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PRODUCTIVITY AND THE DECLINE OF AMERICAN SPERM WHALING

*By George W. Shuster**

But still another inquiry remains; one often agitated by the more recondite Nantucketers. . . . whether Leviathan can long endure so wide a chase, and so remorseless a havoc; whether he must not at last be exterminated from the waters, and the last whale, like the last man, smoke his last pipe, and then himself evaporate in the final puff.

—Herman Melville, *Moby Dick*, 1851

INTRODUCTION

Ever since man discovered he could learn by his mistakes, the analysis of failures has proved to be as productive as the analysis of success. Santayana stated that those who have no knowledge of history are condemned to repeat it. Thus a necessary function of the economic historian has always been the study of prior declines and falls. Only by continuous reappraisal can information on past errors be successfully utilized to obviate the necessity for present trials.

Though perhaps of minor absolute significance by modern standards, one of the most dramatic industrial declines of the nineteenth century was the demise of the American whaling industry. As one of the most often cited of whaling historians, Walter S. Tower, wrote in 1907: "Practically no other industry in the country can present any parallel to the revolution that the whale fishery has undergone in the space of sixty years. From a business representing an invested capital of tens of millions of dollars, and giving employment to tens of thousands of men, it has fallen to a place where whaling is no longer of any great importance even to the communities from which it was carried on."¹

Among the explanations of this decline, the most commonly

stated is the discovery of oil in western Pennsylvania in 1859.² The availability of a cheaper substitute is seen, by this explanation, as drying up the demand for whale oil. In at least one account this explanation has been bolstered by citing the inaccurate, and at best coincidental, "fact" that the total tonnage recorded in the American whaling fleet reached its peak of 198,000 in the year 1858, or one year before the discovery of petroleum.³ For whatever relevance it may have, the tonnage peak of about 233,000 tons was reached much earlier, in 1846.⁴

Although this demand-oriented explanation has dominated the literature, the conclusion of the present study is that supply side factors may have been far more important in causing the decline in the American pursuit of whales. As the slaughter of whales continued for decades with increasing intensity, the whales became more scarce, greatly increasing unit production costs of whale products. In short, the primary cause of the decline in American whaling may well be traced to the demise of the whales themselves.

DEMAND VERSUS SUPPLY SIDE EXPLANATIONS OF DECLINE

That the demand side explanation should have so dominated the literature is not surprising in light of the general spirit pervading, and indeed informing, the industrial revolution and its concomitant technological achievements following one another in accelerating progression. In an age in which progress is viewed as a one-directional movement ever upward, the sideshow of failure is most naturally viewed, if viewed at all, as being caused by someone else's more successful mousetrap. Industrial evolution connotes one industrial mode becoming obsolete only when it is replaced by a newer, more efficient technique. The boundless optimism that characterized the industrial and geographical expansion of this country and Western civilization is in this way carried over into the historical analysis that later seeks to describe it.

Contrasted to a manifest destiny view of industrial revolution which ultimately conceives of the earth as an environment capable of sustaining an infinite progression of new technologies is the more recent emerging appreciation of the earth as capable of sustaining only a finite amount of burdens.⁵ Failure in such a

world is often not the result of obsolescence bred by the newer and better; rather it may arise from too great a success in the particular pursuit in the face of the environment's own constraints. Correctly understood, the decline of American whaling seems to provide an historic example of this latter phenomenon.

The PRELIMINARY REPORT OF THE EIGHTH CENSUS illustrates the tension between these two interpretations of whaling's decline. Written in 1860 after the discovery of petroleum but before its impact could have been fully appreciated, it correctly diagnosed the whaling industry's basic difficulty, if not the degree of its ultimate seriousness: "[a] slight decline in the value of the whale fishery arose from the increasing scarcity of the whale in its former haunts."⁶ However, the same report went on to provide, in a curious mixture, some of the language underlying the demand side philosophy that would later dominate, though not completely erase, the scarcity of supply interpretation:

The scarcity of whale and other fish oils in the arts has been supplied by an increased production of lard oil, and especially by that beneficent law of compensation which pervades the economy of nature, and when one provision fails her children, opens to them another in the exhaustive storehouse of her material resources, or leads out their mental energies upon new paths of discovery for the supply of their wants. Thus, when mankind was about to emerge from the simplicity of the primitive and pastoral ages, the more soft and fusible metals no longer sufficed for the artificer, and veins of iron ore revealed their wealth and use in the supply of his more artificial wants, and became potent agents of his future progress. When the elaboration of the metals and other igneous arts were fast sweeping the forests from the earth, the exhaustive treasures of fossil fuel, stored for his future use, were disclosed to man, and when the artificial sources of oil seemed about to fail, a substitute was discovered flowing in almost perennial fountains from the depths of those carboniferous strata.⁷

It takes an almost imperceptible sleight of hand to convert the "law of compensation" recognizing scarcity as a cause for economic extinction into a "law of displacement" assigning the major executioner's role to alternative developments. Chicken-and-egg obfuscation is all the cloud that is necessary for the invisible hand to convert the rule that failure breeds success into the rule that success breeds failure.

