An Improved Handicap System

Background

Handicap systems initiated in the 1970s are based on formulas with no direct relation to observed results. These systems have proven too generous for older rowers, making it difficult for younger boats to do well in races where a broad spectrum of ages are represented.

Recommendation

A schedule of ratios should be applied to the best time in the event, or to a predicted 'standard' time for the event. The choice of a base time for each event allows for differences in conditions and boat speeds.

1k standard times are suggested as follows:

(seconds)	Men	Women
1x	210	235
2- same as 1x	210	235
2x	190	220
4x	170	195
4+	190	220
4-	180	210
8+	170	195

The ratio/age schedule, and the resulting seconds' handicap for 1k M1x and W1x races with standard times of 210 seconds and 235 seconds, are shown on the following page.

Separate schedules of ratios are proposed for men and for women, because elder women slow down more than elder men. The womens' ratios, as recommended, are based on observation of historic results. The male-female difference will probably be reduced, with the aging of more women rowers from the explosion of women's rowing that started in the late 1970s. For simplicity, a single schedule could be applied for both men and women – so that the best or standard time difference is the only gender distinction. Or, to review in five years.

The ratios should be simple to use. With the ratios and racers' ages entered on a spreadsheet, regatta organizers need only enter their judgment of standard time for the event, or after the race, the best time. The finish time of each individual will instantly compute to adjusted time.

For races longer than sprints of 1k up to 2k, the recommended ratios will result in over-generous handicaps for older rowers. For races longer than 2k, please see discussion below under "head races".

Age	cumulative ratio to standard time	cumulative allowance in seconds, M1x standard time 210 sec's	Age	cumulative ratio to standard time	cumulative allowance in seconds, W1x standard time 235 sec's
27	0.000	0.0	27	0.000	0.0
28	0.001	0.2	28	0.001	0.3
29	0.002	0.3	29	0.002	0.6
30	0.002	0.5	30	0.004	0.8
31	0.003	0.7	31	0.005	1.1
32	0.004	0.8	32	0.006	1.4
33	0.005	1.0	33	0.007	1.7
34	0.006	1.2	34	0.008	2.0
35	0.006	1.3	35	0.010	2.3
36	0.007	1.5	36	0.011	2.5
37	0.008	1.7	37	0.012	2.8
38	0.009	1.8	38	0.013	3.1
39	0.010	2.0	39	0.014	3.4
40	0.010	2.2	40	0.016	3.7
41	0.011	2.4	41	0.017	3.9
42	0.012	2.5	42	0.018	4.2
43	0.013	2.7	43	0.019	4.5
44	0.014	2.9	44	0.020	4.8
45	0.014	3.0	45	0.022	5.1
46	0.015	3.2	46	0.023	5.4
47	0.016	3.4	47	0.024	5.6
48	0.017	3.5	48	0.025	5.9
49	0.018	3.7	49	0.026	6.2
50	0.018	3.9	50	0.028	6.5
51	0.025	5.2	51	0.037	8.7
52	0.031	6.6	52	0.047	11.0
53	0.038	8.0	53	0.056	13.3
54	0.044	9.3	54	0.066	15.5
55	0.051	10.7	55	0.076	17.8
56	0.057	12.1	56	0.085	20.0
57	0.064	13.4	57	0.095	22.3
58	0.070	14.8	58	0.104	24.5
59	0.077	16.1	59	0.114	26.8
60	0.083	17.5	60	0.124	29.0
61	0.090	18.9	61	0.133	31.3
62	0.096	20.2	62	0.143	33.6
63	0.103	21.6	63	0.152	35.8
64	0.109	23.0	64	0.162	38.1
65	0.116	24.3	65	0.172	40.3
66	0.130	27.3	66	0.181	42.6
67	0.144	30.2	67	0.191	44.8
68	0.158	33.2	68	0.200	47.1
69	0.172	36.1	69	0.210	49.4
70	0.186	39.0	70	0.220	51.6
71	0.200	42.0	71	0.229	53.9
72	0.214	44.9	72	0.239	56.1
73	0.228	47.9	73	0.248	58.4
74	0.242	50.8	74	0.258	60.6
75	0.256	53.7	75	0.268	62.9
76	0.270	56.7	76	0.277	65.1
77	0.284	59.6	77	0.287	67.4
78	0.298	62.6	78	0.296	69.7
79	0.312	65.5	79	0.306	71.9
80	0.326	68.4	80	0.316	74.2
81	0.340	71.4	81	0.325	76.4
82	0.354	74.3	82	0.335	78.7
83	0.368	77.3	83	0.344	80.9
84	0.382	80.2	84	0.354	83.2
85	0.396	83.1	85	0.364	85.4

