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6 Capital

Although the distinction is sometimes blurred, tradition divides the capital needed on a whaling voyage into two parts: the vessel and the outfit. The vessel included the hull and the original masts, rigging, and sails. The outfit was a heterogeneous collection: spare sails, extra line and fittings, and lumber to replace the masts or patch the hull; food and provisions; whalecraft, that is, whaleboats and weapons; bricks for repairing the tryworks, spades and rigging for flensing, and staves and hoops for assembling oil-storage barrels.

The investment in vessels and outfits at the industry's peak was considerable. In 1859 the *WSL* reported that sixty-five whalers had sailed from New Bedford the previous year "at an average expense with outfits of $30,500," or $1,017 per crewman using the *WSL*'s estimate (8 February 1859) of thirty crewmen per vessel.[1] If that figure was typical of all 316 vessels that the *WSL* said were in the city's fleet at the time, the capital investment—had they all set sail at once—would have totaled $9,638,000. Twenty years later the industry had shrunk both in the number of vessels and in the capital investment per vessel, but the 123 New Bedford whalers were still valued with their outfits at $2,414,000 (Clark 1887b, 272).

6.1 Vessels

An agent's decisions about a prospective voyage were not necessarily made in a particular order, but each decision limited his choices about other matters. Here a fairly typical order is described, though a given agent may have made his choices differently.

1. Using the Warren and Pearson "All Commodities" wholesale price index as the deflator, the total capital investment in 1880 dollars would be $10,363,440, the per-crewman figure, $1,094 (U.S. Department of Commerce 1975, series E-52).

First the agent chose a type of whale to hunt and an ocean in which to hunt it. These choices narrowed his options for the next decision, the type of vessel. If he were going after bowheads in the Western Arctic, where maneuverability was of paramount importance, he would likely choose a bark. For a short right-whale voyage in the Atlantic, he might choose a smaller vessel—a brig, a schooner, or a sloop. For a sperm-whale voyage in the North Pacific, the odds were that he would choose a wooden sailing ship.[2]

Having chosen a rig, the agent decided the appropriate size of the vessel. Size was recorded in tons, a measure of capacity. Until 1865, however, there was only a loose relationship between measured tonnage and the number of cubic feet within the vessel's hull. In that year a new system of measurement was adopted, and, thenceforth, a vessel's tonnage was a close approximation of its capacity. The formula for calculating tonnage under the old rule[3]—old tons—was

$$[(\text{length}) - (\tfrac{3}{5}\ \text{breadth})] \times [(\text{breadth}) \times (\tfrac{1}{2}\ \text{breadth})] / 95.$$

For new tons, the calculation was much more complicated and has never been reduced to a simple formula.[4] In general, the rule involved multiplying the length by the average cross-sectional area and dividing the result by one hundred.

Because there is no convenient way of converting old tons to new ones, tonnage figures used in this chapter are old tons. When measurements are cited to illustrate the actual sizes of vessels of different tonnages, for most vessels measured before 1865 only length and breadth are given, since registered dimensions ignored reality and logged depth as equal to one-half breadth.[5]

The choices of rig and size carried implications for manning. Although total

2. The seven New Bedford steel-hulled, steam-powered whaling barks entered the fleet after 1878: the *Belvedere* (1880), the *Lucretia* (1881), the *Navarch* (1892), the *North Star* (1888), the *William Lewis* (1888), the first *Mary and Helen* (1879), and the second *Mary and Helen* (1882).

3. An Act to Regulate the Collection of Duties on Imports and Tonnage, 1799, *Stats. at Large of USA* 1:675–76. The rule refers to all double-decked vessels. Virtually all whalers were double-decked. The British measurement rule was similar except that the divisor was 94, not 95. See Scoresby [1820] 1969, 512. See also chapter 12 below.

4. So complicated were the new admeasurement rules that Congress saw fit to place limits on the amount a ship surveyor could charge to remeasure a vessel (An Act to Regulate the Admeasurement of Tonnage of Ships and Vessels of the United States, 1864, *Stats. at Large of USA* 13:69–72).

5. According to *Historical Statistics* (U.S. Department of Commerce 1975, 2:743) the combination of changes in the definition of a ton and in the method of measuring cubic footage probably reduced the official capacities of brigs, schooners, and sloops, but raised the official capacities of ships and barks. Research on whalers, however, suggests that these generalizations cannot be extended to that class. For them the new system of admeasurement apparently reduced the official capacities of whaling ships by about 5 percent, on average, lowered the capacities of barks by about one-sixth, and reduced the capacities of the three smaller classes even more. For those vessels for which both old and new tonnages are available (vessels that were first registered before 1865 but continued to sail after that date), regression analysis indicates that the relationship between old and new tons was approximately, for ships, old tons = $-85.018 + 2.11$ (new tons) $-$ .00217 (new tons)^2; for barks, old tons = $13.370 + 1.44$ (new tons) $-$ .00113 (new tons)^2; for others, old tons = 1.4 (new tons).

crew size was usually less for a bark than for a ship, for any given size a bark required proportionately more labor. Moreover, labor requirements differed among grounds.

Lastly, the agent had to make decisions about age and provenance. Should he build a new vessel incorporating the latest technical improvements, or use a vessel that had proved itself well constructed by surviving five or ten years of service, or select a vessel that, well over retirement age, could be purchased cheaply? If his choice did not involve new construction, he had to decide whether to use a vessel that had proved itself in whaling, acquire and convert a merchant vessel, or perhaps rerig a ship as a bark. As economic conditions changed and as the number of vessels hunting in a particular ground expanded or contracted, the desire to maximize profits and to stay economically afloat in the highly competitive industry continuously forced agents to make new decisions about rig, tonnage, manning, age, and provenance.

6.2 Rigging

The rig composition of the American whaling fleet was never stable (see table 6.1). In the early years ships were the most numerous, and they remained so through the period of expansion, although the number of barks rose in both absolute and relative terms—slowly in the 1820s and 1830s, rapidly in the 1840s and 1850s. In 1841–45 the ratio of the number of ships to the number of barks was 3.7 to 1. By 1871–75 it had fallen to 0.16 to 1, as the expansion of the Arctic fishery, coupled with technical improvements that made it economical to operate large bark-rigged vessels in other grounds as well, made the bark dominant. (Technical improvements are discussed in chapter 7.)

Before the Civil War, the number of barks increased more rapidly than the number of ships. Thereafter, as the fleet contracted, the number of barks declined more slowly. Between 1851–55 and 1871–75, for example, the number of ships fell by over 90 percent, but the number of barks actually rose by about 2 percent. Tonnage tells the same story. Before 1846 barks accounted for 5.9 percent of total New Bedford tonnage; their relative share increased eight times over the next thirty years, and they accounted for 72.4 percent of the total over the last quarter of the century.

Brigs, sloops, and schooners were not numerically important in the years 1816–1905. Together, they accounted for just under three-tenths of the 1,280 voyages to the Atlantic and Hudson Bay and for only twenty-eight of the 2,873 voyages to the Indian, Pacific, and Western Arctic grounds in these years. During the industry's rapid expansion a few entered the fleet and remained for a time. More important, the end of the century saw the substitution of these vessels for barks and ships in the Atlantic and its northern extension, Hudson Bay. The 184 voyages they made to these grounds in the years after 1875 were almost one-half of all the voyages they made between 1816 and 1905.

Ships were usually larger than barks, but they were less maneuverable.

Table 6.1 Numbers of Vessels and Tonnages, New Bedford Whaling Fleet, by Rigging Class, Annual Averages, 1816–1905

	A. Numbers of Vessels			
	Total	Ships	Barks	Other and Unknown[a]
1816–20	31.4	21.2	0.0	10.2
1821–25	56.4	43.4	0.0	13.0
1826–30	79.6	67.6	1.8	10.2
1831–35	141.8	124.6	13.4	3.8
1836–40	173.4	139.2	26.2	8.0
1841–45	228.2	174.6	46.6	7.0
1846–50	252.0	193.0	56.2	2.8
1851–55	314.4	211.8	100.4	2.2
1856–60	320.2	178.6	141.6	0.0
1861–65	219.8	92.6	125.4	1.8
1866–70	180.2	46.2	129.2	4.8
1871–75	124.2	16.6	102.8	4.8
1876–80	128.6	9.8	100.8	18.0
1881–85	96.2	7.6	70.6	18.0
1886–90	59.4	5.4	40.6	13.4
1891–95	37.8	0.8	22.0	15.0
1896–1900	25.6	0.0	13.8	11.8
1901–5	23.4	0.0	14.0	9.4
Means				
All years	138.5	74.0	55.9	8.6
1816–45	118.5	95.1	14.7	8.7
1846–75	235.1	123.1	109.3	2.7
1876–1905	61.8	3.9	43.6	14.3

	B. Tonnages[b]			
		% of Total		
	Total	Ships	Barks	Other and Unknown[a]
1816–20	7,568	79.1	0.0	20.9
1821–25	14,701	87.5	0.0	12.5
1826–30	23,105	92.4	1.8	5.8
1831–35	44,912	92.2	6.7	1.1
1836–40	54,685	86.6	11.5	1.9
1841–45	72,881	83.1	15.6	1.3
1846–50	82,035	82.4	17.1	0.5
1851–55	105,482	73.8	25.9	0.3
1856–60	108,551	61.1	38.9	0.0
1861–65	73,026	47.7	52.0	0.3
1866–70	58,331	31.0	68.0	1.0
1871–75	39,888	16.4	82.1	1.5
1876–80	39,217	9.9	83.0	7.1
1881–85	29,815	10.3	80.0	11.7
1886–90	18,492	11.8	72.6	15.6

(continued)

Table 6.1 (continued)

	Total	% of Total		
		Ships	Barks	Other and Unknown[a]
1891–95	10,700	2.9	67.8	29.3
1896–1900	6,809	0.0	64.9	35.1
1901–5	6,810	0.0	66.6	33.4
Means				
All years	44,278	48.1	41.9	10.0
1816–45	36,309	86.8	5.9	7.3
1846–75	77,886	52.1	47.3	0.6
1876–1905	18,641	5.7	72.4	21.9

Source: Voyages Data Set.

Notes: We counted a vessel as in the New Bedford fleet when it was on a voyage. For example, a vessel that sailed in 1829, returned in 1829, sailed in 1829, returned in 1830, sailed in 1832, and returned in 1833 is counted once in 1829, once in 1830, once in 1832, and once in 1833, but not in 1831 when it was not on a voyage.

When only the sailing or arrival date of a voyage is known, we counted the vessel in the fleet only in that year. Consequently, some of the figures in this table are slightly too low.

[a]The rigging class "Other" is composed of brigs, sloops, schooners, and steam barks.

[b]Panel B underreports total tonnage in a few five-year periods because there are a few voyages in the data set by vessels whose tonnages we do not know.

"Where economy of handling was of special importance, the bark rig was used."[6] Thus, as opportunities increased in the Western Arctic, the bark was in its element. It took time to build new vessels, but technical improvement was hastened by rerigging ships in the now more productive configuration.

Other differences between rigging classes could have affected productivity as well. The length of a typical voyage by a ship was less than that of a typical voyage by a bark in four of the five grounds, but only in the Atlantic was the difference great (see table 6.2). In general, both ships and barks remained at sea longer than brigs, sloops, and schooners. The choice of hunting ground carried with it implications for the expected length of the voyage as well as for the choice of rig type and vessel size. In the latter two cases, however, over time, changes also occurred within grounds. The technological shifts were not, therefore, solely responses to changes in the geographic distribution of economic activity.

6.3 Vessel Size

Not only were there changes in the rigging of a typical whaler, but the average size of each class changed as well (see table 6.3). For ships, average size increased from just over 300 tons in the decade 1816–25 to just over 400 in

6. Hutchins 1941, 218–19. Hutchins is referring here to merchant vessels in the late eighteenth and early nineteenth centuries, but the point has more general relevance.

Table 6.2 **Average Voyage Lengths, by Rigging Class and Ground, New Bedford Whaling Fleet, Sailing Years 1816–1905 (months)**

	Atlantic	Eastern Arctic	Indian	Pacific	Western Arctic
			A. Ships		
1816–25	11.6	—	—	26.2	—
1826–35	13.2	—	18.5	35.8	—
1836–45	18.4	—	25.8	37.5	—
1846–55	20.2	—	37.0	38.7	36.8
1856–65	16.5	18.1	40.5	45.9	45.5
1866–75	18.0	—	43.9	43.0	47.8
1876–85	42.9	—	—	43.6	—
1886–95	—	—	—	—	—
1896–1905	—	—	—	—	—
Means of voyages	14.5	18.1	30.3	37.7	40.4
Means of decades	17.8	18.1	33.1	38.7	43.4
			B. Barks		
1816–25	—	—	—	—	—
1826–35	15.6	—	—	33.1	—
1836–45	20.4	—	26.3	37.5	—
1846–55	24.7	—	35.8	40.2	38.3
1856–65	23.5	17.3	39.8	46.0	49.5
1866–75	29.2	17.2	40.8	46.5	50.4
1876–85	35.0	—	37.3	44.3	—
1886–95	34.3	15.0	35.7	—	—
1896–1905	25.8	—	—	—	—
Means of voyages	27.6	16.6	35.9	42.9	46.1
Means of decades	26.1	16.5	36.0	41.3	46.1
			C. Brigs, Sloops, and Schooners		
1816–25	12.0	—	—	20.3	—
1826–35	11.9	—	—	—	—
1836–45	12.0	—	—	—	—
1846–55	10.6	—	—	—	—
1856–65	—	—	—	—	—
1866–75	14.0	—	—	—	—
1876–85	16.1	14.6	—	—	—
1886–95	25.3	—	—	—	—
1896–1905	17.9	22.8	—	—	—
Means of voyages	15.4	17.3	—	20.3	—
Means of decades	15.0	18.7	—	20.3	—

Source: Voyages Data Set.

Notes: We have included only voyages that sailed from and returned to New Bedford. We have omitted voyages to the Atlantic or the Eastern Arctic that lasted less than two months, believing that they were cut short by misfortune, and those to the Indian, Pacific, or Western Arctic that lasted less than seven months, believing that they did not in fact hunt in those grounds. (The hunting ground was reported when a voyage sailed.)

Each cell of the table reports the average of at least five voyages; averages of four or fewer have been omitted. Voyages are placed in decades on the basis of their sailing years.