EVIDENCE ON THE SUPPLY SIDE

Even though demand side explanations have predominated in the literature,⁸ the well-known fact that whaling voyages became longer and extended to more distant seas during the period⁹ has always kept the door open to interpretations relying more heavily on supply side considerations. However, evidence of longer voyages and more distant whaling grounds¹⁰ is, without more, exceedingly ambiguous. It is possible it could indeed signify increasing difficulty in the task of finding whales, but it could also result from the discovery of ever more fruitful whaling grounds and increasing exploitation of the economies of scale implicit in longer voyages.¹¹ In short, evidence on productivity is necessary in order to decide whether the trend of longer voyages to more distant seas was primarily the result of the push of increasing scarcity in nearer and more familiar areas or the pull of greater vistas of plenty in newly discovered whaling grounds.¹²

There has been no study of production relationships in American whaling during the first half of the nineteenth century. A major reason for this lack may well be the notion, commonly exaggerated beyond its real importance, that there was extreme uncertainty in whale catches.¹³ If this were true to any appreciable degree, it could mean that any attempts to develop normal production relationships in whaling would prove fruitless. Any specification of variables would necessarily leave out the most important of all, the element of chance.

A major exponent of this view of whaling, Professor Tower, both illustrates it well and also provides inadvertently a clue to why it may be a distorted picture:

A comparison of imports and the size of the fleet . . . in a number of different years, will bring out vividly the uncertainty that always attended whaling operations. In a year when the fleet was large the imports might be small, while perhaps the next year a distinctly smaller fleet would bring in cargoes making up a far greater total for the year.

A comparison of the figures for one or two instances will illustrate the point:

The contrast between 1851 and 1854 is most marked. In the three years the number of vessels increased by 115—principally from New Bedford—but in the latter year the imports were distinctly smaller. One hundred of the 115 ships added were ships and brigs, represent-

SIZE OF WHALING FLEET AND QUANTITIES OF IMPORTS

Year	No. vessels	Gallons of sperm oil	Gallons of whale oil	Lbs. bone
1851	553	99,591	328,483	3,906,500
1852	620	78,872	84,211	1,259,900
1853	661	103,077	260,114	5,652,300
1854	668	76,696	319,837	3,445,200

ing an increase of at least \$2,000,000 in the invested capital. The lapse of four years precludes the argument that the new vessels had not had time to secure a cargo and return home—a point that becomes still more manifest if the imports for 1855 and 1856 are considered.¹⁴

The contrast between 1851 and 1854 which Tower points to is “marked” because although the number of vessels figure increased substantially, all production figures decreased slightly. Even more “marked” in the same respect is the contrast of 1851 and 1852 where the number of vessels increased substantially, yet all production figures decreased substantially.

Tower’s conclusion is based on a major conceptual error, however. Given the long voyages in whaling at this time, the appropriate input variable is hardly the total number of vessels in the fleet, which includes vessels docked in port and, more importantly, those still at sea during the year. The number of vessels bringing home the output measured in a given year would be far more satisfactory, though of course an index such as the ton-months of whaling effort that those returning ships represent would be even more ideal if available. Hohman gives figures for the number of vessels arriving in each year: 216, 127, 213, and 214, for the years 1851–1854, respectively.¹⁵ These input figures inject considerably more rationality into the output data. In particular, the substantial output decrease from 1851 to 1852 is readily explained by the correspondingly large decrease in the input variable, and similarly the slight output drop from 1851 to 1854 is certainly consistent with the small decrease in the number of ships returning.¹⁶ This example thus illustrates that despite the conventional wisdom, it may not be so foolish to attempt to find systematic production relationships in whaling after all. Particularly is this so in light of the finding discussed below that by 1850 whale catches were considerably less predictable than in earlier periods.