Handicaps for mixed boats would fall between the men and women.

The recommended 1k ratios are not curves. They are based on three straight lines, with bends at 50 and 65. The incremental difference per year of age is shown here:

Men		increase/year in ratio to standard time	sec/yr if standard time is	**Women**		increase/year in ratio to standard time	sec/yr if standard time is
			210				235
handicap 27-49		0.0008	0.168	handicap 27-49		0.0012	0.282
handicap 50-64		0.0065	1.365	handicap 50+		0.0096	2.256
handicap 65+		0.014	2.94				

Method

John Garrett (Canada) and Carlo Zezza (USA) have worked on this for two years, based on compiled data as noted below.

We think we have found a good approach based on 1km racing in Men's and Women's singles. The situation is less satisfactory for head races due to limited data that includes actual age of younger rowers.

Data on which the proposed revisions are based:

For each of 8 regattas, 6 US Masters National Championships and two FISA World Masters Championships, we selected the fastest few times in each FISA age category.

For the US Masters championships we only used times from finals. The actual age of the rower is used to determine the his or her FISA category, not the nominal category of the particular race. The fastest 50% of times for the final of each FISA category (based on actual age) were chosen. In the selection process lightweights were treated separately from heavyweights but in the subsequent analyses they have been combined.

For FISA Worlds the actual ages were again used to assign rowers to FISA age categories. Since there is no heat/final process to eliminate slower rowers we used only the fastest 1/6 (15%) of times, roughly equivalent to the winners of 6-boat races.

This approach reflects a belief that the handicap should reflect the performance possible by the best trained athletes, whose performance falls off more with advancing age.

Dealing with different regatta conditions

We compared the differences between regattas based on two kinds of statistics. One was based on the actual raw finish times in seconds and the other was based on the ratio of each finish time to the fastest time in the given boat type for a Masters rower in the

regatta in question. The calculated variance between regattas was smaller for the ratio method which partly eliminates differences in conditions.

We conclude that a handicapping system based on a ratio to the fastest regatta time will be more fair because it allows for unusual conditions, e.g. a current.

Application of handicaps in sprint racing

The basic objective of handicapping is to encourage participation in the sport. Normally sprint races are conducted between boats in a given FISA age category, without any handicaps. Older boats often win: within the range of ages in a FISA category the range of variation in training, skill and strength between individual boats is larger than any age related effect. When there is only one boat in a given age category handicapping may be used to provide more satisfying opportunity for that boat to particpate in races against younger or older boats. No handicapping scheme will be perfect – the best that can be expected is to reduce the effects of age to something less than would normally be accepted within a FISA age category.

Resulting proposed revised handicaps for 1km sprint regatas

The same ratios would be applied to all boat/crew combinations, using the average of the handicap ratios of the individual rowers according to their actual age. The fastest or standard times depends on the boat/crew type. *struck out reference to gender because we are proposing separate schedules*