Table 6.3 Average Tonnages and Ages, New Bedford Whaling Fleet, by Rigging Class, 1816–1905

A. Tonnages: Overall Averages for the Decade[a]

	Unweighted		Weighted	
	Average	N	Average	N[b]
Ships				
1816–25	301.8	55	294.1	195
1826–35	330.2	157	321.3	503
1836–45	348.0	219	340.8	691
1846–55	365.7	273	358.9	778
1856–65	373.6	216	376.1	466
1866–75	389.6	56	389.2	111
1876–85	399.1	14	397.7	34
1886–95	402.6	7	398.4	14
1896–1905	—	0	—	0
Means 1816–1905	357.1	360	345.8	2,188
Barks				
1816–25	—	0	—	0
1826–35	224.9	12	226.4	40
1836–45	246.4	54	240.3	176
1846–55	270.8	136	263.7	336
1856–65	288.8	169	290.4	500
1866–75	299.3	146	307.4	412
1876–85	324.6	123	335.5	388
1886–95	335.6	52	348.8	208
1896–1905	329.4	19	346.1	93
Means 1816–1905	302.6	261	301.0	1,727
Other[c]				
1816–25	145.6	30	152.1	79
1826–35	143.0	21	140.2	48
1836–45	136.5	18	130.0	58
1846–55	133.1	8	133.7	12
1856–65	123.4	6	123.4	6
1866–75	141.6	12	119.9	30
1876–85	199.6	30	183.3	117
1886–95	214.2	26	252.4	76
1896–1905	245.8	18	239.5	64
Means 1816–1905	173.9	113	179.6	448

B. Tonnages: Averages for Vessels Joining the Fleet[d]

			Modes of Entrance					
	Total	N[e]	Birth[f]	N	Transfer[g]	N	Rerigging	N
Ships								
1816–25	307.5	50	308.2	11	313.4	33	241.0	2
1826–35	341.5	113	368.4	16	340.1	89	—	0
1836–45	359.0	90	362.6	17	361.8	66	279.1	4
1846–55	395.7	83	408.3	31	404.6	42	275.9	7

Table 6.3 (continued)

	Total	N[e]	Birth[f]	N	Transfer[g]	N	Rerigging	N
			Modes of Entrance					
1856–65	391.7	23	424.3	4	383.9	15	334.7	2
1866–75	—	0	—	0	—	0	—	0
1876–85	424.2	1	424.2	1	—	0	—	0
1886–95	—	0	—	0	—	0	—	0
1896–1905	—	0	—	0	—	0	—	0
Means 1816–1905	357.1	360	377.9	80	356.1	245	280.0	15
Barks								
1816–25	—	0	—	0	—	0	—	0
1826–35	229.0[h]	21	—	0	227.2	10	228.0	10
1836–45	256.1	47	—	0	255.4	35	258.1	12
1846–55	290.3	109	340.0	16	266.4	67	325.5	23
1856–65	322.4	89	380.3	15	262.0	28	340.1	45
1866–75	329.5	67	476.1	2	271.7	30	373.8	33
1876–85	349.5	25	375.7	13	316.2	7	349.5	4
1886–95	414.0	3	419.6	1	—	0	411.1	2
1896–1905	—	0	—	0	—	0	—	0
Means 1816–1905	302.6	361	370.2	47	264.2	177	331.2	129
Other[c]								
1816–25	143.5	29	189.3	3	139.3	22	121.0	3
1826–35	138.4	10	139.5	1	140.0	8	—	0
1836–45	130.5	13	184.1	1	128.2	11	102.1	1
1846–55	123.5	4	—	0	123.5	4	—	0
1856–65	123.4	6	262.3	1	95.6	5	—	0
1866–75	140.1	9	—	0	131.3	8	—	0
1876–85	223.2	25	529.7[i]	5	131.6	17	389.8	1
1886–95	224.5	14	384.5	4	160.5	10	—	0
1896–1905	397.2	3	—	0	397.2	3	—	0
Means 1816–1905	173.9	113	356.0	15	143.8	88	171.0	5

C. Tonnages: Averages for Vessels Leaving the Fleet[j]

	Total	N	Loss	N	Transfer	N	Rerigging	N	Condemnation	N
			Modes of Exit							
Ships										
1816–25	293.4	14	334.3	1	296.0	10	—	0	234.9	1
1826–35	284.8	23	287.4	5	297.5	10	266.0	7	275.9	1
1836–45	321.8	29	339.8	12	468.1	2	275.4	9	306.6	6
1846–55	348.7	83	348.3	40	382.2	15	336.0	21	317.3	7
1856–65	367.6	162	386.0	40	378.9	66	339.4	49	352.9	7
1866–75	387.3	43	416.0	7	383.5	6	381.4	30	—	0
1876–85	395.5	7	428.3	3	391.0	2	350.9	2	—	0
1886–95	402.6	7	376.0	1	404.9	4	411.1	2	—	0
1896–1905	—	0	—	0	—	0	—	0	—	0
Means 1816–1905	355.2	368	365.1	109	368.0	115	341.6	120	320.1	22

(continued)

Table 6.3 (continued)

	Total	N	Modes of Exit: Loss	N	Transfer	N	Rerigging	N	Condemnation	N
Barks										
1816–25	—	0	—	0	—	0	—	0	—	0
1826–35	235.9	4	171.6	1	277.5	2	—	0	217.1	1
1836–45	237.0	14	246.5	4	185.0	3	268.0	6	169.4	1
1846–55	264.3	34	239.9	14	298.8	11	286.3	5	226.9	4
1856–65	296.2	104	291.5	37	316.8	50	334.7	2	234.3	15
1866–75	305.2	77	319.4	43	289.0	22	—	0	284.2	12
1876–85	317.8	73	334.9	30	321.4	30	389.8	1	259.6	12
1886–95	344.8	36	359.1	12	338.3	21	—	0	332.6	3
1896–1905	296.9	5	296.9	5	—	0	—	0	—	0
Means 1816–1905	301.6	347	307.4	146	311.8	139	292.8	14	256.9	48
Other[c]										
1816–25	141.4	22	213.5	1	130.7	13	166.7	6	98.8	1
1826–35	142.7	15	88.4	2	137.8	8	184.2	4	—	0
1836–45	132.6	15	123.1	4	122.3	5	158.9	3	136.0	3
1846–55	133.1	8	169.2	1	122.8	6	158.4	1	—	0
1856–65	100.7	3	—	0	95.1	2	—	0	111.8	1
1866–75	150.0	6	102.9	3	164.4	2	262.3	1	—	0
1876–85	208.1	19	191.2	8	285.1	6	—	0	142.7	5
1886–95	212.3	11	383.4	3	147.2	6	—	0	151.0	2
1896–1905	198.8	11	262.6	4	166.8	6	—	0	135.1	1
Means 1816–1905	163.5	110	195.8	26	153.0	54	175.6	15	136.1	13

	D. Ages: Overall Averages[k] Average	N
Ships		
1816–25	12.1	192
1826–35	16.0	497
1836–45	19.9	685
1846–55	23.5	770
1856–65	25.3	462
1866–75	28.7	111
1876–85	37.2	34
1886–95	44.9	14
1896–1905	—	0
Means 1816–1905	21.1	2,166
Barks		
1816–25	—	0
1826–35	14.0	40
1836–45	20.7	176
1846–55	19.7	335
1856–65	23.6	500
1866–75	30.9	414
1876–85	32.4	386
1886–95	35.6	208

Table 6.3 (continued)

	Average	N
1896–1905	41.2	93
Means 1816–1905	27.5	1,725
Other[c]		
1816–25	6.7	74
1826–35	12.3	44
1836–45	15.8	57
1846–55	14.5	12
1856–65	15.7	6
1866–75	21.5	30
1876–85	21.9	113
1886–95	19.8	73
1896–1905	29.0	64
Means 1816–1905	18.2	432

E. Ages: Averages for Vessels Joining the Fleet[d]

			Modes of Entrance			
	Total	N	Transfer	N	Rerigging	N
Ships						
1816–25	8.0	48	10.5	33	8.0	2
1826–35	11.8	111	13.7	89	—	0
1836–45	12.4	89	14.7	66	25.0	4
1846–55	11.9	83	18.0	42	27.3	7
1856–65	16.3	23	20.2	15	20.0	2
1866–75	—	0	—	0	—	0
1876–85	0.0	1	—	0	—	0
1886–95	—	0	—	0	—	0
1896–1905	—	0	—	0	—	0
Means 1816–1905	11.7	355	14.7	245	23.1	15
Barks						
1816–25	—	0	—	0	—	0
1826–35	14.0	21	11.6	10	17.1	10
1836–45	18.5	47	15.4	35	27.3	12
1846–55	14.1	108	11.7	66	29.2	23
1856–65	24.8	89	22.2	28	34.6	45
1866–75	26.0	69	22.7	31	30.6	33
1876–85	13.2	24	24.3	7	36.3	4
1886–95	20.7	3	—	0	31.0	2
1896–1905	—	0	—	0	—	0
Means 1816–1905	19.6	361	16.5	177	30.6	129
Other[c]						
1816–25	5.5	28	6.1	22	5.7	3
1826–35	10.0	10	11.0	8	—	0
1836–45	12.0	13	11.9	11	25.0	1
1846–55	15.5	4	15.5	4	—	0
1856–65	15.7	6	18.8	5	—	0

(continued)

Table 6.3 (continued)

			Modes of Entrance			
	Total	*N*	Transfer	*N*	Rerigging	*N*
1866–75	18.3	9	20.4	8	—	0
1876–85	16.2	24	21.2	17	4.0	1
1886–95	17.8	14	24.9	10	—	0
1896–1905	26.0	3	26.0	3	—	0
Means 1816–1905	13.0	111	15.5	88	9.2	5

F. Ages: Averages for Vessels Leaving the Fleet[j]

			Modes of Exit							
	Total	*N*	Loss	*N*	Transfer	*N*	Rerigging	*N*	Condemnation	*N*
Ships										
1816–25	11.8	13	9.0	1	11.6	10	—	0	15.0	1
1826–35	18.9	21	14.4	5	21.0	9	19.3	7	—	0
1836–45	24.1	29	20.1	12	12.5	2	30.1	9	26.7	6
1846–55	28.3	83	27.9	40	27.1	15	29.1	21	30.9	7
1856–65	31.4	160	30.8	39	30.1	65	33.0	49	36.0	7
1866–75	34.9	43	36.0	7	47.5	6	32.1	30	—	0
1876–85	30.9	7	31.0	3	30.5	2	31.0	2	—	0
1886–95	48.4	7	66.0	1	53.5	4	29.5	2	—	0
1896–1905	—	0	—	0	—	0	—	0	—	0
Means 1816–1905	29.4	363	28.3	108	28.8	113	31.0	120	30.6	21
Barks										
1816–25	—	0	—	0	—	0	—	0	—	0
1826–35	14.0	4	11.0	1	18.5	2	—	0	8.0	1
1836–45	23.0	14	21.8	4	20.7	3	25.3	6	21.0	1
1846–55	27.3	33	24.6	14	29.0	10	27.4	5	32.0	4
1856–65	26.3	104	30.2	37	22.1	50	20.0	2	31.5	15
1866–75	34.3	78	32.9	43	32.3	24	—	0	44.0	11
1876–85	39.9	73	39.9	31	39.7	30	4.0	1	43.9	11
1886–95	40.9	36	39.2	12	41.1	21	—	0	46.3	3
1896–1905	50.2	5	50.2	5	—	0	—	0	—	0
Means 1816–1905	32.6	347	33.5	147	30.9	140	23.8	14	37.7	46
Other[c]										
1816–25	7.0	21	7.0	1	6.8	12	5.5	6	17.0	1
1826–35	11.3	15	8.5	2	11.0	8	13.3	4	—	0
1836–45	18.5	14	16.5	4	20.8	5	19.0	3	16.0	2
1846–55	16.9	8	15.0	1	17.5	6	15.0	1	—	0
1856–65	19.0	3	—	0	16.5	2	—	0	24.0	1
1866–75	15.3	6	20.7	3	13.5	2	3.0	1	—	0
1876–85	24.2	19	29.5	8	19.2	6	—	0	21.6	5
1886–95	21.3	10	8.7	3	23.6	5	—	0	34.5	2
1896–1905	26.5	11	19.3	4	28.8	6	—	0	42.0	1
Means 1816–1905	17.0	107	19.5	26	16.3	52	10.7	15	24.3	12

Sources: Voyages, When and Where Built, and Entrances data sets.

Note: A vessel was counted in the New Bedford fleet for each decade during which it spent any time on a whaling voyage. For example, a ship that sailed in 1845 and returned in 1848 was counted in the fleet

Table 6.3 (continued)

in both 1836–45 and 1846–55 as a result of that voyage.

[a]The unweighted figures are the average tonnages among vessels; no matter how many voyages a vessel may have made during a decade, it was counted only once within a rigging class (a rerigged vessel that made voyages under each rigging within the same decade would enter the computation twice). The weighted figures are the average tonnages among voyages; for example, a vessel that made three voyages within a decade was counted three times, whereas a vessel that made one voyage was counted only once.

[b]The *N* here do not match those in panel D when either tonnage or age (year built) is missing.

[c]Sloops, schooners, brigs, and steam barks.

[d]A vessel is considered to have joined the fleet in the decade in which it began its first whaling voyage from New Bedford (or managed by a New Bedford agency). A vessel that was rerigged is treated as a different vessel after rerigging—that is, a rerigged vessel enters the fleet twice. Panel E omits the birth category because all newborn vessels are one year old or less; age is at the beginning of the voyage.

[e]When the total number of vessels entering the fleet in a decade is greater than the sum of those entering by particular modes, it is because some entered whose pre-entrance histories we don't know.

[f]"Birth" means built for the New Bedford whaling fleet (specifically, that it made its first New Bedford voyage within the year of its construction or during the next year).

[g]Transferred vessels either moved to New Bedford from another port, or moved to whaling from the merchant fleet, or both.

[h]The bark that entered the fleet in 1826–35 whose mode of entrance is unknown had a tonnage of 257.4.

[i]This figure is distended by the presence of four of the six steam barks in the New Bedford fleet, with tonnages ranging from 579.9 to 634.3.

[j]A vessel is considered to have left the fleet in the decade in which it ended its last voyage from New Bedford (or managed from New Bedford). A vessel that was rerigged is considered to have left the fleet twice. Transferred vessels include those sold to the U.S. government for the Stone Fleet. The averages are for age at the end of the last voyage.