PRODUCTION RELATIONSHIPS IN SPERM WHALING

Aggregation of production of various products through the use of prices in whaling poses all the usual problems in extreme form.¹⁷ Furthermore, since the sperm and whale oil products were to a large extent produced in two distinct arenas—the average sperm whaler bringing home approximately 90 percent sperm oil, and the average right whaler an even greater percentage of whale oil—it is feasible to divide the industry into components. Lastly, by focusing on sperm whaling alone, more specific information on the pressure exerted by whaling on the population of whales is possible, since the different rate and extent of such pressure on right whales does not cloud the estimates. For these reasons the present study was limited to ships engaging in sperm whaling exclusively.

Data from the individual ship listings provided by Alexander Starbuck¹⁸ were used to run regressions of barrels of sperm oil against the ship's tonnage.¹⁹ For the entire study period, 1820–1849, the result was easily significant to the .01 level:

$$\text{barrels} = -26.682 + 5.914 \text{ tons}^{20}$$

$$(145.013) \quad (.421)$$

The standard error of the regression was 514 barrels, and comparing this figure to the mean of barrels, 1987, gives an interesting insight of the dispersion in catches whaling entrepreneurs would have to face. On the average, about two-thirds of the voyages could be expected to bring home sperm oil within about 25 percent on either side of the expected figure. That this type of result could be achieved using only one input variable and embracing a period of years during which production relationships were changing, as discussed below, makes it clear that even on an individual ship basis whaling production was far more predictable than has generally been considered to have been the case.

CHANGES OVER TIME, 1820–1849

A consistent pattern emerges in the analysis of regressions of successive five-year periods between 1820 and 1849. Table I summarizes the results. Beginning with 1830 there is a decrease in the amount of production per ton, and the variability of individual catches increases. Indeed, the period may conveniently be separated into three successive stages:²¹

TABLE I. REGRESSION RESULTS

Time Period	Value of Constant Term	Coef- ficient of Ton- nage Term	Num- ber of Obser- vations	R ²	F-Test	T Sta- tistic	Standard Error of Regres- sion	Mean of Barrels	Mean of Tons
Entire period:									
1820-1849	-26.68 (145.01)	5.91 (.42)	563	.260	(1/561) 197.15	14.04	514.0	1986.8	340.4
Five-year periods:									
1820-1824	-599.79 (257.73)	7.65 (.83)	70	.555	(1/68) 84.70	9.20	351.8	1740.5	306.0
1825-1829	-202.99 (187.78)	7.28 (.56)	121	.590	(1/119) 171.11	13.08	316.5	2224.3	333.2
1830-1834	222.23 (299.69)	5.18 (.84)	152	.202	(1/150) 38.09	6.17	574.2	2049.3	352.9
1835-1839	62.14 (361.76)	5.72 (1.03)	103	.233	(1/101) 30.69	5.54	494.5	2048.1	347.1
1840-1844	-73.98 (533.94)	5.51 (1.51)	79	.147	(1/77) 13.26	3.64	490.0	1860.9	350.8
1845-1849	-50.68 (873.78)	4.68 (2.57)	38	.084	(1/36) 3.31	1.82	622.8	1529.5	337.3

(1) The period 1820-1829 is characterized by high production per ton and reasonable predictability of catch, thus suggesting that during this decade the sperm whale was plentiful in the Pacific Ocean. In general, a ship could expect to obtain about $7\frac{1}{2}$ barrels of sperm oil per ton, or fairly close to capacity.²²

(2) The period 1830-1844 is characterized by decreased yields per ton, about 5 to 6 barrels of sperm oil, and increased uncertainty of catch. However, since there was also a large increase in the number of ships engaged in this fishery compared to the former period, the number of sperm whales in the Pacific appears to have been still reasonably substantial.

(3) The period 1845-1849 shows another marked decrease in yields, to less than 5 barrels per ton, and even greater uncertainty. By this time it is apparent that the sperm whale was becoming a scarce resource.

These demarcations should only be used as rough guides, since the underlying five year periods have been arbitrarily imposed upon the data and there is some problem of lag involved since the dating of each voyage was by departure.²³ Actually, of course, the increasing scarcity of the sperm whale was probably a more or less continuous process, as might be expected in any case involving fairly rapid depletion of a natural resource that does not quickly replenish itself.

Aside from demonstrating the early decline of sperm whaling productivity, these equations have relevance to three related problems:

(1) The significant negative constant term in the period of greatest productivity (1820–1829) is suggestive of increasing returns to scale under conditions of plenty, anticipating larger average ship size in later decades.