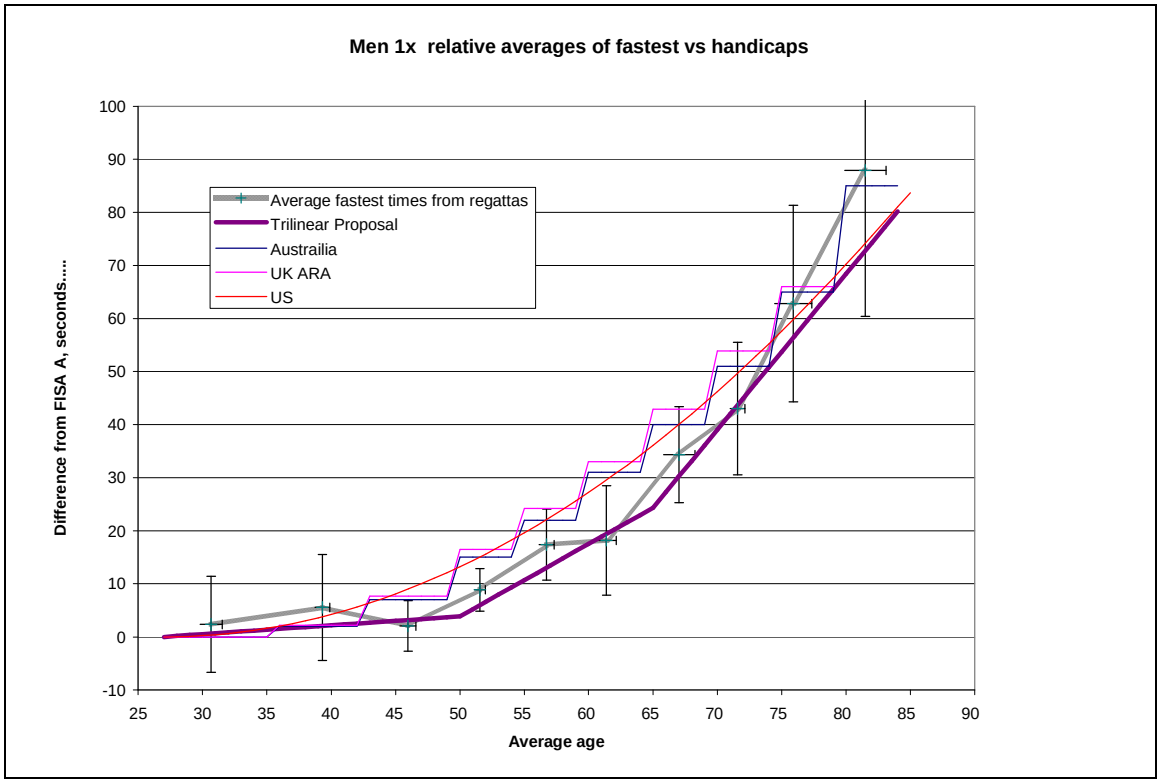

Figure 1: Comparison of actual finish times, existing handicaps and proposal, for Men 1x 1km sprint races.