[k]Panel D contains only weighted figures, since age (unlike tonnage, reported in panel A) changes with time and must therefore be dealt with at the voyage, not the vessel, level. The age is at the beginning of the voyage.

the late 1880s and early 1890s. Overall, the typical ship was almost 350 tons. The magnitude of the trend comes into focus in the following comparison. In 1816 the ship *Richmond* was launched and began a whaling career. She was 92 feet 6 inches long, 26 feet 11 inches wide, and was registered at 291 tons. Forty years later the *Contest* left the boatyard to join the fleet. She was 118 feet 10 inches long, 28 feet 8.75 inches wide, and was registered at 441 tons (Work Projects Administration 1940). The new vessel was 28 percent longer and 7 percent wider, and her register tonnage had increased by more than 50 percent.

The trend in the size of ships was definitely upward, but the pattern was not uniform. Increases amounted to more than 5 percent per decade until 1856–65; subsequently, tonnage edged up only slowly. Until 1856–65 dispersion remained roughly the same (coefficient of variation of about 18); thereafter, it narrowed. The coefficient of variation fell from 1856–65 until the last ship left the fleet (it was only 5 in the decade 1886–95).

Two surmises are warranted. First, larger ships were more productive than smaller, but the industry's adjustment to this dimension of technology was not instantaneous. This is supported by a comparison of ships entering with those leaving the fleet. Over the first seventy years (no ship joined the fleet after

1885), in every decade but two a typical new entry was more than 5 percent larger than the average ship that left (see table 6.3). Second, the relatively slow adjustment can most likely be traced to the time path of the industry's development. Between 1816–20 and 1851–55, the number of ships in the fleet increased tenfold (from an average of 31 to an average of 314). The rate of entry strongly suggests that there were greater than normal profits to be earned, but it also suggests that those opportunities may not have been long-lived. During the years of rapid growth, the desire to exploit short-term profit opportunities seems to have outweighed the marginal gain from choosing a vessel of optimal size, if that choice meant delaying the voyage.

Barks, with an average size of 287 tons, were just over 80 percent as large as ships. While the time-tonnage profile for barks was similar to that for ships, the movements were slightly more accentuated. For ships the increase between the first decade and 1856–65 was about 24 percent, between 1856–65 and 1886–95, 8 percent. For barks the comparable increases were 28 and 16 percent. There were no barks in the first decade, and few in the next two; the apparent increase down to 1856–65 may be no more than a small-numbers illusion. Still, the *Falcon* built in 1817 (and entering the New Bedford whaling fleet in 1830) was 101.08 feet long, 24.5 feet wide, and registered at 273 tons, while the *Alaska* built in 1867 was 122.2 feet long, 28.9 feet wide, 16.9 feet deep, and registered at 340 new (460.9 old) tons. To the extent that these examples are typical, new barks of the late 1860s were about 21 percent longer, 18 percent broader, and, in old tons, almost 70 percent larger.

As with ships, it appears the efficient size of barks increased down to the early 1890s. In every decade but two through 1895, barks entering the fleet were between 3 percent and 21 percent larger than those they replaced. Unlike the size distribution of ships, however, that of barks widened until 1856–65. Thereafter, with the exception of a slight reversal in the decade 1896–1905, the dispersion narrowed, as it did for ships.

For both classes there is evidence that the larger vessels hunted the more distant grounds and the smaller concentrated in the Atlantic and Hudson Bay (see table 6.4). The Western Arctic drew the largest. Vessels hunting there were 5 to 30 percent larger than those in the Pacific; the margin between vessels in the Western Arctic and those in the Indian was even greater.

Although the hunting grounds that attracted the largest vessels were those that were becoming more important, interground shifts do not explain the major portion of the observed increase in vessel size. Instead, tonnage drifted upward for both ships and barks in every ground except the Western Arctic and Hudson Bay. The 32 percent increase in average ship tonnage between the first and seventh decades reflects increases of 3 percent in the Atlantic, 16 percent in the Indian (second to seventh decades), and 35 percent in the Pacific, with a 5 percent decline in the Western Arctic (reflecting only experience after 1848). In Hudson Bay average tonnage rose and then fell. Among barks the 44 percent increase in size from the second to the seventh decade is composed of

Table 6.4 **Indexes of Mean Vessel Tonnages, by Rigging Class and Ground, New Bedford Whaling Fleet, 1816–1905**

A. Atlantic = 100

	Eastern Arctic	Indian	Pacific	Western Arctic
Ships				
1816–25	94	—	95	—
1826–35	—	113	112	—
1836–45	—	105	113	—
1846–55	—	95	105	127
1856–65	123	100	104	111
1866–75	90	96	108	105
1876–85	—	126	125	131
1886–95	—	—	94	—
1896–1905	—	—	—	—
Barks				
1816–25	—	—	—	—
1826–35	—	87	81	—
1836–45	—	103	111	—
1846–55	—	118	150	202
1856–65	174	130	163	186
1866–75	115	118	140	148
1876–85	108	95	123	127
1886–95	78	—	132	132
1896–1905	96	—	143	—

B. 1856–65 = 100

	Atlantic	Eastern Arctic	Indian	Pacific	Western Arctic
Ships					
1816–25	87	67	—	80	—
1826–35	86	—	98	93	—
1836–45	89	—	93	97	—
1846–55	98	—	93	99	112
1856–65	100	100	100	100	100
1866–75	105	77	100	109	99
1876–85	90	—	114	108	106
1886–95	118	—	—	107	—
1896–1905	—	—	—	—	—
Barks					
1816–25	—	—	—	—	—
1826–35	125	—	84	62	—
1836–45	120	—	96	82	—
1846–55	108	—	98	99	118
1856–65	100	100	100	100	100
1866–75	125	82	113	107	99
1876–85	156	97	115	117	106
1886–95	146	65	—	118	104
1896–1905	144	79	—	126	—

Source: Voyages Data Set.

Notes: A vessel was counted in the New Bedford fleet for each decade during which it spent any time on a whaling voyage. No matter how many voyages a vessel may have made during a decade, it entered these computations only once. When only the arrival date of a voyage is known, we counted the vessel in the fleet only in that year.

a 25 percent increase in the Atlantic, a 37 percent increase in the Indian, and an 89 percent increase in the Pacific, with 10 percent and 29 percent declines for those braving the Western Arctic and Hudson Bay, respectively.

Average vessel size was increasing; barks were also becoming larger relative to ships. In the decade 1846–55 the barks that joined the fleet were only about three-quarters as large as the ships they joined. In the two decades 1856–75 seventy-seven New Bedford ships were rerigged as barks; they were, on average, 93 percent as large as the ships that remained ships.[7] In the decade 1876–85, the barks that entered the fleet were almost nine-tenths as large as the ships they joined. The increasing relative size of barks reduced their relative disadvantage in labor costs, while retaining their advantage in maneuverability (Maran 1974).

The examination of the average size of vessels in the fleet indicates that carrying capacity was increasing overall; however, disaggregation by ground suggests that, for both ships and barks, there was little further increase in the size of vessels hunting in any individual ground after the early 1880s (see table 6.4). These comparisons strongly support the conclusion that the increase in size resulted from two distinct phenomena—an adjustment to new economic environments, and a response to new technical alternatives. On the one hand, larger size proved relatively more productive in the distant grounds; a part of the increase reflects only an adjustment to the changing geographic character of whaling. On the other hand, within each ground there is evidence of increasing average vessel capacity. That change was not induced by the environment; it indicates that the entire fleet was moving toward a more efficient technical configuration.

6.4 Vessel-Related Manning Decisions

An agent's decisions about rig, size, and ground had implications for the number of men he would need to hire. For barks there were substantial interground differences in the relative proportions of the two factors of production. (See table 6.5.) The labor/capital ratio was highest in the Atlantic and successively smaller in the Indian, Pacific, and Western Arctic. At the height of Western Arctic whaling, for example, the labor/capital ratio there was only about eight-tenths of that in the Atlantic. The smaller figure in part reflects the use of larger vessels in the more distant ground.[8] Between 1856 and 1885 a bark hunting in the Arctic was, on average, about one-half again as large as a

7. The tonnage comparison is between the average tonnage of the 77 vessels that were rerigged from ship to bark during the years 1856–75 (354.6 tons) and the average tonnage of the 142 vessels that made New Bedford whaling voyages as ships during the years 1856–75 and were not rerigged as barks in that period (382.3 tons).

8. It is possible that there is some measurement bias: vessels hunting in the Atlantic may have been less likely to take on additional crew members after leaving New Bedford than vessels hunting in the Pacific and Western Arctic. If this surmise is correct, however, one would expect to find the same interground variation in the labor/ton ratio for ships as for barks. In fact, there is none.

Table 6.5 Mean Numbers of Crewmen per Ton, by Rigging Class and Ground, New Bedford Whaling Fleet, Sailing Years 1816–1905

	Atlantic	Eastern Arctic	Indian	Pacific	Western Arctic
Ships					
1816–25	.0745	.0836	—	.0735	—
1826–35	.0806	.0756[a]	.0786	.0733	—
1836–45	.0813	—	.0831	.0797	—
1846–55	.0876	—	.0833	.0817	.0791
1856–65	.0794	.0817	.0846	.0801	.0817
1866–75	.0859	.0852	.0816	.0809	.0785
1876–85	.0814	—	—	.0828	.0931[a]
1886–95	—	—	—	.0856	—
1896–1905	—	—	—	—	—
Means of voyages	.0798	.0824	.0830	.0790	.0801
Means of decades	.0815	.0815	.0822	.0797	.0831
Barks					
1816–25	—	—	—	—	—
1826–35	.0909	—	.0984	.0954	—
1836–45	.0974	—	.1016	.0887	—
1846–55	.1154	—	.1019	.0917	.0872
1856–65	.1146	.1016	.0962	.0900	.0865
1866–75	.1100	.1141	.0931	.0879	.0895
1876–85	.1034	.1252	.1015	.0876	.0936
1886–95	.1111	.1078	.1050	.0957	—
1896–1905	.1142[a]	.1192[a]	—	—	—
Means of voyages	.1080	.1103	.0985	.0899	.0885
Means of decades	.1071	.1136	.0997	.0637	.0892
Other[b]					
1816–25	.1008	—	.0885[a]	.1018	—
1826–35	.1180	—	.0960	.0958	—
1836–45	.1420	—	.1303	.0815[a]	—
1846–55	.1587	—	.1241[a]	—	—
1856–65	.1499	.1067[a]	—	—	—
1866–75	.1710	.1191	—	—	—
1876–85	.1499	.1267	—	.0629[a]	.0597
1886–95	.1317	.1236	—	.0971	—
1896–1905	—	—	—	—	—
Means of voyages	.1372	.1242	.1109	.0960	.0597
Means of decades	.1403	.1190	.1097	.0878	.0597

Sources: Voyages and Crew Counts data sets.

Notes: Voyages are placed in decades based on their sailing years. Each voyage's number of crewmen per ton was figured separately, and those numbers were averaged by rigging class, decade, and hunting ground.

[a]One observation.

[b]Sloops, schooners, brigs, and steam barks.

bark hunting in the Atlantic. For ships, in contrast, the labor/capital ratio differed little among grounds, although those that hunted in the Indian Ocean used slightly more labor than others.

Relative to their size, brigs, sloops, and schooners employed much more labor than either ships or barks, and displayed much higher labor/capital ratios. By the end of the period, however, the differential between barks and the smaller vessels had narrowed from close to 30 to less than 20 percent. Combined with the demonstrated maneuverability of brigs, sloops, and schooners, that narrowing partially explains their increasing popularity in the years after 1885.

Overall, barks used more labor per ton than ships, but that conclusion does not hold equally strongly in all grounds, and the differential decreased as the distance from New Bedford increased. In the Atlantic, barks employed 35 percent more labor per ton, in the Indian and Pacific, about 17 percent more, in the Arctic, about 10 percent. In part this reflects nothing more than the relationship between vessel size and ground hunted, but a simple regression using the ratio of the tonnage of barks to the tonnage of ships and the square of that ratio explains only a little more than one-half of the variance in the ratio of men per ton in the two vessel classes.[9] The remaining variance is not so easily explained. It is not related to the passage of time. It is related in part to an interaction between the vessel type (ship, bark) and the species hunted. Including cross terms between the proportion of baleens and the two tonnage variables improves the explanatory power of the model.[10] There is still a substantial unexplained residual, but it appears that there was some relationship among the

9. The regression equation is

$$\underset{}{RELMEN} = \underset{(1.561)}{0.6297} + \underset{(2.105)}{2.3941}\, RELTON - \underset{(-2.733)}{2.1816}\, RELTON^2,$$

with adjusted $R^2 = 0.5396$, F-ratio = 35.577, and Durbin-Watson = 1.713. The ratio of men per ton was computed for each voyage for which a crew count was available, and attributed to the voyage's sailing year. Means of these ratios were computed, by year, separately for barks and for ships. Means of tonnage for barks and ships were also computed, by sailing year, for the same voyages. *RELMEN* is the ratio of the mean ratio of men per ton in barks to the mean ratio of men per ton in ships. *RELTON* is the ratio of the mean tonnage of barks to the mean tonnage of ships. The argument is that the New Bedford fleet represented a sample of all whaling vessels. It is in that spirit that the t- and F-statistics are offered. To the extent that we are talking only about New Bedford vessels, they have no meaning.

10. The regression equation is

$$RELMEN = \underset{(+3.408)}{1.5587} - \underset{(-0.358)}{0.4975}\, RELTON - \underset{(-0.029)}{0.0304}\, RELTON^2 + \underset{(+2.688)}{0.5691}\, (RELTONB) - \underset{(-2.545)}{0.6961}\, (RELTON^2B),$$

with adjusted $R^2 = 0.6236$, F-ratio = 25.018, and Durbin-Watson = 1.922. See footnote 9 for a description of *RELMEN* and *RELTON*. The proportion of oil from baleen whales was computed by dividing the number of barrels of whale oil by the total number of barrels of oil (whale and sperm) returned by the voyage. The mean proportion of oil from baleen whales was computed separately for barks and for ships, by year, and then the ratio of the mean bark proportion to the mean ship proportion. *RELTONB* is the product of *RELTON* and this ratio; *RELTON²B* is the product of *RELTON²* and this ratio.

nature of the capital stock, the species of whales hunted, and the labor requirement.

6.5 Questions of Vessel Age

Over time, vessels tended to remain in the fleet longer. Moreover, despite the spate of construction of vessels built especially for whaling in the 1850s and 1870s, the average age of both ships and barks gradually increased (see table 6.3). If the first decade is excluded from the analysis for barks (there were none) and the last for ships (all had left the fleet), barks aged at a rate of just under five years per decade, ships, just under four. Thus, between 1816 and 1905 the average age of the fleet more than tripled. Average age reached forty-five years for ships in the decade 1886–95 and more than forty-one for barks in the decade that spanned the turn of the century.[11]

On average, older ships left the fleet and younger ones transferred in (see table 6.3). There was considerable decade-to-decade variation, and the trend in the ratio of the age of entry to that of exit was toward lower ratios. For barks the story is similar, although not identical.

