WLSC PHRF TOT Handicapping and Scoring
for
Fall and Spring Race Series

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Introduction: It is very difficult to conduct a totally equitable race with such a diverse group of boats and people as that found at Watauga Lake. We employ two different handicapping systems in an attempt to address these inequities: Club and PHRF (Performance Handicap Racing Fleet). Thus, most boats are actually racing in two races simultaneously in our Spring and Fall Series.

(Disclaimer) No handicapping system is totally fair. However, we have chosen these somewhat imperfect ones while we continue to struggle for an unrealistic goal of perfection.

The WLSC Club system (developed by John Middaugh) includes both the sailboat and the crew in the handicap. We employ this approach to create a competitive atmosphere for those that might not necessarily desire to spend a lot of time and money improving their boat. However, as the boat and crew improves, their handicap is increased over time. Any sailboat can compete in this racing series if they have either a Portsmouth or PHRF rating.

The PHRF system is based only on the sailboat. Thus, the system attempts to factor out crew and boat preparation. The approach assumes that the boat is crewed by a very competent crew and with a boat in excellent condition. Thus, if one does not maintain their boat (sails, hardware, bottom, etc.) well and exert a significant effort in crew training, it will be somewhat difficult to consistently finish high in the PHRF race series.

Only boats with PHRF handicaps can compete in our PHRF TOT (time on time) Fall and Summer racing series. If a PHRF handicap is unavailable, it will be calculated for our PHRF TOD (time on distance) races using the Portsmouth value as a seed. PHRF TOD calculations are used for all fun races, the Frostbite Race, and the Summer Race Series. These latter races do not employ a committee boat and the TOD calculation is used to determine staggered starts for these "pursuit" type races.

This document will attempt to describe our implementation of the PHRF TOT system for the Fall and Spring Race series. The Club and PHRF TOT systems will be described in separate documents.

PHRF System (TOT vs. TOD): The United States Performance Handicap Racing Fleet (US PHRF) system is very well described on the following web site:

http://www.ussailing.org/phrf/index.asp

In previous years, we purchased the US PHRF Handbook. However, the book is relatively expensive. We are currently utilizing the average PHRF handicaps which are found in a list (PDF document) on the following US PHRF website:

http://www.ussailing.org/phrf/Tool_%20HI_LO_AVG%20Report.pdf

There are two ways to handicap races using the PHRF handicaps: Time on Time (TOT) and Time on Distance (TOD). In the TOD calculation, the corrected time is directly related to the distance (i.e. only distance is used in the calculation). On the other hand, in TOT the corrected time is proportional to the distance (i.e. distance is not used directly in the calculation). We use TOT for our Spring and Fall Series and TOD for all our fun races, the Frostbite Race, and Summer races. Examples of the club's TOD calculations used for Fun Races will be described in a separate document.

The vast majority of races in North America employ TOD calculations. However, a study made several years ago by a club committee (Bill Murdoch and others) indicated that TOT yielded less deviation in the spread of the results in our races.

TOT does a better job of correcting for inequities of changes in wind velocity and direction. Unfortunately, it is not as easy to determine your relative position in a race with TOT versus TOD.

Example Calculation: In order to sort through the TOT calculations, I thought it would be useful to include some calculations using some typical boats in our fleet. In Table 1, I have listed numbers for an unrealistic race in which everyone finished the race at the same time for illustrative purposes. (I wouldn't have wanted to be on the committee boat for the race finish that day!) I picked 4500 seconds for the length of the race because this is close to the average race length for the first boat crossing the finish line.

The winner is determined by the corrected time which is calculated by multiplying the TCF (time correction factor) of each boat times its actual time. The winner is based on corrected time. The TCF for each boat is calculated using the following equation.

$$\mathbf{TCF = A / (B + PHRF)}$$

The value for the B constant in the denominator, B + PHRF, is chosen such that combined number is approximately equal to the seconds it should take for a boat to sail a nautical mile.

The commonly employed values which are related to the wind conditions observed are noted below:

B Factor	When Used
480	Heavy Air or all off the wind
550	Average conditions
600	Light air or all windward work

We always use a value of 550 in our calculations. As discussed later, we should probably adjust this constant to correct for inequities in certain circumstances.

The A value is picked such that the average boat in the fleet would have a "nice" looking number of TCF ≅ 1. The commonly accepted value for the constant A is 650. The value of constant A will not affect the relative finishing order of boats, but the value of constant B can affect that order.

Thus, we arrive at the TCF equation employed in our time corrections:

TCF = 650 / (550 + PHRF)

The corrected time is calculated by multiplying the boats actual finish time by the boats TCF:

Corrected time = actual time x TCF

The boat with the lowest corrected time wins the race. Thus in our example in Table 1 in which all boats finish at the same time, the boat will win that has the highest PHRF. For the boat with the lowest PHRF to have won, it would have to have finished 386 (6 min 26 sec) seconds faster. A fairly large number for a race that lasts around 4500 seconds (75 minutes).

