The Evolution of British Navy Wind Force Terms and New Wind Speed Equivalents, 1691-1820

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INTRODUCTION

- Previous research using British Royal Navy logbooks showed a discrepancy between the wind force terms in use in 1815-1816 and those in the modern Beaufort Scale and that wind speed equivalents for each term could not be reliably applied to historical data (Chenoweth 1999). This work presents expands on this older research and depicts the evolution of wind force terms from 1691-1820, prior to the adoption of the Beaufort Scale by the Royal Navy in 1838. New wind speed estimates for the common wind force terms are presented, using two contemporary records that equated wind force terms to wind speed from experimental results.

DATA

The records of 440 Royal Navy logbooks for the years 1690-1826 were obtained from the UK National Archives. Ship encounters with tropical cyclones were used to increase the sample size of rarer wind force terms. Only ships between 10 and 25 degrees north latitude were used and during the main hurricane season of June through November were sampled.

- Two early records of wind force terms equated to wind speeds made by Rous (Capper 1801) and Pocock (1827) were compared with the modern Beaufort Scale to update previous work by Chenoweth (1999). Identical wind force terms in the three scales provide estimated wind speeds and are compared for consistency.

RESULTS

- Table 1 indicates that the actual usage of Royal Navy wind force terms were in a slow continuous evolution throughout the entire period. The winds and gales of the 1690s changed into breezes and gales and their relative frequency underwent major changes. Only by the 1810s are the wind force terms comparable to the Beaufort Scale.

Decade	Little Wind	Small Gale	Moderate Gale	Fresh Gale	Strong Gale	Hard Gale	Light Airs	Light Breeze	Moderate Breeze	Fresh Breeze	Strong Breeze
1691-1700	9.4	9.4	20.1	33.5	3.5	24	0	0	0	0	0
1701-1710	8.7	3	26	31.9	5.9	23.7	0	0	0.7	0.2	0
1711-1720	10.6	0.3	26.6	32.3	5.4	24.5	0	0	0.3	0	0
1721-1730	11.8	0	15.3	38	3.6	29.6	0.2	0	0.4	1.1	0
1731-1740	15.8	0	14	42	5.1	20.9	0.2	0.4	0.7	0.9	0
1741-1750	8.8	0.3	7.8	43.9	9.9	26.5	1.9	0	0.8	0.3	0
1751-1760	8.4	0	1.5	38.6	11.5	21	8.8	1.9	2.3	6.1	0
1761-1770	4.6	0	2.6	22.8	14.4	13.7	12.2	3.6	5.5	20.6	0
1771-1780	1.8	0	0.2	23.6	21.8	9.8	6	4	6.6	25.2	1
1781-1790	1.8	0	0	13.3	18	6.3	1.1	5.2	12.6	29	2.9
1791-1800	0	0	0	10.1	25	3.4	16.4	5.2	8.6	27.2	4.1
1801-1810	0	0	0.3	10.8	17.4	3	10.8	6.5	9.7	29.8	11.8
1811-1820	0	0	0.4	11.6	20.9	1.6	4.7	3.5	10.1	26	21.3

TABLE 1 . Frequency of wind force terms in ships encountering tropical cyclones in the North Atlantic Ocean, by decade, from 1691-1820, expressed as a percentage frequency of each decade's total. The relative frequency of wind force terms is biased due to sampling methods but shows the gradual evolution of wind force terms recorded in British Royal Navy logbooks. Bold values indicate the most common term used in each decade. Underlined values denote a significant change in the frequency of each wind force term. The 1750's marks the emergence of terms associated with the Beaufort Scale.

- "Fresh gales" were most common to 1770 but were replaced by "Fresh breezes" after 1770. The emergence of a "proto-Beaufort" scale in the 1750s is evident.
- Wind force terms tend to emerge and disappear in about 2 to 3 decades.
- "Hard gales" undergo a decline from ~24% prior to 1780 to less than 2% of all terms by 1820. Wind forces are for eight-hour increments up to ~1795 and then for two- to four-hour increments. Frequent lulls and squalls of wind in tropical cyclones are difficult to capture at such large sampling intervals.