Overall, the average age of ships in the New Bedford whaling fleet was 21.1 years, of barks, 27.5 years. For comparable periods, the average whaling life of ships was 16.0 years, of barks, 20.9 years. There was a greater difference in their physical life. Ignoring vessels that sank while whaling, the average age of condemned ships was 30.6 years, that of barks, 37.7.

6.6 Questions of Vessel Provenance

Vessels could be added to the New Bedford fleet by construction to order, by transfer from the merchant marine or from some other port, or by rerigging. Over the years 1816–1905, 80 ships and 47 barks entered the fleet after being built as New Bedford whalers; 245 ships and 178 barks transferred from other ports or other activities; rerigging added 12 ships and 118 barks. (See table 6.6.) Most vessels entered the fleet as transfers, but from the point of view of the industry's development, the other modes of entry are more interesting.[12]

11. The reader may wonder how it is possible that the average ages can be thirty-eight and forty-seven years, when the average age of a vessel when it was condemned was only thirty-seven. The latter is an average for the entire period 1816–1905 and is comparable to overall average ages for ships and barks of twenty-five and twenty-six years.

12. The history of the bark *Pacific*, out of New Bedford, is perhaps typical. "[The *Pacific*] is an old fashioned barque, built to ply as a packet between New York and Liverpool, which duty she performed with faithfulness and satisfaction to her owners; and in her palmiest days bore the reputation of being the fastest ship out of New York; but the improvements in shipbuilding necessitated her owners to dispose [of her] . . . . She was bought by a New Bedford merchant, who, after altering her for the purpose, put her into the whaling trade, where for years she maintained her reputation as a swift sailer, until clippers were introduced . . . . [She increased] her good name until 1855, at which time she was fifty-three years old, and with the exception of being new topped and coppered, the latter at the completion of each voyage, she had undergone no repairs" (Whitecar 1864, 24–25).

Table 6.6 **Modes of Entrance into the New Bedford Whaling Fleet, by Rigging Class, Sailing Years 1816–1905 (numbers of vessels)**

	Total	New Whalers[a]	Transferred Whalers[b]	Rerigged Whalers[c]	Transferred Merchantmen[d]	Rerigged Merchantmen[e]	Unknown
Ships							
1816–25	52	11	0	1	33	1	6
1826–35	114	16	8	0	81	0	9
1836–45	89	17	14	0	52	3	3
1846–55	84	31	13	0	29	6	5
1856–65	22	4	7	1	8	0	2
1866–75	0	0	0	0	0	0	0
1876–85	1	1	0	0	0	0	0
1886–95	0	0	0	0	0	0	0
1896–1905	0	0	0	0	0	0	0
Total	362	80	42	2	203	10	25
%		22	12	1	55	3	7
Barks							
1816–25	0	0	0	0	0	0	0
1826–35	21	0	1	5	9	5	1
1836–45	47	0	2	1	33	8	3
1846–55	110	16	2	8	65	13	6
1856–65	86	15	15	15	13	27	1
1866–75	69	2	10	21	21	9	6
1876–85	25	13	5	3	2	1	1
1886–95	3	1	0	2	0	0	0
1896–1905	0	0	0	0	0	0	0
Total	361	47	35	55	143	63	18
%		13	10	15	40	17	5

Sources: Voyages, When and Where Built, and Entrances data sets.

Notes: Vessels are placed in decades on the basis of the sailing dates of their first New Bedford voyages. We determined that a vessel was built as a whaler if it entered the whaling fleet (either in New Bedford or elsewhere) within one year of being built. If the rerigging of a rerigged vessel—either whaler or merchantman—was ship to bark, or bark to ship, the vessel was counted in this table twice, once for the beginning of its service in each of the two rigging classes.

[a]Vessels, built as whalers, that began their careers in New Bedford.

[b]Vessels, built as whalers, that began their careers in other ports but were eventually transferred to New Bedford.

[c]Vessels, built as whalers, that sailed from New Bedford for a while in one rigging class and later in another. Their history prior to their rerigging might include service from another port, but need not.

[d]Vessels, built as merchantmen, that eventually became New Bedford whalers. If they sailed as merchantmen from other ports, their reassignment as whalers might have coincided with their transfer to New Bedford, but need not.

[e]Vessels, built as merchantment, that sailed from New Bedford as merchantmen, later became New Bedford whalers, and still later were rerigged. Their history prior to their rerigging might include service from another port, but need not.

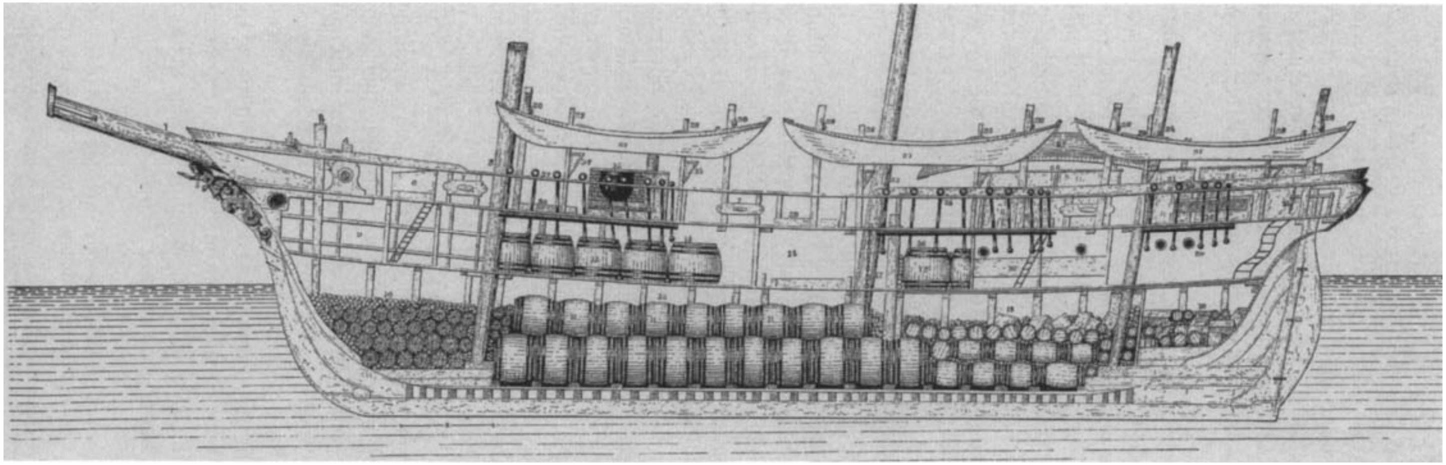
Rerigging, a change in masts and sails that converted a vessel of one class into a vessel of another, was important only in the middle years of the period (1846–75), when it accounted for more than one-third of the entering barks. Almost all of the new barks had started life as ships. Rerigging represented an efficient market response to the rapid expansion of the Western Arctic ground, where large vessels were required but where barks had proved themselves more efficient than ships.

In the second half of the century, because of the declining markets for whaling products and the influence of design changes, vessels (particularly barks) that were specifically designed for whaling began to replace the transfers of the earlier era (Chapelle [1935] 1982, 288; see chapter 7 below on design changes). In the 1850s and early 1860s new designs included modified clippers—vessels such as the 411-ton *Young Hector* (116.67 feet long, 27.96 feet wide, and 16.33 feet deep) designed to carry 2,100 barrels of oil, the 424-ton *Othello* (118.67 feet, 28.08 feet, and 15.5 feet) capable of carrying 2,200 barrels of oil, and the 460-ton *Onward* (124 feet, 28.67 feet, and 17 feet)—and, in the late 1860s and the 1870s, modified down-easters such as the 405-ton (old tonnage) *Alice Knowles* (115 feet, 27.95 feet, and 16.7 feet).[13]

Before the mid-1840s, when almost any ship or bark (and a few brigs, sloops, and schooners, as well) could earn above-normal profits, many merchant vessels were redirected to whaling. Profits fell in the 1850s, but as early as 1863 the *WSL* (13 January) reported that the recent improvement in the industry's outlook could be partly attributed to "the greater number of suitable vessels that have this last year been fitted for the fishery, compared with those that have been fitted during the last few years; the growing determination in the minds of merchants not to introduce into service any more such expensive vessels as new clippers, and bulky ships that were never meant for whalers, but introduce vessels of proper size, and only such as may be built expressly for the business, and that can sail at a comparatively low figure." Slightly more than a decade later, the *WSL* (11 January 1876), emphasizing the change in relative costs, reported, "Some vessels may possibly be added to the fleet from the merchant service; but as such ventures are attended with so heavy an outlay for repairs, alterations and whaling inventories, it is not probable that many such additions will be made." Previously, in a less competitive era, merchant vessels did not need extensive alterations before they could hunt profitably. In 1878 (15 January) the editor made the point again: "Ship-building has revived, and twelve whalers were built during the year, it being now apparent that at the present prices new vessels can be built cheaper than merchantmen can be altered into whaleships." "The building of ships for the whaling service marks a new era in the business, and is an encouraging feature" (16 January 1877).[14]

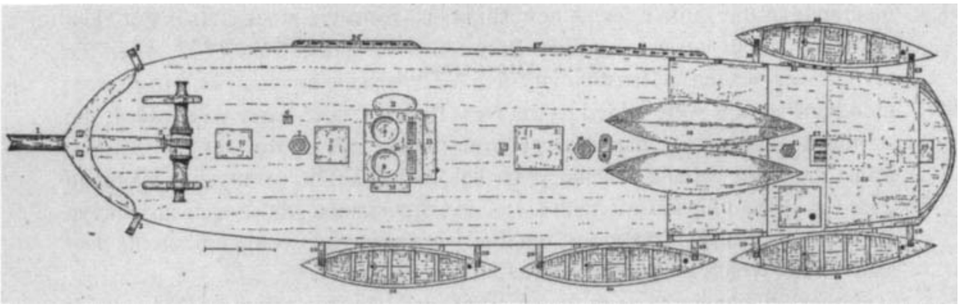
13. *WSL* 6 September 1853 (*Young Hector*), 14 June 1853 (*Othello*), 15 August 1854 (*Onward*); Work Projects Administration 1940 (*Alice Knowles*). The old tonnage of the *Alice Knowles* was computed from her length and width.

14. The word *ship* is used in its nontechnical sense, that is, to mean vessel.



This cross-section view of the bark *Alice Knowles* of New Bedford and the following deck plan and deck view of a whaleboat were drawn by C. S. Raleigh for *The Fisheries and Fishery Industries of the United States,* compiled by George Brown Goode and published by the U.S. Commission of Fish and Fisheries in 1887. The *Alice Knowles* was built at Weymouth, Massachusetts, in 1878 and first registered in New Bedford in June 1879. The bark foundered at sea in 1917 on her twenty-fifth whaling voyage.

At the bow of the vessel is the forecastle, the quarters of the seamen and greenhands (see ladder). At the stern are the captain's quarters (see ladder), and forward of them the steerage, quarters for the boatsteerers, cooper, and steward or ship's boy. The hold is entirely used for storage of supplies and oil.



The deck plan of the *Alice Knowles.* The large I-shaped apparatus toward the bow is the windlass and bitts. Immediately behind it is the forecastle's companion, leading to the crew's quarters. Then comes the foremast, the fore hatch, the tryworks, the main hatch, the mainmast, the pumps, two spare whaleboats stored atop the deckhouse, the mizzenmast, the cabin skylight (for the captain's quarters), the afterdeck house (containing the galley), and the wheel and screw box. The four whaleboats hung from davits over the side are ready for use.

The *WSL* proved prophetic. In the decade preceding its first comments (1866–75), thirty vessels had left the merchant marine to join the New Bedford whaling fleet. Six other vessels whose provenance cannot be ascertained with certainty (they may have been merchant vessels, or whalers transferring from other ports) were also added. Over the same period, additions from all sources totaled sixty-nine. Thus, transfers from the merchant marine accounted for at least 43 percent of new entrants (and perhaps as many as 52 percent). In the next decade the only transfers were three merchantmen that joined the fleet in 1876. Between 1876 and 1885 shifts from the maritime service accounted for a little more than 10 percent of the entrants.

Ships in the New Bedford fleet that were built for whaling were about 5 percent larger than ships built as merchantmen and then converted to whalers. The differences were substantially greater for barks: barks built for whaling were almost 23 percent larger, and ships converted to bark rig, 29 percent larger, than barks that were converted merchantmen. It appears that agents responded to short-run profit opportunities by employing almost any "ship, barge, or rowboat" that would float; but, if the decision involved substantial long-term investment—for either construction or alteration—they were careful to select vessels close to optimum size.

Both ships and barks joining the New Bedford fleet were substantially younger than the ships and barks in the fleet as a whole (see table 6.3). Contemporaries believed, and it remains a part of whaling lore, that the fleet was a dumping ground for vessels too old to be employed profitably elsewhere. The experience at New Bedford indicates a different story. The *WSL*'s annual review for 1876 (16 January 1877) laments that "the character of the fleet . . . has suffered of late by the adding of worn out merchant vessels, which obtain insurance at the same rates as new ships just from the stocks." It is not clear how that conclusion was reached. Between 1867 and January 1877, when the review was written, at least twenty-five (and perhaps as many as thirty-three) merchant vessels were added to the New Bedford fleet. They were old, if the standard was the merchant fleet or even the average age of vessels that had transferred into whaling in the years before 1860. The twenty-five averaged 23.8 (or, if the four vessels with a clouded provenance whose ages are known are added, 23.4) years. Old, yes, but they were nine years younger than the fleet as a whole, which averaged 32.8 years.[15]

Perhaps the answer lies in the aging of merchantmen relative to whalers. It is certainly possible, given the ravages of wood rot, that a twenty-five-year-old merchant ship was *really old,* while a thirty-year-old whaler—its hull and deck protected by ablutions of whale oil—was no more than *mature.* It is also possible that in 1879, when the editor wrote, "[I]t is to be regretted that so many vessels in an unseaworthy condition are sent out upon whaling voyages," he was pointing a finger at all New Bedford whaling agents, not just the few that had bought merchant vessels (*WSL* 14 January 1879). However, even if the transfer of twenty-year-old merchantmen degraded the fleet (a fleet that was, on average, always more than twenty years old), it was a phenomenon that affected ships only in the decade 1856–65 and barks only between 1865 and 1885. No ship moved from the merchant to the whaling fleet after 1865 and no bark after 1885. In the earlier years the average age of transfers was always less than twenty years and, it goes without saying, always less than that of the existing fleet.