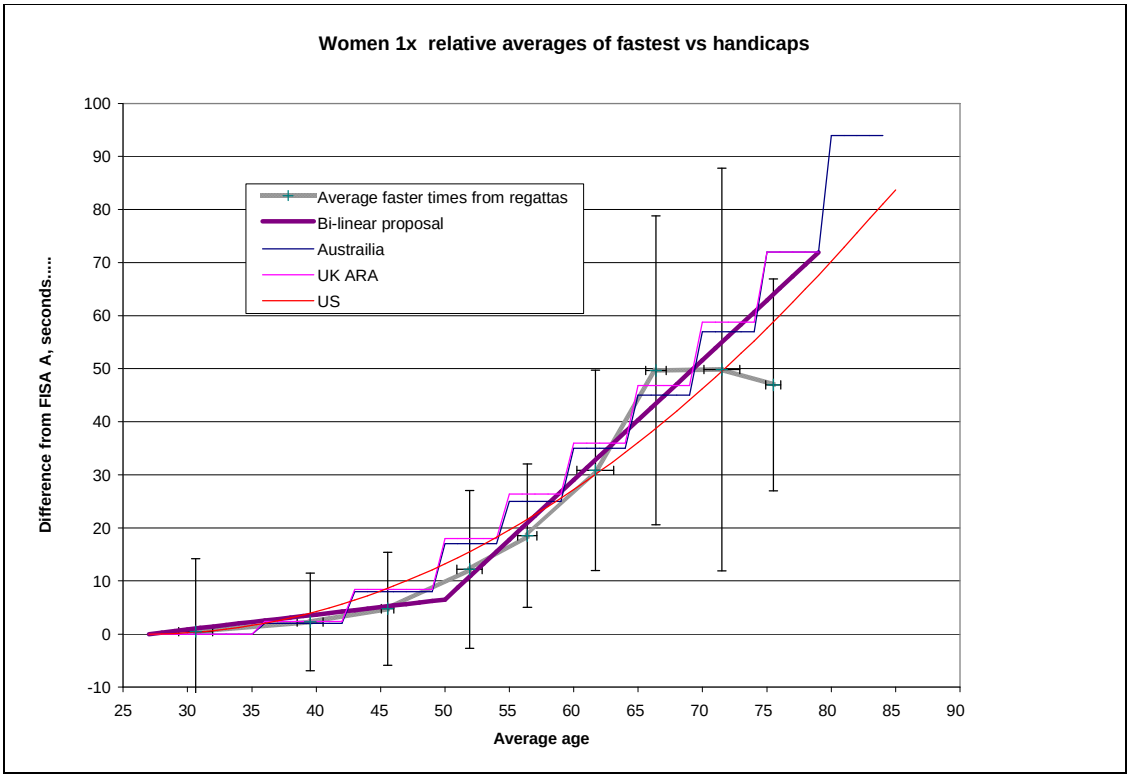

Figure 2: Comparison of actual finish times, existing handicaps and proposal, for Women 1x 1km sprint races.