The calculations for the PHRF TOT races are somewhat cumbersome. However, we employ a very sophisticated Excel spreadsheet (developed by Jeff Arnfield and other unknown members) for calculating the results which makes the process manageable with a laptop computer at the dock.

Awarding Points for Each Boat in Race: The season trophy winners are determined by awarding points for each race. The previous scoring system is being supplanted with the "High Point Average System" this year. This new system, with respect to our club, is described in detail on the US Sailing website:

http://www.ussailing.org/rules/documents/SCORING_A_%20LONG_SERIES_09.pdf

I believe the "High Point Average System," for the reasons listed in the above document, is more appropriate for a longer series of race. I think our previous system was better suited for a regatta or "race week" situation in which the same boats participate in each race.

The "High Point Average System," is also known as the "at bat" scoring system. It is calculated in a manner similar to that employed for a batting average in baseball. The

United States Sailing document describes the system in enough detail, thus, the system will not be described in this document. Using the new "High Point Average System," the actual number of points cannot be accurately determined until the results for the entire series are available.

Determining Relative Position in TOT Races: As I mentioned previously, it is not as straight forward to calculate your relative position in a TOT race versus a TOD race. In the example in Table 1, I inserted a column labeled "Corrected Time 600 sec (10 min)."

Thus, if Captain Little had a keen interest in beating Captain Middaugh (just a hypothetical situation), he would need to be ahead 2 seconds (517-515 sec) for every 10 minutes in the race. Thus as Captain Little approached the finish line in a 1 hour 30 minute race, he needs to be ahead by >18 seconds (2 sec x 90 min/10 min). Still not a trivial calculation, but if you know who you want to beat and the difference in time for 10 minute period, one can estimate if you are ahead during the race or if you won at the end of a race.

Problems with PHRF TOT in "Non-average" Conditions: We only use a B value of 550 in our calculations, which is for average wind conditions. We should probably change this factor with conditions to make the TOT handicapping more equitable. Possibly next year with some additional study we can set a procedure to decide on acceptable adjustments in this variable.

In essence by varying this constant B, the TOT race is not dependent only on time since the B + PHRF should be determined by the time it takes for the boat to sail a nautical mile. We probably need to factor in the total race length and select limits for employing the correct value for this constant.

We have a particularly bad situation when the wind totally dies for long periods of time. Table 2 show how much time the highest PHRF boat in the examples would gain on the boat with the lowest PHRF in 40 minutes (seen it happen often!). This is a bad situation since the "clock continues to run" in PHRF TOT races, but the boats are not moving. This is essentially "unearned" time. The boats with low PHRF's are losing time to those with high PHRF which will have to be gained once again when the wind starts to blow. I don't think even the TOT with a B value of 600 would totally correct this inequity, but it might help.

In this example, running the race as TOD versus TOT might have help. However, it would be difficult to determine guidelines for changing the PHRF protocol during a race.

Table 1: Example Calculation Assuming All Boats Finished at Same Time for Illustrations of Several Concepts of PHRF TOT Racing.

Boat	Captain (s)	PHRF	Racer's Time	TCF (Average wind)	Corrected Time for 4500 sec race	Corrected Time 600 sec (10 min)	Finish Place
Tanzer 22 CB	Murdoch	243	4500	0.820	3689	492	1
Oday 27-2 IB	Bryson/Galloway	228	4500	0.835	3760	501	2
Chrysler 26 SK	Arnfield	225	4500	0.839	3774	503	3
Balboa 26	Lucas	219	4500	0.845	3804	507	4
Catalina 27 IB	Middaugh	207	4500	0.859	3864	515	5
Catalina 270	Little	204	4500	0.862	3879	517	6
Catalina 27 TM IB	Catoe	201	4500	0.866	3895	519	7
Hunter 26.5	Donovan	189	4500	0.880	3958	528	8
Catalina 28 TM	Cathelyn	186	4500	0.883	3974	530	9
Hunter 28.5	Linebarger/Banks	180	4500	0.890	4007	534	10
San Juan 28	Hallier	180	4500	0.890	4007	534	11
J-22	McMillan	177	4500	0.894	4023	536	12
Capri 25	Ford	174	4500	0.898	4040	539	13
J-24	Guy/Greene	168	4500	0.905	4074	543	14

CB = centerboard
IB = In-board motor (normally diesel), versus some models would be OB,(out-board)
SK = swing keel

Table 2: Calculation of Time Differences with Different B constants in TOT formula.

Boat	Captain(s)	PHRF	TCF (low wind, B=600)	Corrected Time 600 sec (10 min) low wind	TCF (avg wind, B=550)	Corrected Time 600 sec (10 min) avg wind	TCF (high wind, B=480)	Corrected Time 600 sec (10 min) high wind
Tanzer 22	Murdoch	243	0.771	463	0.820	492	0.899	549
J/24	Greene / Guy	168	0.846	508	0.905	543	1.00	602
Difference 10 min:				45 sec		51 sec		63 sec
Difference 40 min:				180 sec		204 sec		252 sec