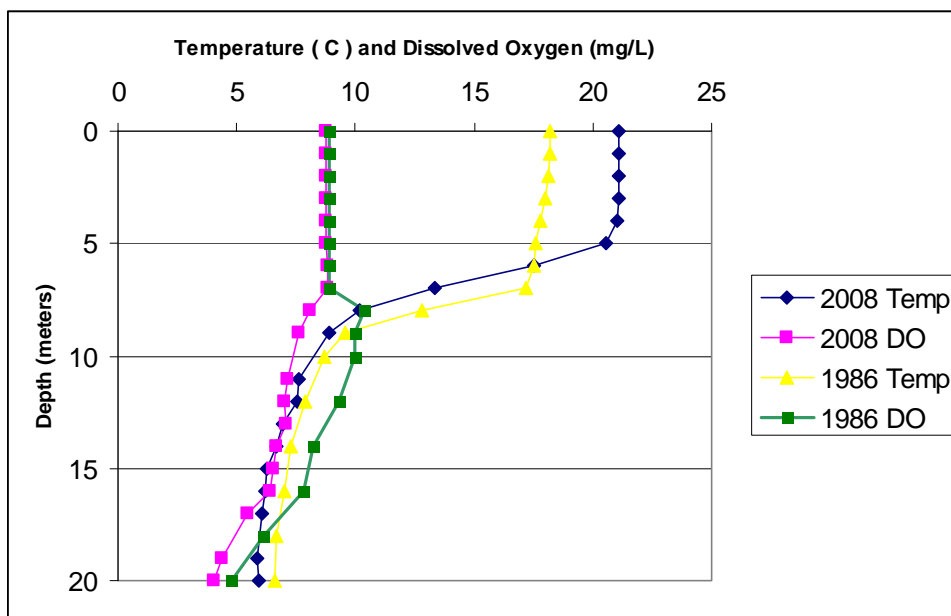
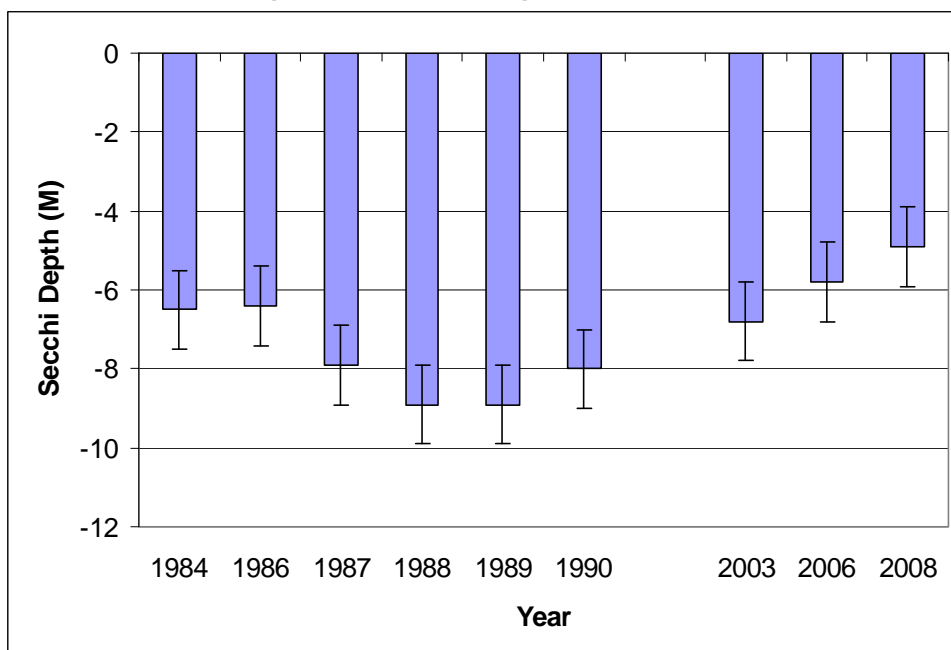


Figure 4. Trout Lake long term secchi data



### Watershed, water quality, and fishery summary

Trout Lake is a moderate-sized (259 acres) lake with a maximum depth of 69 feet (Figure 2). Nearly a quarter (23 percent) of the lake is littoral. It is located ten miles northeast of Grand Marais and forms part of the headwaters of the Kadunce River. Trout's small watershed (Figure 1) relative to its surface area (3.6:1 ratio) accounts for its relatively long water residence time (~11 years). Watershed land use is almost entirely forested and wetland; there is a limited amount of lakeshore development – one resort and a few cabins on the southeast shore. Trout Lake was previously sampled by the MPCA since it was one of the ecoregion reference lakes, part of a statewide sediment diatom reconstruction study, and the subject of a lake assessment. Details on those efforts may be found in <http://www.pca.state.mn.us/publications/reports/lakes-wqdiatoms.pdf> and <http://www.pca.state.mn.us/publications/reports/wq-lar3-13.pdf>.