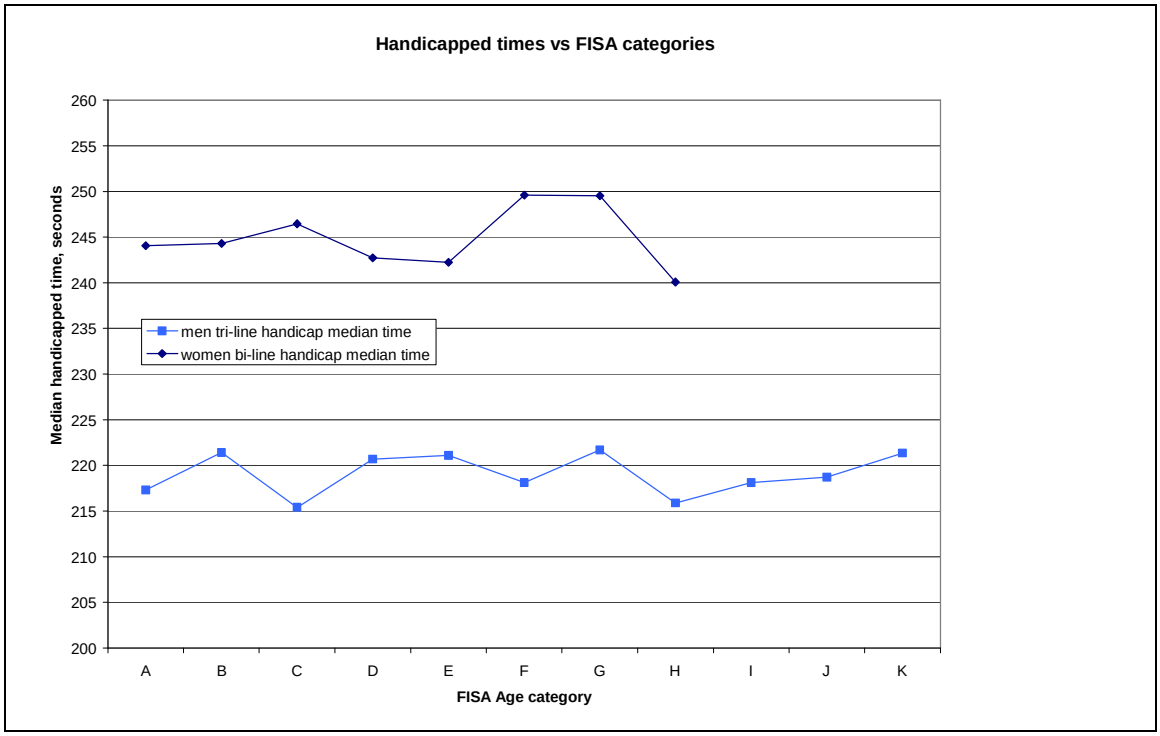

Figure 3: Results of applying proposed handicaps to actual regatta fastest finish times, median of the fastest 15% of times plotted against FISA category. A perfect handicapping scheme would produce a straight line. A difference of 5 seconds or less between categories is probably acceptable since variations within an age category are typically this big. The proposed tri-line handicap for men is achieves this, but the women are problematic, mainly due to much smaller numbers of rowers in the older categories.

How did we develop and test these handicaps?

We experimented with various methods of fitting lines and curves to the observed data but the results were unsatisfactory. The limited amount of data and the observed variability combined to produce large "standard errors" to curves fit by normal statistical methods. We could not distinguish between related curves.

A "non parametric" or "rank correlation" approach was more successful. The time ratios were ranked from smallest ratio to largest and the rower age was also ranked from youngest to oldest. This approach directly addresses what the handicap is trying to do, which is to eliminate the correlation between age and placement.

We looked first at various age groups, e.g. 75 up, 70 up, etc. In each case we ranked the ages, youngest =1, etc and the ratios of finish times to regatta fastest, smallest =1 and then calculated the correlation between the age ranks and the time ratio ranks. We then experimented with applying a linear correction to the ratios in each age group. We tried different corrections until we found the value that reduced the correlation between time ratio rank and age rank to zero.