Whatever their provenance, whaling vessels were used intensively, in the sense that the interval between voyages was typically very short. Well over one-half the vessels returning to port from whaling voyages were refitted and ready for sea again within three months; another 30 percent were ready within six months (see table 6.7). The refitting interval varied from one period to another, and there is no clear time trend, but, early and late, the interval in port was short.

6.7 Questions Involving Mode of Exit

How a vessel exited the fleet had no direct relation to the agent's initial decisions about a voyage, but it was important to the industry's profitability and, therefore, to the probability that the vessel would make another voyage. Some transferred out of the New Bedford whaling fleet to join the whaling fleets of other ports. Some transferred out of whaling in order to engage in other maritime activities—either at New Bedford or elsewhere. Some were rerigged and thereby, in the terms of this study, reborn as new vessels. Some

15. The average age of the fleet as a whole for the decade 1867–76—that is, of all vessels that spent time on whaling voyages during the decade—was calculated as of 1872.

Table 6.7 **Intervoyage Intervals, New Bedford Whaling Fleet, 1816–1905 (numbers of intervals)**

	0–1 Months		2–3 Months		4–6 Months		7–12 Months		13–24 Months	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
1816–35	132	24.0	249	45.3	116	21.1	36	6.5	17	3.1
1836–60	165	9.8	719	42.5	622	36.8	157	9.3	29	1.7
1861–65	32	13.3	63	26.1	60	24.9	55	22.8	31	12.9
1866–85	207	29.7	225	32.3	116	16.6	115	16.5	34	4.9
1886–1905	161	46.9	56	16.3	56	16.3	57	16.6	13	3.8
Total	697	19.8	1,312	37.3	970	27.5	420	11.9	124	3.5

Source: Intervals are calculated from sailing and arrival dates in the Voyages Data Set. An interval is associated with the arrival year of the preceding voyage, and it is on the basis of that arrival year that an interval is categorized into a time period.

Notes: Because dates are recorded only as month and year, the lengths of intervals may be misleading. An interval of one month may, for example, be shorter than an interval of zero months: April 1 to April 29 is a longer period of time than April 30 to May 2. Intervals of more than twenty-four months have been omitted (there were eighty-five during this period). We assume they reflect transfers out of and back into the New Bedford whaling fleet.

More than eight hundred voyages that took place during this period are not represented herein, either because they are the last New Bedford voyages of their vessels (and thus have no succeeding voyages to define intervals), because they are the first such voyages (with no preceding voyages), or because some portion of the necessary dates is missing.

were condemned. Some were lost at sea. In all, 107 ships and 137 barks transferred, 120 ships and 14 barks were rerigged, 98 ships and 133 barks sank, and 22 ships and 48 barks were condemned. (See table 6.8.)

To the owners the existence of a ready market for vessels in other maritime activities meant that they were not exposed to large capital losses in periods of falling whaling profits. From the point of view of technical change, that malleability meant it might well be profitable to build vessels designed for whaling and to continue to modify existing vessels to make them more productive—even when the fleet was contracting as less productive vessels shifted to the merchant marine. It should be noted, however, that the larger the proportion of vessels designed for whaling, the less malleable the capital stock. Between 1856, when the number of vessels in the New Bedford fleet stood at 337, and 1885, when it had fallen to 76 (the number of barks had declined from 138 to 58), 5 new ships and 30 new barks—designed and built specifically for whaling—were registered and entered the fleet. An additional 39 ships were rerigged as barks.

Transfer was less important as a means of exit than as a source of entrants, but it still accounted for almost four-tenths of the total. In response to changes in relative profit rates, owners could quickly shift capital from whaling to the merchant marine or vice versa. For the whaling industry, the long run was by no means long.

Table 6.8 **Modes of Exit from the New Bedford Whaling Fleet, by Rigging Class, for Vessels Completing Their Last New Bedford Voyages in 1816–1905**

	Total	Lost at Sea[a]	Rerigged[b]	Civil War[c]	Condemned[d]	Sold/ Withdrawn[e]	Stone Fleet[f]	Unknown
Ships								
1816–25	15	2	0	0	1	10	0	2
1826–35	24	5	6	0	1	11	0	1
1836–45	29	12	9	0	6	2	0	0
1846–55	84	40	22	0	7	15	0	0
1856–65	160	28	46	12	7	57	10	0
1866–75	44	7	31	0	0	6	0	0
1876–85	9	3	4	0	0	2	0	0
1886–95	7	1	2	0	0	4	0	0
1896–1905	0	0	0	0	0	0	0	0
Total	372	98	120	12	22	107	10	3
%		26	32	3	6	29	3	1
Barks								
1816–25	0	0	0	0	0	0	0	0
1826–35	4	1	0	0	1	2	0	0
1836–45	13	4	5	0	1	3	0	0
1846–55	35	14	6	0	4	11	0	0
1856–65	105	23	2	14	15	45	6	0
1866–75	80	43	0	0	12	25	0	0
1876–85	75	32	1	0	12	30	0	0
1886–95	36	12	0	0	3	21	0	0
1896–1905	5	5	0	0	0	0	0	0
Total	353	133	14	14	48	137	6	0
%		38	4	4	14	38	2	

Sources: Voyages Data Set (for date of last voyage and rigging class) and Exits Data Set (for mode of exit).

Notes: Vessels are placed in decades on the basis of the completion dates of their last New Bedford voyages. The completion date is the date of shipwreck, condemnation, or destruction for a vessel that did not arrive home safely. In a few cases in which the completion date is missing, the sailing year is substituted.

The numbers of vessels exiting the fleet are not comparable to the numbers reported in table 6.6 as entering the fleet because of the tables' time limits: some vessels (more ships than barks) entered the fleet before 1816 and exited after 1816; some vessels (more barks than ships) entered the fleet before 1905 and exited after 1905.

A vessel may be counted more than once in this table, as in table 6.6, if it was rerigged during its New Bedford whaling career. With that exception, vessels are counted only once, although this simplifies the careers of some vessels. For example, the bark *Alto* entered the fleet as a transferred merchantman in 1844 (she was built at Tiverton, RI, in 1826 and purchased from Fairhaven). After five New Bedford voyages, she was sold to Fairhaven in 1862; in 1867 she was again purchased in New Bedford. On a sixth New Bedford voyage (1867–70) the *Alto* was shipwrecked at the Falkland Islands. Only the 1844 entrance is counted in table 6.6; only the 1870 exit is counted in this table.

[a]Vessels lost at sea include those sunk by their crews in mutinies.

[b]Rerigged vessels didn't actually exit the fleet; they exited one rigging class and entered another.

[c]"Civil War" means destroyed by a Confederate raider.

[d]"Condemned" means declared unseaworthy by a government official.

[e]Some vessels sold/withdrawn were transferred to other ports, either as whalers or as merchantmen; others remained in New Bedford but left the whaling fleet; a few were broken up soon after being sold. (A total of twelve ships and ten barks are included in this category only because they returned safely to New Bedford from their last New Bedford whaling voyages. For the others, we have found evidence of sale or of subsequent activity from another port.)

[f]Vessels in the Stone Fleet were purchased by the U.S. government in 1861 and sunk at the entrances to the Charleston and Savannah harbors in an effort to block those ports.

One hundred and eighteen ships entered the repair yards and reemerged as barks. They were appreciably smaller than the ships that were not rerigged (table 6.3, panel B), and twice as old. This observation provides additional support for the conclusions that the expansion into the Western Arctic employed a number of ships that had begun to appear unprofitable and that, at least after the mid-1870s, barks had emerged as the technology of choice, not only in the Arctic, but also in the other three grounds.

Information on condemnations and losses at sea was also important to agents. The profits of the agents and owners of the vessels in question were, obviously, directly affected. Information about losses at sea aided them in estimating the potential profits from a voyage directed to one ground as opposed to another, and, because losses today affect insurance rates tomorrow, helped them assess future profit levels. Vessels were frequently lost. Of the 763 in the New Bedford fleet whose fate is known, 271 were lost to the hazards of the sea and another 26 fell to Confederate raiders during the Civil War. Those 297 do not include 70 vessels so worn out or badly damaged that they were condemned abroad during the course of a voyage.

There were the very unlucky vessels such as the bark *Atlantic* ("[w]recked on sailing day with 29 men lost") and the *Sarah (2nd)* ("capsized in a hurricane seven hours out, three men saved") (Hegarty 1959, 20, 7). There was the *Canada,* "lost on coast of Brazil on account of intemperance of Brazilian officials" (Starbuck 1878, 535). There were vessels whose charts were faulty—the *Ceres (1st),* for example, (lost "on a Reef . . . not laid down on any chart") and the *Logan* ("Lost on Sandy Island Reef Jan 26, 1855; owing to Chart being wrong") (Wood 1831–73, 2:143). There were those such as the *George Washington (2nd),* the *Pantheon,* the *Smyrna,* and the *Tobacco Plant* that never returned because they were burned by their crewman in such diverse places as Talcahuano, Nukahiva, St. Helena, and Honolulu (Starbuck 1878, 437, 505, 595; Wood 1831–73, 3:107). There were those such as the *Inga* and the *Superior* that were destroyed, usually with substantial fractions of their crews, by unfriendly natives (Starbuck 1878, 453, 551). There were the *Ann Alexander* and the *Kathleen,* which, like the *Pequod,* were sunk by the very whales they were trying to catch. The *Courser* was "[r]un down by steamship *Ytata*" (Starbuck 1878, 466, 641; Hegarty 1959, 35). Finally, there were those whose destinies are not known—the bark *Exchange* ("A missing vessel; her fate was never known"), the *Monongahela* ("supposed to have been lost on Fox Island . . . all hands lost"), and the *Montezuma* ("Missing—Probably lost in a gale") (Starbuck 1878, 469; Dias, "Catalogue of New Bedford Whaling Ships," 154; Wood 1831–73, 2:467). The problems of agents attempting to direct the whaling fleet from hundreds of miles away are encapsulated in the experiences of three poorly named New Bedford vessels: the *Hope (1st),* wrecked in the Bay of Islands; the *Hope (2nd),* "lost on Brampton Shoals"; and the *Hope (3rd),* "[l]ost at Island of Coetiva" (Starbuck 1878, 399, 549, 569).

There were clusters of losses—Confederate raiders sank many vessels, and almost the entire Arctic fleet was caught in the ice pack in 1871—and considerable year-to-year variation, but the upward trend in the loss rates for ships and barks is slight. For brigs, sloops, and schooners there is some evidence of improvement over the last few decades (see table 6.9).[16] There were, without question, marked differences among the loss rates for different classes of vessels and, for a given class, among hunting grounds. The crude loss rate per voyage for all vessels was 6.3 percent; but the figure for ships was 7.4, for barks 5.2, and for others 5.2.[17] Brigs, sloops, steam barks, and schooners were at sea for relatively shorter periods of time, and adjustment of the measure to reflect the period of exposure alters the inter-rig contrasts. The loss rate per year at sea for all classes averaged 2.7 percent. It was 2.9 for ships, 2.2 for barks, and 4.2 percent for other vessels.[18] Thus, other vessels go from having the lowest loss rate to having the highest.

The few brigs and schooners that ventured to the Indian Ocean did not fare well, but it was the second safest ground for barks (after the Atlantic) and was reasonably safe for ships also. The Pacific was slightly less kind to ships than the Indian, but was the second most dangerous ground for barks. For both ships and barks the Western Arctic was most treacherous. For ships the loss rate was three times as high there as in the Atlantic (the safest ground). For barks it was twice as high as for the Pacific.

On average, ships sank less frequently than barks, but the difference was not independent of the ground hunted. Nowhere was the loss experience of barks better than that of ships. In the Pacific and Western Arctic, however, the rate was more than 100 percent higher. These were profitable grounds, and barks were widely innovated in both.

Surprisingly, the vessels lost at sea were somewhat larger than the average in their class, but they were about the same age. The correlation between size and loss rate is partly explained by the experience in the Western Arctic. That ground drew the largest vessels, and it was also the most dangerous.

In the nineteenth century, vessel longevity was relatively short. Between the ocean below and the storm above, dampness was endemic, and vessels were particularly subject to the ravages of decay caused by fungi and bacteria. So severe was the problem that the average age of a sailing vessel in the maritime service has been estimated at only a dozen years. Such was not the case for whalers. Oil bubbling on the tryworks and barrels filled with oil stored below deck made a whaler unpleasant for the crew, but oil permeated the wooden hull of the ship and made it almost impervious to rot.

Thus, if they could escape unhappy crewmen, restive natives, hurricanes, gales, and uncharted reefs, whaling vessels were particularly long lived. When, after her eleventh voyage in 1852, the 1807-built *Phocion* was broken up, contemporaries noted that she was of a "remarkably bad model" (Starbuck 1878,

16. The average loss rate for other vessels between 1816 and 1846 was 10.6 percent. Between 1846 and 1875 it rose to 14.4; between 1875 and 1905 it fell to 5.6.

17. The crude loss rate per voyage is (the number of vessels lost divided by the number of voyages) multiplied by one hundred.

18. The rate is the number of vessels lost per number of vessels at sea multiplied by one hundred.

Table 6.9 **Annual Loss Rate, by Rigging Class and Ground, New Bedford Whaling Fleet, 1816–1905 (vessels lost per one hundred vessel years afloat)**

	All[a]	Atlantic and Eastern Arctic	Indian	Pacific	Western Arctic
Ships					
1816–25	0.82	0.00	—	1.16	—
1826–35	0.65	0.90	0.00	0.56	—
1836–45	1.21	0.99	0.94	1.30	—
1846–55	2.66	0.00	1.59	2.44	4.66
1856–65	4.46	10.68	4.99	4.01	4.69
1866–75	3.15	8.76	0.00	2.21	4.53
1876–85	3.98	0.00	0.00	2.46	46.19
1886–95	7.87	0.00	—	8.45	—
1896–1905	—	—	—	—	—
Means of voyages	2.37	1.65	2.07	2.13	4.94
Means of decades	3.10	2.67	1.25	2.82	15.02
Barks					
1816–25	0.00	0.00	—	0.00	—
1826–35	3.32	12.56	0.00	0.00	—
1836–45	1.74	1.37	2.59	1.46	—
1846–55	2.74	2.38	4.09	2.27	0.00
1856–65	4.95	3.37	5.70	5.02	5.42
1866–75	5.69	4.64	2.12	5.47	12.17
1876–85	6.21	3.73	8.73	6.72	17.71
1886–95	5.42	2.40	0.00	7.69	0.00
1896–1905	4.47	4.38	0.00	4.70	0.00
Means of voyages	4.76	3.65	4.03	4.78	9.19
Means of decades	3.84	3.87	2.90	3.70	5.88
Other and unknown[b]					
1816–25	3.00	3.71	0.00	0.00	—
1826–35	4.90	6.32	0.00	0.00	—
1836–45	11.27	9.85	46.08	0.00	—
1846–55	11.01	13.48	22.22	0.00	—
1856–65	25.51	25.51	—	—	—
1866–75	9.65	9.65	—	—	—
1876–85	8.29	9.07	—	0.00	0.00
1886–95	2.67	1.17	—	7.72	0.00
1896–1905	6.39	5.99	0.00	10.26	—
Means of voyages	6.48	6.59	16.67	4.48	0.00
Means of decades	9.19	9.42	13.66	2.57	0.00

Source: Voyages Data Set. An elaborate system was devised for giving lengths to voyages for which some date information is missing, in order to include all voyages in the calculation of vessel years of voyaging.