(2) The decline of sperm whaling helps to explain the absolute decline of Nantucket, the port most specialized in Pacific sperm whaling, beginning in the 1840's.

(3) The decline of sperm whaling anticipates the decline of the entire whaling industry. The greatest total American sperm oil catch in any year, of over 5 million barrels, was brought home in 1837, and was not approached again after 1845. The largest whale oil catch of over 10 million barrels was brought home in 1851, and not approached after 1854.²⁴

CONCLUSION

These findings serve to explain and modify previous accounts of the decline of American whaling. It is easy to rationalize Tower's conclusion that "[o]ne of the most potent causes working toward the downfall of whaling" was "the uncertainty of the business"²⁵ by saying that uncertainty was certainly magnified over time by the increasing scarcity of the sperm whale. At the same time, however, it is necessary to revise Tower's impression that such uncertainty had "always been the case with the whale fishery".²⁶

Using Scammon's estimate of the amount of oil recovered from one sperm whale, Starbuck calculated that from 1804 through 1876, 225,521 sperm whales were slaughtered by the American fleet.²⁷ The total world population of this type of whale, by comparison, is now estimated to be about 250,000.²⁸ It is thus no surprise that a major factor in the decline of this industry was excessive depletion of the whales themselves. This is not to deny that demand factors may have exercised an influence as well. It is to say that the demand side has probably been over-emphasized in the past.

Herman Melville himself did not believe what the "more recondite Nantucketers" were already telling him by 1851. Instead he answered his question "Will He Perish?":

. . . we account the whale immortal in his species, however perishable in his individuality. He swam the seas before the continents broke water; he once swam over the site of the Tuileries, and Windsor Castle, and the Kremlin. In Noah's flood he despised Noah's Ark; and if ever the world is to be again flooded, like the Netherlands, to kill off its rats, then the eternal whale will still survive, and rearing upon the topmost crest of the equatorial flood, spout his frothed defiance to the skies.

Moby Dick, Chapter 105

Yet it may not be accidental irony that one possible reading of his great whaling allegory is precisely that too triumphal success over Nature—slaying the White Whale—may involve man's—Ahab's own self-defeat.



FOOTNOTES

* Yale Law School, Class of 1973; B.A., 1967; M.S., 1969. The author would like to thank Professor Peter Temin of M.I.T. for his assistance.

¹ Tower, Walter S., *A History of the American Whale Fishery*, University of Pennsylvania Publications in Political Economy and Public Law, No. 20, Philadelphia, Pennsylvania, 1907, p. 72.

² Thus Samuel Eliot Morison concludes that "[w]orld-wide whaling out of Sag Harbor, New Bedford, and other New England ports reached its apogee in the 1850's; the discovery of oil in Pennsylvania in 1859 sounded its knell," *The Oxford History of the American People*, Oxford University Press, New York, N.Y., 1965, p. 584. In so concluding, Morison followed a well-established precedent of emphasis: (1) "[w]ith the discovery of oil in Pennsylvania the prosperous days of the whale fisheries ended," Jennings, Walter W., *A History of Economic Progress in the United States*, Thomas Crowell Co., New York, N.Y., 1926, p. 496; (2) "[t]he period of the Civil War abruptly marked the decline of whaling. Petroleum was displacing whale oil as illuminant and lubricant, and natural gas was making inroads. These were the enduring causes of decay," Mitchell, B., and Mitchell, L.P., *American Economic History*, Houghton Mifflin Co., Cambridge, Mass., 1947, p. 419; and (3) "[a] rapid decline ensued when petroleum provided a cheaper substitute for the main product," Wright, Chester W., *Economic History of the United States*, McGraw-Hill Book Co., New York, N.Y., p. 309.

³ Faulkner, Harold U., *American Economic History*, Harper and Row, New York, N.Y., 1960, p. 231.

⁴ Tower's series has a peak of 233,262 tons reached in 1846, Tower,

op. cit., p. 121. Hohman's peak is 233,189 tons, in the same year, Hohman, Elmo Paul, *The American Whaleman, A Study of Life and Labor in the Whaling Industry*, Longmans, Green, and Co., New York, N.Y., 1928, p. 45.

⁵ Another way of expressing the contrast is to say that the causes of extinction need not proceed by Schumpeterian cycles. No rule suggests that economic evolution can only take place through the displacement of successive forms by more potent competitors. An economic death can occur as the result of natural forces even before the ultimate substitute, if any, is yet born.

⁶ *Preliminary Report on the Eighth Census*, 1860, p. 70.

