Sea Grant
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Coastal Sportfisheries
FACT SHEET

THERMAL FRONTS: MAGNETS FOR GREAT LAKES SALMON AND TROUT

by Michael Voiland and Diane Kuehn

INTRODUCTION

Since 1982, many serious trollers have significantly improved their spring catch of steelhead, salmon and lake trout in offshore waters of Lake Ontario. One reason behind their increased success has been research and educational efforts carried forth by the New York Sea Grant Program. Through a comprehensive program of radio-tracking fish, synthesizing past research data, and organizing offshore boat trolls among fishermen, Sea Grant researchers and educators have helped Lake Ontario anglers fit many pieces of the springtime fish location puzzle together into a new and productive body of fishing knowledge.

How productive, you might ask? Well, by 1985, over 90 percent of lake charter skippers questioned indicated that they had used the new information and improved their catch accordingly. This new information is based on scientists' improved understanding of the nature and behavior of thermal fronts in Lake Ontario and how the movements and locations of trout and salmon may correspond to these fronts. A "thermal front" is defined as any interface between water masses of significantly different temperatures where relatively rapid water temperature changes occur. "Thermal bar", "thermocline", and "thermal break" refer to different types of thermal fronts.

The following information on fishing Great Lake springtime thermal structure relates specifically to studies conducted on Lake Ontario, and experiences reported there. But as our basic understanding of Great Lake limnology (the study of lakes) suggests, this new knowledge developed on the littlest Great Lake should be easily transferable and adaptable to the bigger ones. If use of the new information has the same impact as it has had on Ontario, then spring salmonid catches may be greatly improved on its "bigger sisters."

Before we proceed, one note of clarification. In terms of improved catches likely to be realized when applying this information, experiences on Lake Ontario indicate that the biggest payoff likely will come in catching more steelhead (rainbow) trout, followed (in descending order of catch) by chinook, lake trout and, lastly, coho. With very few exceptions, catches of brown trout have not occurred in association with the thermal phenomena described below.

THE WINTER-SUMMER TRANSITION

Everything discussed in this article pertains directly to how one can locate and fish Great Lake thermal fronts present during the period from about April 1 to about mid-June. Within this 75-day time frame, Lake Ontario undergoes a dynamic transition from winter mode to summer mode. This period sees the lake change from a very cold water body, having frozen or near freezing (32 degrees F) surface waters underlaid with warmer waters between 33 and 39 degrees, to a relatively warm water body, having surface temperatures exceeding 50 degrees and underlaid by cooler water temperatures down to near 39 degrees. Obviously, in the case of the other Great Lakes, the warming process and features may be slightly different in degree and timing, given contrasts in the lakes' water volume and regional climate. But all the lakes do undergo the winter-summer transition.

It's important for Great Lake anglers to understand that they will be fishing in waters that are highly dynamic -- thermally speaking -- during this transition time. The Lake Ontario experience suggests that those who apply an understanding of these dynamics are likely to make more productive fish-location decisions on a daily basis.

THE THERMAL BAR

Probably no single thermal front has captured more press in recent years than one referred to as the thermal bar. Similarly, it's likely that no thermal feature has been more often misidentified or incorrectly described. We'll try here to give the most accurate and understandable explanation we can of the bar, its action and its function in the lake.

The spring thermal bar on any larger lake in the cooler latitudes is a relatively short-lived, migrating temperature feature within which lake *turnover* takes place. It is, so to speak, a surface-to-bottom vertical wall that is located where 39-degree water temperature first occurs on the surface as you move away from shore. Inside, or nearshore, of it, surface and subsurface temperatures are above 39 degrees; outside, or offshore, of it, surface and subsurface temperatures are below 39 degrees (Figure 1).