Notes: Voyage beginning and ending dates are recorded as month and year. The loss rate was thus calculated by (1) summing the number of months spent in the ground by vessels of a rigging type during a decade; (2) dividing that sum by twelve; (3) counting the vessels of a rigging type lost in a ground during the decade; (4) dividing the number of vessels lost in the ground by the number of vessel years spent in the ground; (5) multiplying the result by one hundred.

[a]The voyages used in calculating this column are only those used in calculating the ground-specific rates reported here. Voyages to mixed grounds and to unknown grounds are completely omitted.

[b]"Other" comprises sloops, schooners, brigs, and steam barks.

463). The *Maria* was apparently better designed. In the record of her thirteenth whaling voyage, Starbuck notes, "This is the 'old' Maria which has already performed [1828] four voyages to London, three to Brazil Banks, one to Indian Ocean, one to Falkland Islands, and fifteen to the Pacific since 1783" (257). Nor was this the old *Maria*'s last voyage. She went on to complete twelve more (including an 1849 voyage during which the ship and its captain were seized by natives in the Johanna Islands) before she was finally condemned at Talcahuano, Chile, on her twenty-sixth outing in 1863.[19] The 345-ton *James Arnold* (new tons), built in 1852, completed twelve voyages before 1894 when, having already brought back oil and bone valued at $876,425, she was sold to new owners for £1,000. The ship continued whaling (with a crew still using hand-held harpoons and lances) under the Chilean flag until at least 1925, and during this period brought her new owners an additional $340,900 (Chatterton 1926, 126–27; Hegarty 1959, 29).

A final example of the longevity of the American whaler can be found in the 1889 report of the New Bedford Board of Trade:

> The oldest vessels in the world today are the Rousseau and True Love; the former now lies at the wharf at the foot of North street. . . . She was built for Stephen Girard, of Philadelphia, by Nicholas Vandusen, and was launched from the yard of the Vandusens, near Shakamaxon street, on the Delaware, in 1801. She is 95 feet long, 28 feet broad, and 18 feet deep, and registers 305 tons. Her rig was that of a full rigged ship and at the time of her building she was considered a fair sized vessel . . . . After doing service for Mr. Girard for several years, her rig was changed and she was regarded as one of the fastest barks sailing from Philadelphia. . . . [I]n the latter part of 1831, she was purchased by the late George Howland . . . who was extensively engaged in the whale-fishery in the early part of this century. (Pease and Hough 1889, 70)

From the time the *Rousseau* was purchased by Howland until she was retired in April 1886, she made thirteen whaling voyages, to the Atlantic, Pacific, and Indian grounds, and even from the last—a forty-six-month venture in the Atlantic—the bark returned with 1,360 barrels of sperm oil, 180 barrels of whale oil, and 1,400 pounds of bone.

Not all vessels were as long-lived as the *Maria*, the *James Arnold*, and the *Rousseau;* but the average ages of the twenty-one ships and forty-six barks that were condemned were 30.6 and 37.7 years, respectively. The average age of the twelve condemned brigs, sloops, and schooners was only 24.3 years, but that figure is still substantially above the average for the merchant service.

Seventy-five of the eighty-three vessels that were condemned or broken up experienced that fate in the course of a whaling voyage. Officers and men were left in such places as Sydney, Rio, Île de France (Mauritius), the Cape Verde

19. Starbuck 1878, 461, 569. Starbuck says that after the *Maria* was condemned she was "used as a coaler till 1866, then fitted again for a whaler."

Islands, the Bering Strait, and the Beaufort Sea. At times the vessels were too badly damaged to be salvaged; at times their owners determined that salvage would cost too much; at times, it appears, owners were victims of international embezzlement schemes. Given agents' and owners' ability to search out profits, however, there can be little doubt that the eight that were condemned upon their return to home port were truly worn-out.

Vessels that were condemned were older than those that remained. They were substantially smaller than the average, but standardization for age would remove at least part of that difference.

6.8 Trends in Vessel Costs

The British blockade during the War of 1812 all but destroyed the American whaling fleet, which in 1814 consisted of only a few vessels, one from New Bedford. The next year, sixty-eight vessels (ten from New Bedford) left American ports for the whaling grounds. In the case of the New Bedford fleet, the numbers rose from 10 in 1815, to an average of 31.4 over the quinquennium 1816–20, to a peak of 320.2 during the five years 1856–60, before declining to 23.4 in the first years of this century. (See table 6.1.) The fleet represented a substantial capital investment, but estimating its magnitude depends, among other things, on estimating building costs.

Unfortunately, there is no adequate series on the cost of building whaling vessels nor, in fact, a totally reliable—or even a generally accepted—series on the cost of building wooden sailing vessels in general. Table 6.10 and figure 6.1 present two sets of estimates of the real cost per ton of the latter. The first series, "All Data," is derived from estimates in a wide range of literary and quantitative sources. It represents arithmetic averages of the costs of building "a vessel" or "an average vessel" as reported in these sources. The second series, "U.S. Commissioner," is taken from the *Report of the Commissioner of Navigation* for 1887 and 1888 (U.S. Department of the Treasury 1888). Unfortunately, the sources of the commissioner's estimates are not given. Although there are year-to-year differences, on average the two series track quite closely.[20] The major differences occur in the years between 1847 and 1855. It appears that the commissioner's data do not reflect the higher costs of building clipper ships, a design that became very important in those years. Conversely, because of the novelty of the design, the "All Data" series may be too heavily weighted by the clippers. Since the whaling fleet did draw some modified clippers (the *Lapwing*, *Onward*, *Othello*, and *Young Hector*, for example), the actual cost of whaling vessels probably fell between the two estimates.

Over the entire period there is little evidence of a trend in real prices (see figure 6.1). Given the rapid improvements in design and equipment in the middle of the nineteenth century, however, a quality-adjusted index would un-

20. The simple correlation coefficient is .79 (R^2 = .62).

Table 6.10 **Real Cost per Ton of New Wooden Sailing Vessels, United States, 1814–87 (1880 dollars)**

	All Data		U.S. Commissioner	
	Adjusted and Interpolated	Five-Year Moving Average	Adjusted and Interpolated	Five-Year Moving Average
1814	42.44	—	—	—
1815	42.12	—	—	—
1816	41.80	41.80	—	—
1817	41.48	41.48	—	—
1818	41.16	41.16	—	—
1819	40.84	40.84	—	—
1820	40.52	41.11	—	—
1821	40.20	41.97	40.20	—
1822	42.83	43.42	40.22	—
1823	45.47	45.47	40.25	40.25
1824	48.10	46.01	40.27	40.79
1825	50.73	46.19	40.29	41.49
1826	42.93	46.00	42.93	42.35
1827	43.72	45.44	43.72	43.35
1828	44.52	43.90	44.52	44.86
1829	45.31	44.19	45.31	45.63
1830	43.00	44.60	47.80	46.03
1831	44.40	45.17	46.78	46.08
1832	45.79	45.52	45.76	45.84
1833	47.37	46.27	44.74	44.98
1834	47.06	46.83	44.12	44.54
1835	46.75	47.20	43.50	44.53
1836	47.19	47.34	44.59	44.93
1837	47.63	47.63	45.68	45.68
1838	48.07	48.07	46.77	46.77
1839	48.51	48.34	47.86	47.97
1840	48.95	48.44	48.95	49.29
1841	48.54	49.59	50.61	50.72
1842	48.13	51.80	52.26	52.30
1843	53.84	55.06	53.92	53.95
1844	59.55	56.49	55.74	55.20
1845	65.26	59.97	57.23	56.05
1846	55.66	64.30	56.86	56.48
1847	65.56	69.46	56.48	56.48
1848	75.47	71.19	56.11	56.11
1849	85.37	72.70	55.73	55.32
1850	73.87	73.83	55.36	54.12
1851	63.21	70.08	52.92	52.51
1852	71.23	62.60	50.49	50.49
1853	56.72	58.38	48.05	48.05
1854	47.99	55.64	45.63	46.46
1855	52.73	50.67	43.18	45.72
1856	49.54	51.37	44.97	45.82
1857	46.35	56.58	46.77	46.77
1858	60.22	57.96	48.56	48.56
1859	74.08	61.42	50.37	50.58

Table 6.10 (continued)

	All Data		U.S. Commissioner	
	Adjusted and Interpolated	Five-Year Moving Average	Adjusted and Interpolated	Five-Year Moving Average
1860	59.61	61.67	52.15	50.75
1861	66.86	57.15	55.06	48.55
1862	47.60	50.94	47.60	43.66
1863	37.59	45.74	37.59	38.80
1864	43.02	38.06	25.91	33.48
1865	33.62	34.53	27.84	29.96
1866	28.46	33.22	28.46	28.65
1867	29.98	33.20	29.98	29.96
1868	31.04	35.55	31.04	31.59
1869	42.89	37.40	32.48	33.44
1870	45.36	38.62	35.98	34.66
1871	37.73	39.33	37.73	35.75
1872	36.06	38.46	36.06	36.97
1873	34.62	37.62	36.52	38.00
1874	38.55	39.00	38.55	39.38
1875	41.16	42.02	41.16	41.51
1876	44.59	47.61	44.59	45.09
1877	51.16	51.04	46.72	48.59
1878	62.60	52.48	54.42	50.46
1879	55.70	53.27	56.08	51.25
1880	48.33	52.25	50.48	51.08
1881	48.54	49.35	48.54	49.81
1882	46.08	48.96	45.86	49.35
1883	48.09	50.83	48.09	50.79
1884	53.76	52.74	53.76	52.70
1885	57.70	53.52	57.70	54.17
1886	58.07	—	58.07	—
1887	49.98	—	53.22	—

Sources: For the "All Data" columns: Chapelle [1935] 1982, 1967; Chatterton 1926; Cutler 1930; Fairburn 1945–55; Goldenberg 1976; Hall 1884; Hutchins 1941; La Grange 1936; Lubbock 1929; Macy [1835] 1970; McKay 1928; Rogers 1950. For the "U.S. Commissioner" columns: U.S. Department of the Treasury 1888.

Notes: The commissioner's prices after 1865 presumably refer to prices per new ton. We adjusted these figures downward by a little less than 5 percent (on the assumption that the prices refer to ships—see note 5), in order to convert them to prices per old ton. Similar adjustments were made to the "All Data" series. Prices were deflated by means of the Warren and Pearson "All Commodities" wholesale price index (U.S. Department of Commerce 1975, series E-52).

doubtedly display a negative trend. (See chapter 7 on these improvements.) One final caveat: it is generally agreed that smaller vessels cost more per ton than larger ones. Thus, the cost of the 350- to 400-ton barks and ships that made up the bulk of the whaling fleet may have been somewhat higher than the estimates reported in table 6.10; the costs of brigs, sloops, and schooners were certainly higher.

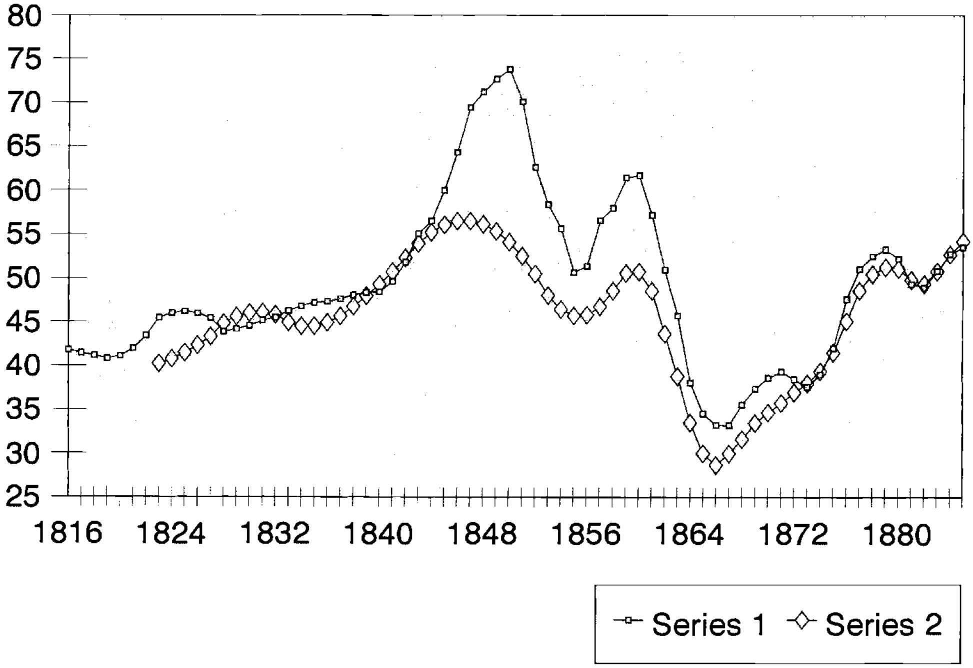


Fig. 6.1 Real cost per ton of new wooden sailing vessels, United States, 1847–87 (1880 dollars)

Source: The five-year moving average data from table 6.10. Series 1 is the "All Data" prices, series 2, the "U.S. Commissioner" prices.