Trout Lake supports a naturally reproducing lake trout population, which is near the southern edge of their natural range. The lake also supports a rainbow trout fishery, which is stocked annually by the DNR. Trout Lake is one of the most sensitive Sentinel lakes; the cold water fishery could be negatively impacted by climate warming, exotic species, or an increase in lake-shore development. The exotic species, spiny water flea (*Bythotrephes cederstroemi*) was not found in Trout Lake in 2008. However because other lakes along the Gunflint Trail (Caribou, Devil Track, Flour, Greenwood, Gunflint, McFarland, Pine, and Saganaga) have been found to be infested with them, Trout is at risk for an infestation.

In general, suitable habitat for lake trout is defined as water with dissolved oxygen (DO) concentrations of 6 mg/L or more and temperatures of 12 C or less. Based on a 2008 mid-summer (July) DO and temperature profile Trout Lake had suitable habitat over a depth range from about 8-16 meters (Figure 3). Comparing profiles from the MPCA's July sampling in 1986 shows little change in the profile when compared to 2008 (Figure 3). Oxygen concentrations in the epilimnion (upper layer) are nearly identical, deep water oxygen levels were also very similar.

The most recently completed water quality assessments took place in 2003 (MPCA), 2006 (Cook County) and 2008 (MPCA). Total phosphorus (TP), chlorophyll-a and Secchi transparency data indicate oligotrophic conditions and excellent water quality (Table 2). The data from these two recent studies are quite comparable and in general most summer-mean concentrations are within or below the typical range for minimally-impacted (reference) lakes in the Northern Lakes and Forests (NLF) ecoregion. The TP, chlorophyll-a and Secchi values for Trout Lake are within the water quality standards for NLF lake trout lakes (TP<12 µg/L, chlorophyll-a <3.0 µg/L and Secchi >4.8 m) and the lake would be considered "fully supportive of aquatic recreational uses."

Trout Lake has a discontinuous Secchi data base with data from c1984-1990 and then 2003, 2006, and 2008 (Figure 4). Based on these data, summer-mean Secchi ranges from 6.0-9.0 m in most summers. Secchi transparency appears to be slightly declining in recent years, however because of its discontinuous nature the current data should not be viewed as a long-term trend. The large breaks in this database indicate the need for long-term measurements that would ideally be conducted by a volunteer in the Citizen Lake Monitoring Program (CLMP).

The 2008 Physical Habitat Assessment data indicated that all 10 randomly chosen near-shore sites had similar riparian land cover and habitat. The lake bottom was dominated by boulders and cobble, and the shoreline was almost entirely mature forest- a mixture of deciduous and coniferous.

Trout is one of relatively few inland lakes that support naturally reproducing populations of lake trout. Under most climate change scenarios, lake trout will be an imperiled species in Minnesota. Although Trout Lake has a small, forested watershed with very low nutrient levels, the relatively small volume of thermal habitat (Figure 1) in this lake makes this lake particularly vulnerable to future increases in water temperature. Over-exploitation, future large-footprint developments, and pressures from non-native smelt are additional stressors operating on lake trout populations. Rainbow smelt invaded in the early 1980's and through predation and competition, may be responsible for the extirpation of native cisco. Aquatic plants are naturally sparse in Trout Lake, which is to be expected based on the 2008 Physical Habitat Assessment.

Because of Trout's uniqueness as a natural lake trout lake, this lake has been targeted for greater meteorological and water quality monitoring with automated sensors built and maintained by the USGS if funding is approved by LCCMR. These data will be housed in national monitoring database (National Water Inventory System) and used to adapt models to predict the future status of lake trout habitat.

**Table 3. Focal species captured during recent surveys and their size and abundance compared with other lakes in its lake class**

Species	Stocked	Abundance	Trend	Size	Notes
Lake trout*	N	High	Variable	Small	
Rainbow trout*	Y	Low	Declining	Average	
Brook trout	N	Low	Uncertain	Average	
Rainbow smelt	N	High	Variable	Large	Discovered in 1981
Cisco	N	Low	Declining	Large	Possibly extirpated
Yellow perch	N	High	Variable	Small	

\*Management emphasis on these species

**Table 4. Aquatic plant summary**

Percent cover of aquatic plants $\leq$ 15ft deep	40%
Lake depth beyond which most vegetation disappeared	6ft
Number of common species (i.e., $\geq$ 10% cover)	1
Non-native plant infestation	NA