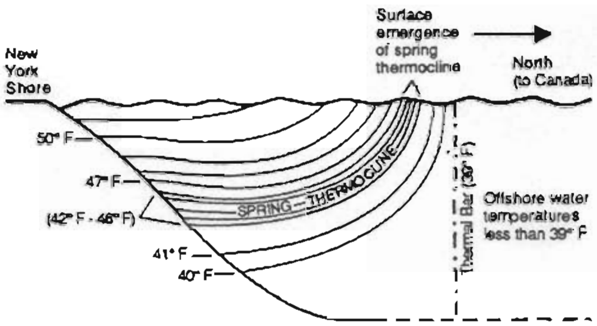


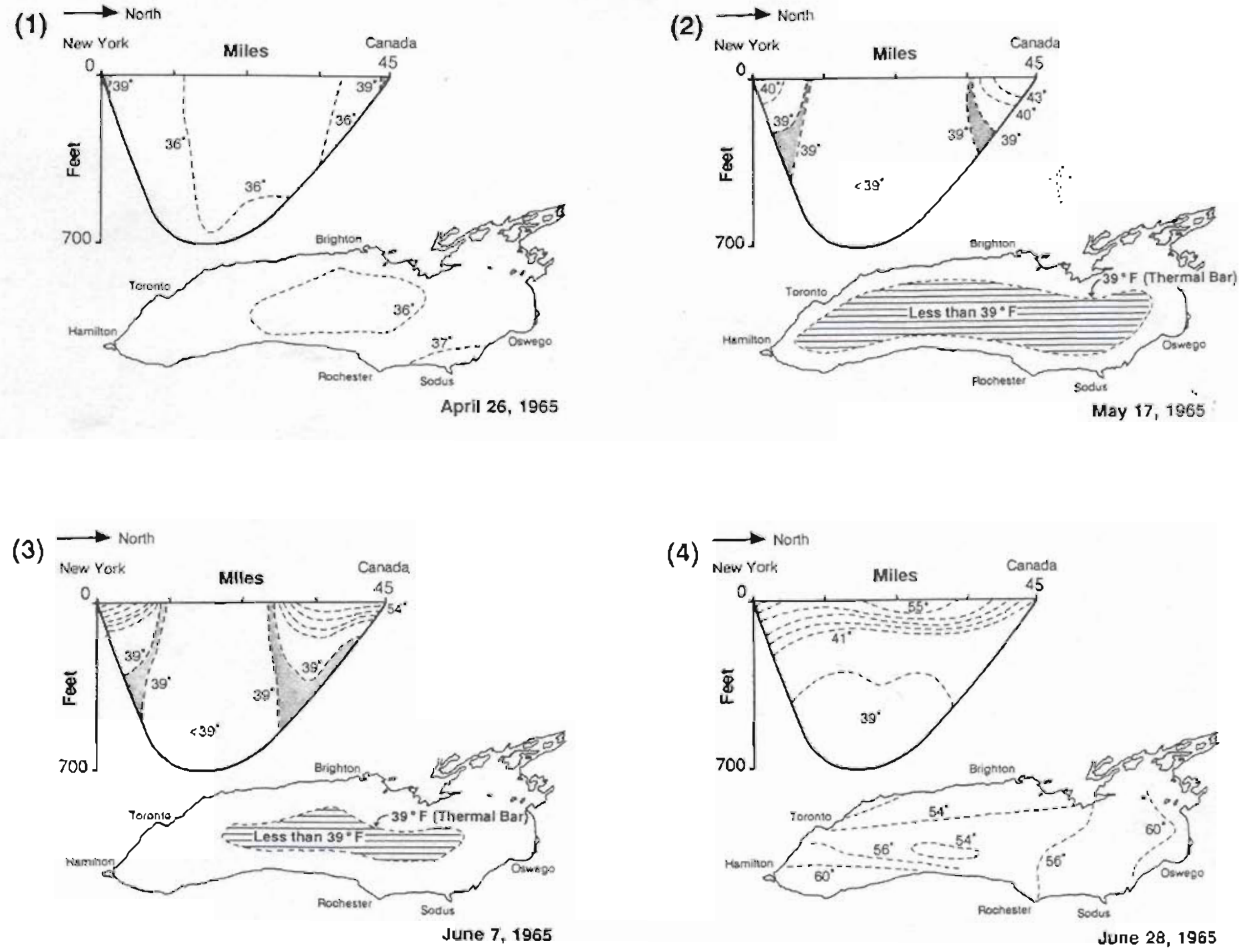
Figure 1. Idealized representation of spring water temperature profile on Lake Ontario, including the thermal bar and the spring thermocline. Note the pocket of warmer water formed inshore of the spring thermocline. Anglers on the lake have had greater success catching rainbows and other salmonids at the bar's surface and the surface emergence of the thermocline.