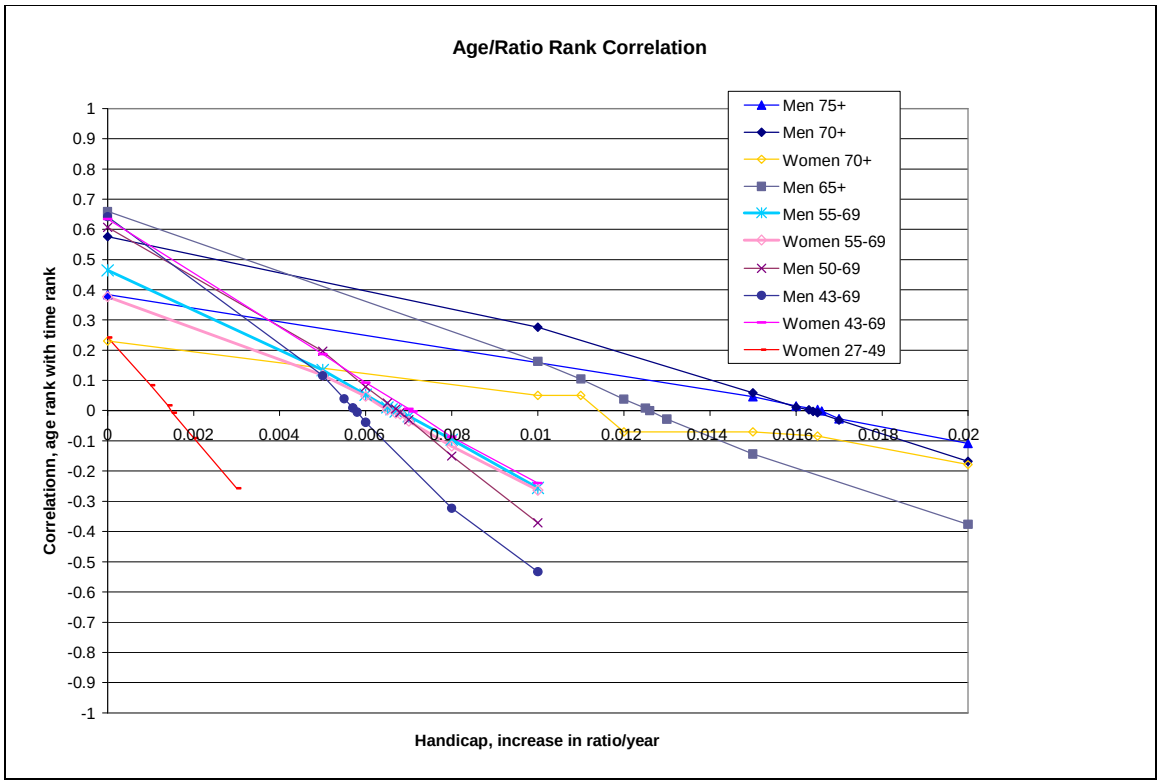

Figure 4 shows this process in visual form. The objective is to find the value for increase in handicap per year of age which gives zero correlation between the rank of the rower's age and the rank of the rower's finish time.

The values for 70+ and 75+ were essentially the same (about 0.0165/year for men) but 65+ was lower, suggesting a change in slope somewhere in the late 60s. Similarly 55-69 and 50-69 were essentially the same (about 0.0065/year for men) but 43 to 69 was different, suggesting that the rate of change between 50 and 69 was reasonably consistent. Less than 50 was a problem because the 43 to 50 age bracket (FISA C) is actually a bit faster than the younger ages, where the best rowers may be on national teams and not in veteran races.

We then tried putting together a "tri-line" that included the whole age range, with the elbows at 50 and 70. Simply using a line with no handicap from 27-49, 0.0065 from 50 to 69, and 0.0165 from 70 up, still left a significant correlation between age rank and ratio rank so we made some further adjustments with the objective of minimizing the correlation between age rank and ratio rank over the whole age range.

Figure 5 shows the result of applying a handicap where the ratio to the fastest time increases at 0.0008/year between 27 and 49, 0.0065/year between 50 and 64, and 0.014/year after that. The reason these numbers are bigger than the slopes obtained from isolated age groups is that the older groups have an average ratio as well as the slope. Although these values give the lowest overall correlation it isn't all that sensitive to the 65+ value: a value of 0.013 or 0.015 wouldn't make the correlation too much worse.