WIND SPEED EQUIVALENTS

- Experiments in India by Rous (Capper 1801) and in England by Pocock (1827) provide contemporary estimates of wind speed and equivalent wind force terms. Table 2 compares these values with those ascribed to the modern Beaufort Scale. They confirm results from Chenoweth (1999) that the uncritical use of the modern scale to historical wind force terms will produce an over-estimation of the "true" wind speed equivalent.

Capper (1801) Wind Force Term	Velocity in miles per hour	Pocock (1827) Wind Force Term	Velocity in miles per hour	Beaufort Scale Wind Force Term	Velocity in miles per hour
Almost calm	1	Not stated	/	Light Air	1-3.
Just perceptible	2-3.	Not stated	/	Light Breeze	4-7.
Gentle Breeze	4-5.	Gentle Breeze	3-5.	Gentle Breeze	8-12.
Not stated	/	Active Breeze	7-12.	Moderate Breeze	13-18.
Fresh Breeze	10-15.	Pleasant Gale	14-18	Fresh Breeze	19-24
Fresh Gale	20-25	Brisk Gale	20-26	Strong Breeze	25-31
Strong Gale	30-35	Strong Gale or Wind	30-38	Moderate Gale	32-38
Hard Gale	40-45	High Wind	40-50	Fresh Gale	39-46
Storm	50-60	Not stated	/	Strong Gale	47-54
Not stated	/	Furious Wind or Storm	55-65	Whole Gale	55-63
Violent Hurricanes,	80-100	Tempest	70-80	Storm	64-72
Tempests, etc.	80-100	Hurricane	80-100	Hurricane	73 and up

TABLE 2 . Wind force terms equated to wind speeds derived from early experiments at measuring wind speed by Rous in Bengal in the 1790s (Capper 1801) and Pocock in England over a number of years from 1816-1826 (Pocock 1827). Despite differences in some terminology the comparable results indicate qualitative agreement in the perception of wind force and the number of terms used over the same range of speeds. When compared with the modern Beaufort Scale it is evident that uncritical application of identical wind force terms produce a positive wind speed bias.

- Only three identical wind force terms and equated wind speeds from Rous and Pocock are available for comparison with the modern Beaufort Scale. A gentle breeze is defined as 3-4 mph and 3-5 mph by Rous and Pocock , respectively. The Beaufort Scale assigns it 8-12 mph. A strong gale is defined as 30-35 mph and 30-38 mph versus 47-54 mph in the Beaufort Scale. Contemporary observers estimate much lower wind speeds than would be derived from an uncritical application of the modern Beaufort Scale to early wind force terms. All scales are in good agreement for hurricane force winds.

NEW WIND SPEED ESTIMATES

- Table 3 provides estimates of wind speed for circa 1700 and circa 1815 for Royal Navy ships. These subjective estimates are informed by both Rous and Pocock and the number of wind force terms in use in each era. More terms were used in later years. This change was probably driven by changes in sails and ship design as suggested by Kinman (1969). These new wind speed estimates are being compared with damage reports in hurricanes to further check their relative accuracy.

Wind Force, circa 1815	Wind Speed	Wind Force, circa 1700	Wind Speed
Calm	0	Calm	0
Light Airs Inclinable to Calm	0-2.	Little Winds and Calms	0-2.
Light Airs	2-4.	Little Winds	2-5.
Light Breeze	4-8.	Small Gale	5-10.
Moderate Breeze	8-12.	Moderate Gale	10-15.
Fresh Breeze	12-18.	Fresh Gale	15-20.
Strong Breeze	15-25	Strong Gale	20-30
Fresh Gale	20-30	No comparable term	/
Strong Gale	25-40	No comparable term	/
Hard Gale	35-60	Hard Gale	30-50
Exceeding Hard Gale	50-80	Storm or Tempest	50-70
Hurricane	70 and up	Hurricane	70 and up

TABLE 3 . Estimated wind speeds for the most common wind force terms used by the Royal Navy in circa 1815 and circa 1700. Four of Beaufort's original wind force terms were rarely used by the Royal Navy including "Gentle Breeze". Note the prevailing sense of the word 'gale' in 1700 to be the same as a 'breeze' in 1815 and two fewer terms in the 1700 scale.

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