What's so magical about 39 degrees, and where does lake turnover come into play? Well, at 39 degrees, water is at its densest or heaviest. This is the part of natural law that dictates why ice (at 32 degrees) can float (it's lighter). In fact, all water with temperatures above or below 39 degrees is lighter (less dense) than water right at 39 degrees.

This process drives springtime turnover in lakes in cooler climes. To wit, as near-shore waters first rise to 39 degrees in early spring, they get heavy and sink to the bottom. This heavier water is replaced with warmer water from inshore and cooler water from offshore which, when mixed, reaches 39 degrees and sinks. This unalterable process takes place at the bar, powering the turning-over of all lake waters.

As spring progresses, more warm water collects in the adjacent nearshore zone due to stream inflows and solar heating. This zone expands and the bar moves offshore as more and more cold offshore lake core water is being warmed and turned-over (Figure 2). This offshore migration runs its course during the

Figure 2. Offshore progression of the lake's thermal bar is noted on the surface and in cross-section in these illustrations adapted from a 1965 Canadian study (Rodgers, 1966).



Predicting a Disappearing Act

Offshore boat anglers on Lake Ontario may be able to get an early fix on how long that lake's springtime warming phase may run, and when the thermal bar might disappear. Thanks to research done at the Canada Centre for Inland Waters and an educational fact sheet produced by New York Sea Grant Extension, Lake Ontario anglers can calculate an approximate thermal bar submergence date. Armed with this information, fishermen can estimate if the surface thermal fishing season will run late into June (or even July), or will likely "run out of gas" in early or mid-May. Fishing techniques and search patterns can be adjusted accordingly.

The calculation is based on average winter (December 1-March 31) air temperature data generally available from a local National Weather Service Office, college science department, or other sources. The bar's disappearance date, given in number of days beyond April 1st, can be computed using tables in the fact sheet, *Predicting When Lake Ontario's Thermal Bar Disappears?*, by David MacNeill. Contact Sea Grant, 52 Swetman Hall, SUNY, Oswego, NY 13126.

75-day transition period referred to earlier, until no water having a temperature of 39 degrees or less exists on the lake surface -- usually in early to mid-June (see the insert, "Predicting a Disappearing Act"). At that time, the lake assumes the character of its summer mode as described earlier.

The thermal bar migrates offshore at a slow rate before about May 15 on Lake-Ontario and at a much faster rate after that, again due mainly to the warming power of the late spring sun. On average, the Ontario bar moves about 1/3 of a mile a day during the transition period. Also, the bar migrates more quickly over areas having slight depth changes, and much more slowly over bottoms having steep offshore gradients. Lastly, the bar's general offshore progression is fairly consistent and predictable year to year, except when extreme weather conditions advance or delay migration to some extent (Figure 3).

THE SPRING THERMOCLINE

Just a few years ago, scientists had no real inkling of the existence and importance of another spring thermal front now known as the spring thermocline. For years, the characteristics and functions of this feature were simply attributed to the thermal bar. Both the bar and the spring thermocline usually occur in close proximity to one another, possibly masking each other's distinct role and qualities from earlier scientific investigations.

In any case, the spring thermocline is, as its root word "cline" connotes, a zone of rapidly declining water temperatures. According to studies done in the early 1970s on Lake Ontario, the spring thermocline represents that strata of water temperature change between 46 and 42 degrees. Yet unlike the generally horizontal summer thermocline, the spring version is inclined and has an emergent offshore end at the water's surface (Figure 1). Thus, it is both a surface area and a sub-surface layer. Also, it is a zone of sharp changes in many measures of water quality, including biological productivity, turbidity (muddiness) and current (Figure 4), as well as density and temperature.