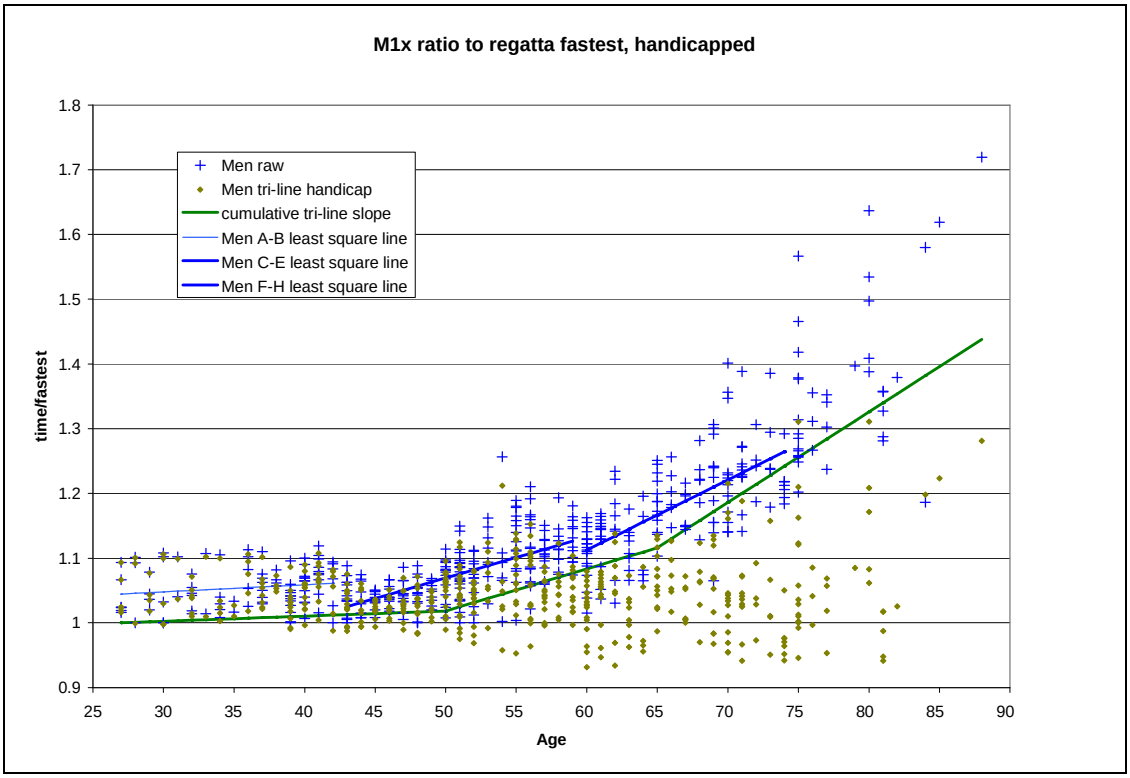

Figure 5 Effect of proposed tri-line handicap on individual finish times for Men 1x

We also applied the same approach to the Womens 1x with data from the same regattas treated in the same way. The result is less satisfactory. This is partly due to much lower numbers of older women rowers, so that one or two individuals have a greater effect on the overall result. A handicapping scheme consisting of an increase in ratio of 0.0012 per year for ages from 17 to 50 and then of 0.0096 per year gave the smalled correlation between age rank and time rank, but this issue needs to be revisited in 10 years when there are more women over 60 participating in regattas

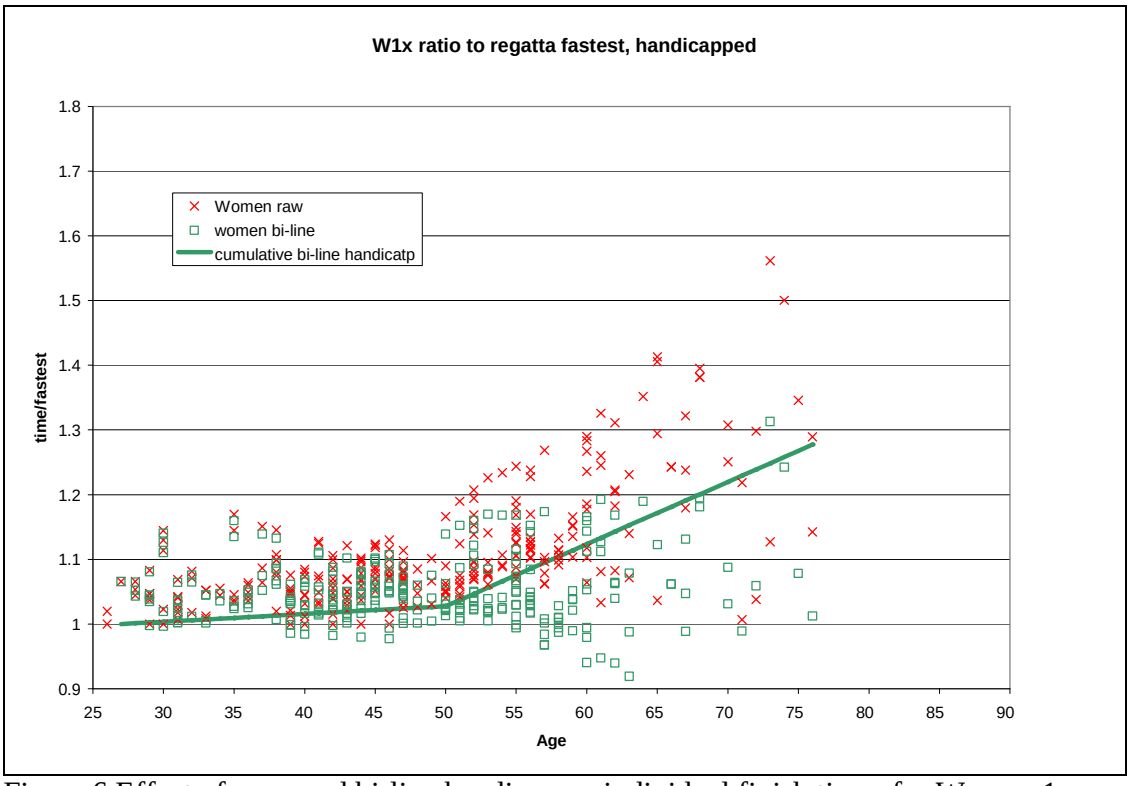

Figure 6 Effect of proposed bi-line handicap on individual finish times for Women 1x

Head Races - Can the same curve be used over significantly different distances?