⁷ *Id.*

⁸ Another "demand side" explanation that is sometimes mentioned is the change in women's fashions, which meant that whalebone was no longer a very marketable commodity. However, even the timing is wrong for this explanation, since the decline in whaling greatly preceded the change in fashion. See Johnson, Van Metre, Huebner, and Hanchett, *History of Domestic and Foreign Commerce of the United States*, Vol. II, Carnegie Institution of Washington, Washington, D.C., 1915, p. 171.

⁹ For example, voyages from Nantucket to the Pacific increased from about two years in the first decade of the century to about four years in the 1840's. The mid-point of about three years was reached about 1830. From data in Starbuck, Alexander, *History of the American Whale Fishery, From Its Earliest Inception to the Year 1876*, published by the author, Waltham, Mass., 1878.

¹⁰ Note that the two facts are not the same. Even for the same whaling grounds, for example, voyages could increase in length of cruising time if whales became more scarce.

¹¹ The most obvious cause of the latter is of course the fact that for fixed whaling grounds a longer voyage maximizes the proportion of time spent in actual whaling as opposed to transit.

¹² Evidence on productivity can come from many sources. Beside the direct estimates calculated in this study, indirect indicators of decreasing productivity and increasing scarcity can be found. For example, two years before petroleum was discovered, *Scientific American* noted: "The whale oils which hitherto have been much relied on in this country to furnish light, are yearly becoming more scarce, and may in time almost entirely fail . . .," *Scientific American*, Vol. XII, June 27, 1857, p. 239, as quoted in Louis C. Hunter, "Products of the Earth, 1866-1918," *The Growth of the American Economy* (H.F. Williamson, ed.), Prentice Hall, New York, N.Y., 1951, p. 46.

¹³ Edmund Burke, in a commonly quoted speech in 1774, referred to American Whaling as "their most perilous mode of hardy industry",

quoted by Pitkin, Timothy, *A Statistical View of the Commerce of the United States of America*, (1816, Hartford, Charles Hosmer), reprinted by Augustus M. Kelley, New York, N.Y., 1967, pp. 43-44. Tower talks of "the uncertainty of the business," *op. cit.*, p. 72; Starbuck discusses "the many perils encountered in this pursuit," and the "ups and downs of the business," *op. cit.*, p. 145; and Hohman states that: "The most significant and certainly the most troublesome feature of whaling, as viewed by an entrepreneur, was its element of risk. No other well-established and legitimate industry was subject to such wild and unpredictable fluctuations of fortune. Financial returns ranged from ruinous losses to fabulous gains; and the whaling merchant became not only a vendor of oil and bone, but also, and preeminently, a dealer in risks," *op. cit.*, p. 272.

¹⁴ Tower, *op. cit.*, pp. 118-19. Note that aggregate uncertainty, based on annual averages, implies far greater individual ship uncertainty.

¹⁵ Hohman, *op. cit.*, pp 328-29.

¹⁶ Focusing only on sperm whaling a similarly imperfect but hardly irreconcilable picture emerges:

Year	Vessels Arriving*	Gallons of Sperm Oil
1851	53	99,591
1852	50	78,872
1853	64	103,077
1854	34	76,696

* Hohman, *op. cit.*, pp. 328-29.

¹⁷ The large increase in the price of whalebone from a low of seven cents a pound in 1807 to a high of 96½ cents in 1857, and the consequent or related shift into its production, is the most striking practical difficulty. The prices of sperm and whale oil also fluctuated a great deal during this period, Tower, *op. cit.*, p. 128.

¹⁸ Starbuck records, for all voyages of which he had a report, such items as home port, date of sailing, date of return, tonnage of ship, captain and owner of ship, destination, and barrels of sperm oil, barrels of whale oil, and pounds of whalebone brought home, as well as an occasional comment on matters such as the unfortunate death of the captain. For many entries the data is incomplete but given the very large listing, this constitutes a relatively minor problem. In the interests of narrowing the study here, data were obtained on entries which had the following information complete and met the following characteristics:

- 1) sailed between 1820 and 1849 inclusive,
- 2) sailed from either Nantucket or New Bedford,
- 3) sailed to the Pacific Ocean,
- 4) sailing date listed,

- 5) return date listed,
- 6) tonnage listed,
- 7) ships only (barks, brigs, etc., excluded),
- 8) brought home only sperm oil (no whale oil or whalebone).

This subsample numbered 563 voyages.