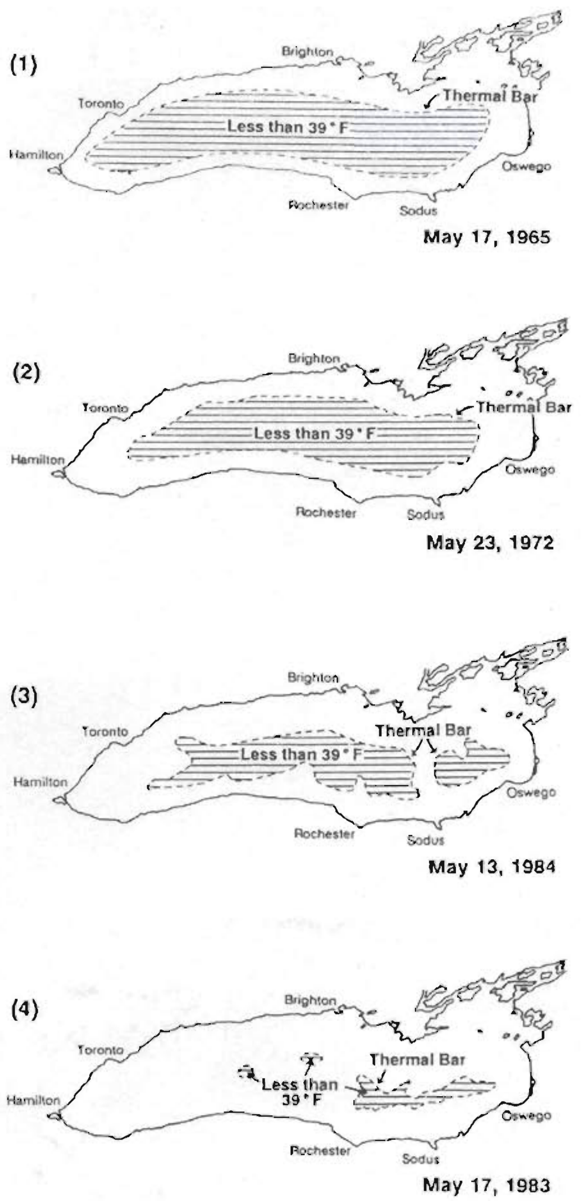


Figure 3. General consistency in the thermal bar's location (and the extent of lake warming) from year to year is evident in surface temperature maps from late May in 1965, 1972 and 1984 (maps 1-3). In contrast, map 4 shows how one of the mildest winters on record in the Northeast advanced the warming process on the lake, so that, on about the same date, much less water at 39 degrees or lower was found on the surface in spring 1983.

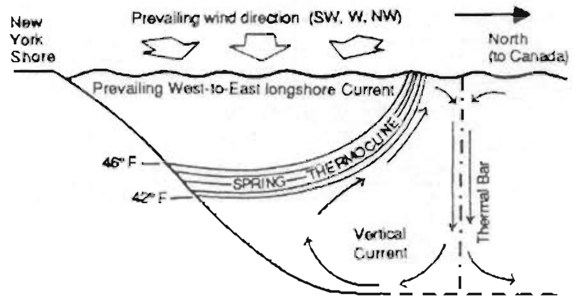


Figure 4. Idealized representation of some water movements at the thermal bar and spring thermocline. Note the sinking actions taking place at the bar. Also, note how corresponding upwelling along the bottom edge and longshore current shear along the top edge of the submerged spring thermocline may occur, creating a variety of current effects that may be attractive to salmonids.

Given their nature as places of change, the spring thermocline and the thermal bar are very much what ecologists define as *ecotones* or, in lay terms, edges or fronts. Like a hedgerow abundant with wildlife, the thermocline and bar have demonstrated their attractiveness to trout and salmon on Lake Ontario. Like a suspended reef, these features have shown the ability to concentrate salmonids in the lake's offshore regions.

PUTTING THERMAL KNOWLEDGE TO WORK: A RECIPE FOR FISHING GREAT LAKE THERMAL STRUCTURE

Finding the Features

Of course, the definitive way to locate the thermal bar and the emergent spring thermocline is to use a water surface temperature system. Moving offshore, you've found the bar when the temperature meter first intercepts 39-degree surface water. Then, as you move inshore of the bar, your gauge should detect the relative rapid thermal gradient between 46 and 42 degrees that constitutes the surface edge of the spring thermocline. A surface temperature meter is not always an absolute necessity, however. The downwelling created atop the bar and corresponding upwelling and current effects occurring near the upper and lower sides of the spring thermocline (Figure 4) frequently cause the formation of surface slicks of collected debris, such as insects, bird feathers, grass, dead forage fish, and other material. Also, the same factor often creates distinct differences in water surface tensions and ripple effects that are especially noticeable to the eye on calmer days. Another way to eyeball the bar and spring thermocline is to look for sharp water color or turbidity changes. Generally speaking, waters offshore of the *dynamic duo* tend to be less biologically productive and darker in color than more inshore waters.