Head race results* suggest that the performance of elder racers declines less than in sprint races. The authors' opinion is that a separate schedule of ratios should be used for ages 50 and up. This schedule is shown on the following page.

The rationale is based on the reasons for the difference.

One reason may be that the best elder rowers have more efficient technique. If we believe that technique should be rewarded, the ratios might be taken over from the sprint schedule.

A more likely reason is physiological change. Muscle mass deteriorates with age. The cardio-vascular system may deteriorate, but not at the same rate.

… short races depend more on power
… long races depend more on endurance

It is possible that elder racers even become more aerobically efficient, as muscles shrink.

… muscle mass varies with the cube of the radius
… surface area (skin area) varies with the square of the radius

The cardio-vascular system resides primarily just below the surface. As we age, our delivery of oxygen remains relatively unchanged, but has less muscle to feed. (Long distance runners with pipestem legs are an extreme example of this kind of efficiency.)

Observation of ages up to 50 in head races is scanty, coming from Silverskiff in Italy and from the Scullers' Head in London. We have extensive observations from the Head of the Charles, but only in the Grand Masters and Veterans M1x divisions, (50-59 and 60-69).

The schedule that follows is consistent with 1k results up to the age of 50, and with Head of the Charles results for ages 50+:

age	cumulative ratio to std/best time	cumulative allowance in sec's M1x standard time 1080 sec's
28	0.0000	0
29	0.0004	0.47
30	0.0010	1.06
31	0.0022	2.35
32	0.0029	3.10
33	0.0039	4.23
34	0.0053	5.75
35	0.0070	7.51
36	0.0088	9.51
37	0.0109	11.74
38	0.0132	14.20
39	0.0157	16.90
40	0.0184	19.84
41	0.0213	23.01
42	0.0245	26.41
43	0.0278	30.05
44	0.0314	33.93
45	0.0352	38.04
46	0.0392	42.38
47	0.0435	46.96
48	0.0479	51.77
49	0.0526	56.82
50	0.0575	62.10
51	0.0648	70.03
52	0.0699	75.51
53	0.0752	81.21
54	0.0807	87.14
55	0.0864	93.29
56	0.0923	99.66
57	0.0984	106.26
58	0.1047	113.08
59	0.1112	120.12
60	0.1180	127.39
61	0.1253	135.37
62	0.1312	141.69
63	0.1372	148.21
64	0.1434	154.90
65	0.1498	161.78
66	0.1563	168.84
67	0.1630	176.09
68	0.1699	183.52
69	0.1770	191.13
70	0.1842	198.92
71	0.1916	206.90
72	0.1991	215.06
73	0.2069	223.41
74	0.2148	231.94
75	0.2228	240.65
76	0.2311	249.55
77	0.2395	258.63
78	0.2480	267.89
79	0.2568	277.34
80	0.2657	286.97

The preceding is based on a formula. The formula is intended to replicate the tri-linear recommendation up to age 50 and provides a curve to correspond with the slope of Head of the Charles results from age 51 to 69, with extension to ages 70+. Like the tri-linear recommendation for sprint races, there are three "breaks", with the first at 49-50. In the head race schedule, the second break is at age 59 (muscle mass loss is greatest in the 50-59 age range). The formula and associated variables follow:

$$\frac{\frac{(\text{Age}-27)^2}{\text{"D"}} + \text{"C"}}{\text{"E"}}$$

Variables	"C"	"D"	"E"
28-50	0.00044	10	920
51-59	4.8	10.5	920
60+	25	12.8	920