6.9 Outfits

Although whaling vessels lasted far longer than vessels in the merchant service, their outfits were largely expended over the course of a voyage. The *WSL* noted with considerable pride that the ship *Cortez* on a voyage to the Arctic Ocean and the Sea of Okhotsk—during which it circumnavigated the globe—"came back with the same suit of sails which she sailed with." It went on to comment that the master of the *Cortez,* Peter Cromwell, would have managed the same feat on his last voyage (also a globe-girdling trip to the Arctic and Okhotsk), had it not been for a hurricane.[21]

A vessel usually carried two suits of sails. A suit for a 425-ton bark took

21. "[The *Cortez*] has made three successive and successful voyages in the Arctic Ocean and Ochotsk sea, during a period of seventy-six months, circumnavigating the globe upon each of them. During this period she has laid ten months in this port, and has brought in an aggregate of 8,200 bbls of whale oil, 350 bbls of sperm oil, and 123,000 lbs of whalebone. During her last two voyages she has been commanded by Capt Peter Cromwell, of Holmes Hole. His energy, tact, and prudence are fully proved by the successful and profitable character of his cruises. Among other details we may mention that from the second voyage the Cortes came back with the same suit of

2,900 yards of canvas, and that suit would have cost about $1,555.[22] Not all the outfit survived a voyage, even when the vessel was well officered and enjoyed nothing but pleasant weather. For example, when the *Golconda* was captured and burned by the Confederate cruiser *Florida*, "she was just ending her cruise, and had even thrown overboard the previous day her 'try-works' used for boiling the last whale down" (Chatterton 1926, 171).

Although outfits varied over time and with the size of the vessel, the *WSL*'s report (8 February 1859) of the outfitting of the New Bedford fleet in 1858 indicates the mountain of supplies needed to equip the whalers. In that year the agents who managed the sixty-five New Bedford vessels bought

1. Materials: 1,200 cords of oak, 260 cords of pine, 260,000 feet of heading, 33,000 pounds of rivets, 530,000 pounds of copper sheathing, 15,000 pounds of sheathing nails, 52,000 pounds of copping nails, 400 barrels of tar, 739,000 pounds of cordage, 32,500 feet of boat boards, 65,000 feet of pine boards, 205,000 yards of canvas, 13,000 pounds of cotton twine, 234,000 yards of assorted cloth, 39,000 pounds of white lead, 5,200 gallons of linseed oil, 400 gallons of turpentine, 13,000 pounds of other paint, and 120 casks of powder.

2. Food and provisions: 13,650 barrels of flour, 260 barrels of meal, 10,400 barrels of beef, 7,150 barrels of pork, 19,500 bushels of salt, 97,500 gallons of molasses, 39,000 pounds of rice, 1,300 bushels of beans, 39,000 pounds of dried apples, 78,000 pounds of sugar, 78,000 pounds of butter, 19,500 pounds of cheese, 16,300 pounds of ham, 32,500 pounds of codfish, 78,000 pounds of coffee, 14,300 pounds of tea, 13,300 pounds of raisins, 1,950 bushels of corn, 2,600 bushels of potatoes, 1,300 bushels of onions, 400 barrels of vinegar, 2,000 pounds of sperm candles, 32,500 barrels of fresh water, 130,000 pounds of tobacco, 2,800 gallons of new rum, and 1,000 gallons of other liquors. There were also bakers' bills for $16,250, $9,750 for preserved meat, $6,500 for tinware, and $3,900 for medicine.

3. Whalecraft and whale-rendering equipment: 1,000,000 barrel staves, 1,000 tons of iron hoops, 450 whaleboats, 36,000 feet of oars, 8,500 iron poles, 22,500 pounds of flags, 23,000 bricks, and 200 casks of lime. In addition, the agents paid $2,600 for hoses and bellows and $9,750 for whaling guns, bombs, and lances.

4. Refitting and miscellaneous expenses: $65,000 to ships' carpenters, $32,500 to ships' chandlers, $19,500 to riggers, $13,000 to blockmakers, $52,000 to blacksmiths, $13,000 to caulkers, $22,750 to sailmakers, $16,250 to painters, $26,000 to sparmakers, $4,875 for nautical instruments, $19,500 for stevedores, $4,875 for trucking, and $5,200 for towing and pilotage. These

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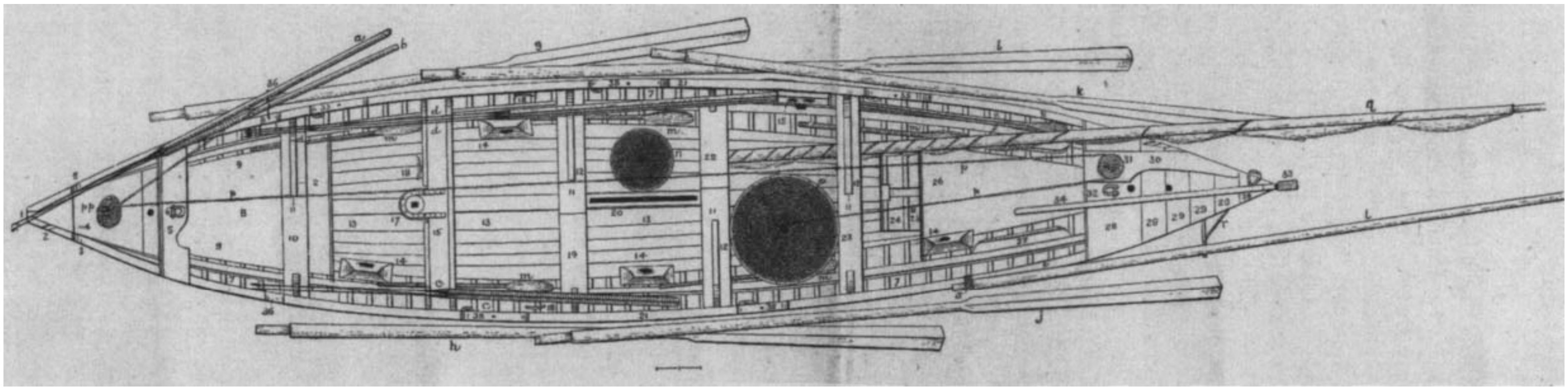
sails which she sailed with, and the same thing would have occurred upon her return from her last voyage if she had not experienced a hurricane. This is exceedingly creditable to the good old ship, and good evidence of her many good qualities. Another fact is equally creditable to her commander. On her last voyage, with three exceptions she brought back her entire original crew; and on her previous voyage all her men except two" (*WSL* 26 April 1853).

22. Hall 1884, 28. The $1,555 is in 1880 dollars. The nominal cost was $1,400.



The whaleboat was typically packed with gear. Across the starboard side of the boat in this picture, and extending over the bow, are two toggle harpoons, both attached to a line. The line comes from the large tub amidships on the port side (holding 275 fathoms [1,640 feet]), runs to the stern, around the loggerhead, then forward to the box in the bow, and from the box to the harpoons. When one or both harpoons struck a whale, the line would run through the gap in the very tip of the bow (the gap is called the *bow-chocks*). A second, smaller tub of line (75 fathoms [450 feet]) is situated forward and to the starboard of the large tub. Two spare harpoons lie at the side of the boat to port, and three lances lie to starboard. Paddles are placed under the thwarts at the rowing positions. On the starboard side toward the stern, two boat spades are stored, ready to the hand of the boatheader. The unseated mast extends over the stern on the starboard side, while the steering oar is parallel to it on the port side. The tiller would have been used only when the boat was under sail. When the sail was in use, the mast was seated forward, in the horseshoe-shaped *mast-hinge block*. The indentation on the port side of the forward thwart is called the *clumsy-cleat*. The harpooner placed his left thigh in the cleat to steady himself while preparing to dart his harpoons. (For a left-handed harpooner, the clumsy-cleat would be on the starboard side.) Three oars are arrayed on the starboard side, and two on the port. The forward starboard oar is the harpooner's oar. Although it is difficult to see in this drawing, the five oars are of different lengths. "The boats were dry and rode 'as gracefully as an albatross . . . for lightness and form, for carrying capacity compared with its weight and sea-going qualities, for speed and facility of movement at the word of command, for the placing of men at the best advantage in the exercise of their power, by the nicest adaptation of the varying length of the oar to its position in the boat, and lastly, for a simplicity of construction which renders repairs practicable on board ships, the whaleboat is simply as perfect as the combined skill' of generations of boatbuilders could make it" (Ansel 1978, 2, quoting William M. Davis's *Nimrod of the Sea*).

figures do not include the $13,000 advanced the captains for expenditures at sea, the $130,000 advanced to crews, and the $39,000 used to fill the slop chests. This last involved the purchase, among other things, of 3,150 monkey jackets, 4,550 pairs of thick trousers, 1,200 pairs of thin trousers, 5,200 woolen shirts, 3,250 cotton shirts, 3,900 undershirts, 3,900 pairs of drawers, 7,800 pairs of socks and stockings, 1,800 pairs of blankets, 1,300 bed comforters, 6,500 pairs of shoes, 1,500 pairs of boots, 1,200 smocks, 1,350 tarpaulin hats, 1,600 palm-leaf hats, 1,600 guernsey frocks, 3,900 tin pots and pans, and 4,700 jackknives.

Heavy expenditures on materials for refitting at sea were necessitated by the punishment vessels absorbed. The reports of those all but destroyed by hurricanes, typhoons, or uncharted reefs are many. Here are three examples.

In mid-December 1856 the *Benjamin Tucker* limped into Honolulu with jury masts. On 3 November she had lost her bowsprit, fore- and mainmasts, and mizzen topmast in a hurricane. Over fourteen days, while "the sea was so rough and the vessel rolled so that it was impossible to stand up without holding on to the rail," the crew, using "broken spars, spliced rope, and torn sails," managed to jury-rig the fore- and mainmasts so that the vessel could maneuver into smoother waters and eventually sail into Honolulu. The damage was so extensive that it took the repair yard more than two months and $14,000 to prepare the *Benjamin Tucker* for sea again (*WSL* 10 March, 5 May 1857).

In 1858 Captain Benjamin Kelley and the crew of the *Henry Kneeland,* lying at anchor off the coast of Patagonia, found themselves in a hurricane that lasted thirty hours. The ship lost her anchor and chains, and the crew were obliged to "cut away all three masts and jib boom to save the ship from going ashore." When the storm was over, Captain Kelley and his men "rigged up jurymasts, took the foreyard for a foremast, slung the three topsail yards for lower yards, and bent the topsails for courses." It took them two days to get the ship ready for sea.[23]

Not only hurricanes made repairs at sea vital. While cruising off Guam in March 1860, the captain of the *Rapid* discovered that someone had set the vessel afire. In order to control the fire, the crew bored holes in the hull below the waterline and flooded the hold with nine feet of water. "The ship was pumped and baled out in thirteen hours. The lower deck beams, carline and ceiling were badly charred, and the foremast burnt some" (*WSL* 11 and 18 December 1860).

Once the fire damage was repaired, they continued the voyage. On 26 June, while the vessel was dodging ice on the Sea of Okhotsk, a heavy current pushed her onto a rock where she stuck fast. When the ship finally floated off, there were forty-two inches of water in the hold. After five hours the crew were able to pump it out, but they discovered that the *Rapid* was taking additional

23. *WSL* 25 January 1859. The *course* is the lowest sail on a square-rigged mast. The crew of the *Henry Kneeland* were assisted by the crew of the *Harrison,* which had also ridden out the hurricane. "The Harrison sustained no damage beyond the parting of her best chain."

water at a rate of fifteen inches an hour. They built a box pump that allowed them to control the flow, fought free of the ice, and sailed for Ayan, a small Russian town on the coast.

Since there were no facilities to heave down the ship (which was leaking at the rate of thirty-six to thirty-eight thousand strokes per twenty-four hours), they "discharged the cargo and hauled the ship up on the beach at low water." There they "found the false keel was gone, about 20 feet [of the] stem and keel badly split and chafed to pieces, [the] copper and sheathing gone from the keel, say from 10 to 12 feet, [and the] garboard streaks [*sic*] open on both sides as far as the keel was split."[24] Using what tools they had, they were able by 21 July to build a box of tarred blankets and pine plank that covered the scar. Finding that the vessel was "comparatively tight," they reloaded, and sailed on 31 July.

After losing the anchor and forty-eight fathoms of chain on 7 August, they sailed eastward; but, while working her way through a dense fog, the *Rapid* collided with the bark *Jeannette Winslow.* The accident cost the *Jeannette Winslow* a fly, jib boom, and starboard boat; the *Rapid* lost a fly jib and tore the foresail. It was too much for Captain Francis D. Drew's vessel; she gave up the voyage at Honolulu in October (*WSL* 11 and 18 December 1860). Drew managed to send home 1,512 barrels of whale oil and 15,660 pounds of bone (Starbuck 1878, 537).

The crew's ability to effect repairs at sea was important also because captains and agents were convinced that repair facilities in foreign ports exploited whalers. There were frequent charges that unscrupulous officials condemned damaged whaling vessels and forced their captains to sell them to local interests at far less than their true value. In 1858, for example, the *WSL* (17 August) complained loudly about the treatment of the bark *George Washington.* "This vessel—recently a whaler of this port, and which was condemned at Sydney, N.S.W., in November 1857 as unseaworthy and subsequently sold to parties there, has been repaired at an expense not exceeding £25, loaded, and sent out to Callao. Her name has been changed to the 'Statesman.' " The *WSL* (22 January 1867) reported, "The vessels engaged in the Greenland whaling . . . are at far less expense than those in the North Pacific," in part because, aside from repairs at sea, "[t]here is no re-fitting ships at any but home ports."

Expenditures on food, provisions, and whalecraft need little explanation. Crewmen had to be fed, and, given the unstructured nature of the voyage, there was never a guarantee that the vessel would be near a port when food ran out. The food shipped was supplemented by fish caught and fresh fruit purchased along the way. Paita, Peru, for example, had "long been a famous resort for the sperm whaling fleet in the Pacific, and fruits and vegetables brought from the fertile valleys of Puna, can be obtained in great abundance, and until the immense emigration to California at reasonable prices" (*WSL* 3 August 1852). At

24. *Garboard strakes* are the planks next to the keel of a wooden ship.

Honolulu food was expensive; once the Gold Rush had run its course, San Francisco became an attractive substitute. Quoting approvingly from the *San Francisco Price Current* of 9 November 1860, the *WSL* (25 December 1860) reports, "Provisions can be obtained here at much less cost than at the Sandwich Islands, with the trivial exception against us in Sugar and Molasses. Recent quotations in the Honolulu papers note Beef worth $18; here it can be had for $16, and a good article of California packed at $10 @ $12. Pork can be had here at $15 @ $16; there it costs $20 @ $22. Bread costs at Honolulu 6½ @ 7 cents; here it is worth 3½ @ 4 cents." Overall the cost of food and provisions ran about $5.00 per crewman per month.[25]

The description of the dangers of the hunt given in chapter 5 suggests the loss rate of whaleboats; the estimates in chapter 4 of the numbers of whales wounded but not captured suggest the speed at which harpoons and lances were expended. Even success was not without cost. Each whale that was killed and towed back to the vessel required enough staves and iron hoops to make from 10 to 250 barrels.