How wide is the surface zone making up the two features? Over the last few years on Lake Ontario, zone widths exhibiting the full temperature gradient of 39 to 46 degrees have been reported to range from a few hundred feet on some days to a half mile or so on others.

Planning and Predicting Daily Movements of Features (and Fish!)

As a rule, the bar and spring thermocline tend to parallel the shore as prevailing onshore winds help to maintain a temperature profile and ribbon much as seen in Figures 1 and 2. If strong offshore winds arise, however, the ribbon of warmer nearshore waters can literally be blown offshore in the form of an island or bubble. If winds of this nature occur before and during your fishing trip, you'll probably find yourself running farther offshore in pursuit of the moving bubble and fish. Remember, too, that both the bar and spring thermocline will run their migratory course and be found farther and farther offshore with each passing week, as spring progresses toward summer.

Finding and Hooking Fish

An approach suggested by "tried and true" application of thermal information by charter skippers and ardent anglers on Lake Ontario in recent years is as follows:

1. Head offshore, locating the bar (39 degrees) with your surface temperature gauge. Longline on the surface preferably using planer boards to spread your pattern. Keep lures well behind the boat (50-150 feet). The major portion of the catch at the bar on Ontario has been steelhead and lake trout.

2. Next, particularly if the bar is not producing that day, troll inshore until you locate the spring thermocline (46 to 42 degrees) manifesting on the surface. Again, longline on the surface within this temperature band for steelies and some cohos and kings.

3. If your main target is kings, try downrigging, using your subsurface temperature system to keep lures between 46 and 42 degrees within the submerged portion of the spring

thermocline. On Lake Ontario, many spring chinook are taken by anglers deep trolling near this feature. Remember the temperature band constituting the thermocline will likely incline deeper as your boat moves toward shore, as seen in Figure 1.

4. Experiment! Try fishing atop the thermal bar and spring thermocline, then just inshore and offshore of these two features. Why? Two reasons. First, the track record from Lake Ontario indicates that, each year, a slightly different fish aggregation pattern will develop in association with these thermal features. For example, in 1982, most catches were reported right atop the bar. In 1983, most catches seemed to occur smack within the 46-42 degree spring thermocline surface edge. In 1984, best catches were at the warm (46-45 degree) edge of the thermocline, and in 1989, fishing well inshore of the 46-42 degree thermocline was most productive for many anglers.

The second reason to experiment is because localized winds and an irregular coastline that has spits, peninsulas, points, and shoals can produce indentations, oxbows and bulges in the normally parallel-to-shore thermal features. Paying attention to where catches are best and by adjusting your trolling pattern and location accordingly can often make for a fuller cooler.

5. Don't ignore other thermal fronts. In late spring, randomly occurring surface temperature gradients generically known as "thermal breaks" often occur. These breaks appear well inshore, usually between 50 and 60 degrees. Depending on the day, break gradients can be as slight as three degrees (say, 53 to 56 degrees) or as severe as 10 degrees, and can occur over a relatively short trolling distance. Lake Ontario experiences have suggested that these breaks hold fish and tend to be most productive when they represent the sharpest break to be found that day. They're definitely worth exploring.

Private Company Markets Surface Temperature Charts

In 1989, Offshore Services, Inc. (2679 Route 70, Manasquan, NJ 08736) began offering subscription service for Lake Ontario and Lake Michigan surface temperature charts. The company's information, provided to subscribers through the mail or fax machine, is based on heat-sensitive imagery generated from the NOAA-11 weather satellite. At the time this fact sheet was published (August 1990), no other commercial companies were providing Great Lake surface temperature chart services to the public.

OSI offers its service from mid-May to about mid-September. According to President Len Belcaro, subscribers opting for Offshore's facsimile service can look forward to having surface temperature data in their hands at least twice a week, and within a few early morning hours of the satellite's nighttime pass. "Outside of when cloud cover blocks our 'eye in the sky,' anglers can consistently have a real edge by using the charts to find offshore thermal breaks," claims Belcaro.

REFERENCES

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August 1990

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