Starbuck's data is not without its problems. Starbuck himself mentions the following difficulties:

- 1) Oil sold by ships in foreign ports to pay for repairs is not reported. (However, where known, Starbuck lists such oil in his additional comments section. Where he did so, the amount has been included here.)
- 2) Oil not reported in the shipping journals was not reported.
- 3) Crediting oil to ships of the same name from the same home port was done in Starbuck's best judgment.
- 4) Oil was sent home in casks, which may have a variable number of barrels.

Starbuck used a constant of $4\frac{1}{2}$ barrels to the cask where conversion had to be made. (Even the barrel was apparently variable. Robotti puts a barrel at 30 gallons of oil, Robotti, Frances D., *Whaling and Old Salem*, Fountainhead Publishers, New York, N.Y., 1962, p. 40. Tower, *op. cit.*, p. 126, uses a conversion factor of $31\frac{1}{2}$ gallons per barrel.)

In addition to these problems there is the omnipresent bane of printer's error, as illustrated by the fact that sometimes ships are listed as returning before they have left. The effect of all these problems is probably to increase the variability of the variables, thus decreasing "goodness of fit," and possibly biasing the estimates of parameters. Add to this the fact that nowhere do we have information on all factors of production, and the result is necessarily the expectation that only a limited amount of the production relationship will be described. Starbuck's data does have the crucial advantage of allowing one to deal with individual ship data. Variations are not smoothed out by the aggregate averaging process. Thus the variation that is observed here is probably greater than would have faced the actual whaler.

¹⁹ Regressions were also run with length of voyage as a second independent variable, but these did not add anything of value to the discussion here. One interesting result, not entirely unsuspected, was the consistent negative sign attached to this variable, reflecting perhaps the dogged determination of Yankee captains to stay out despite, indeed because of, repeated disappointments. See Hohman, *op. cit.*, p. 86, for an explanation of this behavior in terms of the implicit rule of full-ship-or-do-not-return.

²⁰ Full regression results are reported in Table I.

²¹ The F-test described by Chow, which employs information on error sums of squares and degrees of freedom, was used to determine if

these three periods were indeed significantly different in a statistical sense. The results easily pass the .01 significance level, indicating that each of the three periods does indeed differ from those adjacent. See Chow, Gregory, "Tests of Equality Between Two Sets of Coefficients in Two Sets of Regressions", *Econometrica*, July, 1960, pages 591-605.

²² To determine ship capacities, all ships bringing home only oil, whale or sperm or both, which left the ports of Nantucket or New Bedford between the years 1800-1835 inclusive were analyzed in two groups, by port. The barrel returns were then listed in categories according to ship tonnage: up to 199 tons, every ten tons up to 399 tons, then 400-49 tons, and 450 tons and up. Then the approximately top ten percent of the barrel observations in each of the 23 tonnage classes were averaged, and these 23 observations formed the data for the two regressions of total barrels on tonnage. Both the Nantucket and the New Bedford regressions were similar, with insignificant constant terms, a slightly greater than 8.0 coefficient for tonnage, and R² values of .948 and .924 respectively.

This method of determining approximate capacity could be questioned. However, the goodness of fit and the great similarity between the two estimates suggest that something approximating ship capacity may be measured by the rule-of-thumb of eight barrels to a ton.

²³ The fact that the groupings may be somewhat arbitrary is illustrated by the fact that Chow tests showed a significant (.01 level) difference between the first three successive five-year periods, but not between any two successive five-year periods after that point. The successive ten-year periods all differ from each other at the .01 level.

²⁴ Tower, *op. cit.*, page 126. Other aggregate data reinforces the conclusion derived from productivity analysis that whaling was in decline much earlier than 1859. In terms of total number of vessels in the fleet the series provided by Tower, Hohman, and Starbuck reached peaks of 736, 735, and 731, in the years 1846, 1846, and 1845, respectively. *Op. cit.*, pages 121, 45, and 662 ff., respectively. In terms of total tonnage in the fleet, the series provided by these same three authors reached peaks of 233,262 (1846), 233,189 (1846), and 233,149 (1845), respectively. *Op. Cit.*, pages 121, 45, and 662 ff., respectively. Finally, Starbuck records the peak of number of vessels returning home as 257 in 1845. *Op. cit.*, pages 662 ff.

²⁵ Tower, *op. cit.*, page 72.

²⁶ Tower, *op. cit.*, page 72.

²⁷ Starbuck, *op. cit.*, page 661.

²⁸ Scheffer, Victor B., *The Year of the Whale*, Charles Scribner's Sons, New York, N.Y., 1969. The author intended this as only a rough estimate; precise estimates are not available.