It should be clear that the capital investment in outfits was not trivial, but for the early years there is a paucity of direct observations on the level of that investment. Obed Macy ([1835] 1970, 221) puts the cost of a three-hundred-ton whaleship in 1835 at $22,000 and the cost of outfits at an additional $18,000.[26] Elmo Hohman estimates the outfitting cost for a sperm-whaling voyage in 1844 at $19,774.75, for a right-whaling voyage in the same year at $17,129.45. He puts the value of a vessel employed in either at $31,224.72.[27]

There is more direct information for later years. The outfitting costs of thirty-six voyages operated by Joseph and William R. Wing between 1860 and 1870 are reported in Martin Joseph Butler's study (1973, 87) of the Wing agency. Unfortunately, it is not clear whether the costs include advances to the crew, nor can one disentangle the expenditures on food and other items. For the period of the 1870s and early 1880s the outfitting records of the *Milton* for four voyages to the Pacific and one to the Atlantic (1869, 1871, 1876, 1880, and 1884–85) have been preserved (*Milton* and *Callao* Account Books). Table 6.11 brings together these direct observations for the period 1860–85.

An analysis of the *Milton* and Wing outfitting costs (assuming that the latter do not include advances to the crew) is suggestive. A simple regression (table 6.12, panel A) of the total cost of an outfit on new tonnage, new tonnage squared, a measure of expected voyage length (the average voyage length of vessels returning from the designated ground over the previous three years), and the year of sailing, for the forty-one voyages reported in table 6.11, gives

25. Hohman 1928, 267–71, 325; appendix 5C. Hohman believes that the real content of subsistence per man changed virtually not at all, at least during the period 1844–65.

26. The real cost in 1880 dollars was also $18,000.

27. Hohman 1928, 325. These figures are all in nominal dollars. The costs in 1880 dollars would be $13,235 for Macy's Nantucket vessel and $25,681 and $22,246 for Hohman's sperm-whaling and right-whaling outfits. Hohman puts the value of the vessel at $31,225 ($40,552 in 1880 dollars).

Table 6.11 **Cost of Outfits, New Bedford Whaling Voyages, Sailing Years 1860–85**

Sailing Year	Name of Vessel	Rigging	Old Tons	New Tons	Ground	Voyage Length (months)	Nominal Cost ($)	Real Cost[a] (1880 $)
1860	Kathleen	bark	306.1	205.5	Indian	46	17,979	19,332
1860	Sunbeam	bark	359.5	255.5	Pacific	44	19,463	20,928
1860	Awashonks	bark	342.1	376.3	Indian	19	24,213	26,035
1861	A. R. Tucker	bark	218.1	130.0	Atlantic	36	13,261	14,900
1862	John Dawson	bark	237.4	173.5	Atlantic	25	13,769	13,239
1862	Awashonks	bark	342.1	376.3	Atlantic	39	8,458	8,133
1863	Charles W. Morgan	ship	351.3	313.8	Western Arctic	42	28,948	21,765
1863	Osceola	bark	195.0	158.5	Indian	36	18,786	14,125
1863	Brewster	ship	215.5	170.0	Indian	25	22,368	16,818
1863	Emily Morgan	ship	367.8	365.0	Western Arctic	59	29,001	21,805
1864	John Dawson	bark	237.4	173.5	Atlantic	28	19,180	9,938
1864	A. R. Tucker	bark	218.1	130.0	Atlantic	17	17,794	9,220
1864	Kathleen	bark	306.1	205.5	Indian	35	29,953	15,520
1864	Sunbeam	bark	359.5	255.5	Pacific	41	33,552	17,384
1864	Laetitia	bark	275.0	208.2	Pacific	46	29,456	15,262
1865	A. R. Tucker	bark	218.1	130.0	Atlantic	34	20,139	10,886
1865	Atlantic	bark	366.6	292.0	Indian	30	40,453	21,866
1865	Stafford	bark	205.8	155.2	Atlantic	23	22,589	12,210
1865	Triton	bark	299.8	264.8	Atlantic	35	34,160	18,465
1865	Awashonks	bark	342.1	376.3	Western Arctic	56	34,621	18,714
1866	Osceola	bark	195.0	158.5	Pacific	43	28,444	16,347
1866	Abraham Barker	bark	401.0	380.3	Pacific	47	48,918	28,114

(continued)

Table 6.11 (continued)

Sailing Year	Name of Vessel	Rigging	Old Tons	New Tons	Ground	Voyage Length (months)	Nominal Cost ($)	Real Cost[a] (1880 $)
1866	Brewster	bark	215.5	170.0	Atlantic	lost	25,522	14,668
1866	Xantho	bark	325.0	206.3	Atlantic	36	37,461	21,529
1867	John Dawson	bark	237.4	173.5	Atlantic	36	34,068	21,030
1867	Charles W. Morgan	bark	351.3	313.8	Western Arctic	49	35,182	21,717
1867	Kathleen	bark	306.1	205.5	Indian	48	32,255	19,910
1867	Stafford	bark	205.8	155.2	Atlantic	34	24,672	15,230
1868	A. R. Tucker	bark	218.1	130.0	Atlantic	22	19,456	12,314
1868	Atlantic	bark	366.6	292.0	Indian	48	37,722	23,875
1868	Sunbeam	bark	359.5	255.5	Pacific	38	35,442	22,432
1868	Triton	bark	299.8	264.8	Atlantic	40	35,095	22,212
1868	Laetitia	bark	275.0	208.2	Pacific	44	34,644	21,927
1868	Emily Morgan	bark	367.8	365.0	Western Arctic	lost	48,215	30,516
1869	Milton	ship	388.0	373.0	Pacific	44	40,162	26,597
1870	John Dawson	bark	237.4	173.5	Indian	27	27,277	20,205
1870	Awashonks	bark	342.1	376.3	Western Arctic	lost	39,545	29,293
1873	Milton	ship	388.0	373.0	Pacific	36	36,932	27,768
1876	Milton	ship	388.0	373.0	Pacific	42	25,126	22,842
1880	Milton	ship	388.0	373.0	Atlantic	44	17,618	17,618
1885	Milton	ship	388.0	373.0	Pacific	lost	25,197	29,644
Means			302.6	253.9			28,464	19,323

Sources: Most of the nominal outfitting costs are from Butler 1973, 87. Those for the *Milton* are taken from *Milton* and *Callao* Account Books. Values for rigging type, old tons, ground, and voyage length are from the Voyages Data Set. Values for new tons come from Work Projects Administration 1940.

[a]Nominal costs are converted to real costs using the Warren and Pearson "All Commodities" wholesale price index (U.S. Department of Commerce 1975, series E-52).

Table 6.12 Factors Influencing Outfitting Costs, New Bedford Whaling Voyages, Sailing Years 1860–85

A. Total Cost, All Observations

	Dependent Variable: Total Outfitting Cost
Statistical properties	
F	14.8
Adjusted R^2	.58
Dependent mean	19,325.2
Observations	41
Parameter estimates	
Intercept	−26,021.0**
Vessel tons (new)	109.5***
Vessel tons (new) squared	−0.2
Expected voyage length (months)	154.8**
Sailing year	354.0**

B. Cost per New Ton, All Observations

	Dependent Variable: Outfitting Cost per New Ton
Statistical properties	
F	13.3
Adjusted R^2	.481
Dependent mean	80.4
Observations	41
Parameter estimates	
Intercept	4.7008
Vessel tons (new) squared	−0.0004*
Expected voyage length (months)	0.5321**
Sailing year	1.2488**

C. Cost per New Ton, Omitting One Outlier

	Dependent Variable: Outfitting Cost per New Ton
Statistical properties	
F	13.4
Adjusted R^2	.489
Dependent mean	80.4
Observations	40
Parameter estimates	
Intercept	19.7674
Vessel tons (new) squared	−0.0004*
Expected voyage length (months)	0.5769**
Sailing year	0.9984

(continued)

Table 6.12 (continued)

D. Cost per Old Ton, All Observations	Dependent Variable: Outfitting Cost per Old Ton
Statistical properties	
F	4.7
Adjusted R^2	.218
Dependent mean	64.2
Observations	41
Parameter estimates	
Intercept	−19.5952
Vessel tons (old) squared	−0.0002*
Expected voyage length (months)	0.6074*
Sailing year	1.192*

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

an initial framework for such an analysis. Although subject to substantial variation, more than one-half of the total real cost of an outfit can be explained by the four variables.

The coefficients all have the expected sign, and all but new tons squared are significant at the 10 percent level or better. It obviously cost more to outfit a larger vessel than a smaller one, but the increase in cost was probably not proportional to size. The average cost of the forty-one outfits was $19,183. Thus, the difference in outfitting costs between the smallest vessel in the enumeration (the 130-ton *A. R. Tucker*) and the largest (the 376-ton *Awashonks* and 380-ton *Abraham Barker*), when expected voyage length and year are set at their average values, was $6,311.9. By the same measure (with tons, tons squared, and year set at their average levels), the difference in outfitting costs between a vessel scheduled for the shortest expected voyage length (18.3 months to the Atlantic in 1868) and the longest (48.4 months to the Pacific in 1864) was $4,660. Vessels at sea longer than average, however, certainly reprovisioned more than once, and those reprovisionings are not captured in the outfitting costs.

A different, and perhaps more interesting, specification, designed to take account of the increase in average vessel size over time, attempts to explain the per-ton cost of outfitting (table 6.12, panel B). Almost one-half of the variance is explained by the three independent variables (tons squared, expected voyage length, and year). Given an average cost of outfits of $75.55 per ton, the implied difference between the smallest and the largest vessel is $45.48, between the shortest and the longest expected voyage, $15.98.

Both of these exercises raise questions. There is a problem about the role of time. The regressions indicate that costs rose over time, although, in the per-ton case, its impact is somewhat dampened. In neither case, however, has time been assigned an important role in the analysis, even though at first glance it appears to have been a more powerful determinant of costs than expected voyage length. This apparent lapse was deliberate—YEAR outliers have a disproportionate effect on the regression analysis. The removal of a single voyage (the 1885 voyage of the *Milton*) dramatically reduces both the size and the significance of the coefficient on YEAR (see table 6.12, panel C). The removal of no single voyage affects the coefficients on the other variables significantly. Moreover, incorporation of the estimates for 1835 and 1844 supports the belief that there was not a significant long-term increase in the real costs of outfits.

A second question is raised by the use of "new" rather than "old" tons. The old calculation, based on the assumption that depth was equal to one-half breadth, often mismeasured the carrying capacity of a vessel (see chapter 7), but the agent knew its actual capacity. Luckily, for both the Wing vessels and the *Milton*, data on new tons—measurements that do reflect actual capacity—are also available. Using old tons (table 6.12, panel D), although leaving the coefficients largely unchanged, reduces the explanatory power of the second model from 48 to 22 percent.[28] Thus, it seemed appropriate to substitute the new measure for the old in this analysis, since, to the extent that agents' decisions were tempered by their estimates of the capacities of vessels, those estimates were probably based on figures similar to the revised tonnages. It is unfortunate that new tonnages could not be computed for the vessels that had passed out of the whaling fleet by 1865.

6.10 Conclusions

Even if there had been no technical change, the years from 1816 to 1906 would have seen a substantial shift in the profile of the stock of whaling vessels, but much less change in outfits.

The smaller classes of vessels—brigs, sloops, and schooners—were important only during the early years of rapid expansion and at the end of the period, when voyages to Hudson Bay and Davis Strait became relatively important. Ships constituted the bulk of the fleet over the first quarter century; after the 1840s the number of barks grew and eventually exceeded the number of ships. The ratio of ships to barks fell from almost ten to one in the early 1830s to one to thirty in the early 1890s. Part of the substitution can be attributed to technical changes that reduced the manning requirements for barks;

28. In the variant with old tons, however, the significance levels improve across the board.

part reflects the benefits realized in the Western Arctic from their greater maneuverability, outweighing their continued higher manning ratios.

In general, ships were between one-fifth and one-sixth larger than barks; more important, both classes increased in size over time, particularly during the first five decades. Between 1816–25 and 1886–95 the size of ships increased by about one-third, the size of barks, by one-half. Larger vessels were more productive than smaller ones, but adjustment to the more efficient size was slow. In part the sluggish response reflects the time it took to shift the fleet to the Pacific and Arctic, where there were special advantages to size. Interground shifts, however, do not come close to explaining all of the increase in average size. Larger vessels were more productive in every ground, but the slow pace of substitution need not have been the product of either custom or irrationality. Given the malleability of the capital stock—there was an almost unlimited supply of merchantmen that could be drawn into the fleet—and the large potential profits during the period of rapid expansion, ownership of any vessel capable of hunting was more rewarding than investment in the best vessel still in the shipyard.

The majority (three-fifths) of New Bedford vessels transferred into the fleet from other ports or maritime activities; almost one-fifth were built as New Bedford whalers; another one-fifth were whalers that were rerigged. The relative importance of the new and rerigged vessels increased rapidly as the industry began to stagnate, and then to decline. As market pressures increased, ships were rerigged as barks to hunt bowheads in the Western Arctic; newly built vessels were often barks of the modified clipper design—a combination that brought with it excellent handling qualities.

Finally, whaling was a risky business. Of the 763 vessels that can be traced, almost 40 percent were lost at sea or, during the Civil War, to the assaults of Confederate raiders. While most vessels made more than a single voyage, the loss rate per voyage was still a healthy 6 percent, and that figure does not include the seventy vessels that were so badly damaged at sea that they were condemned—most often in a foreign port—during the course of a voyage.

Technological change aside, there is less evidence of change in outfitting costs over time, although costs for a long voyage in the Arctic or North Pacific were expected to be higher than for a short cruise to the South Atlantic. No matter what the destination or length of voyage, outfitting costs were not trivial; on average they accounted for almost two-fifths of the total capital cost of a whaling voyage.

Outfits included food (although fresh produce was purchased along the way), the harpoons, lances, and whaleboats used in the hunt itself (to say nothing of the barrel staves needed to transport the oil home), and a mountain of supplies that would enable the crew to repair the vessel should it fall prey to weather, ice, uncharted rocks and shoals, or the machinations of an angry crewman. Sabotage, particularly arson, was not uncommon. Supplies included not only extra suits of sails, spare masts, and iron or hemp for rigging, but also enough lumber and copper to permit the crew to replace and resheath large sections of the hull.

Taken together, the capital invested in a typical whaling voyage amounted to something in the neighborhood of $50,000 (1880 prices)—a substantial sum in the middle of the nineteenth century. An agent's decisions about the composition of that investment were crucial to the profitability of the enterprise.