

Historical Catches of Humpback Whales, *Megaptera novaeangliae*, in the North Atlantic Ocean: Estimates of Landings and Removals

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Introduction

Humpback whales, *Megaptera novaeangliae*, in the North Atlantic Ocean have been the subjects of an enormous amount of research in recent decades, including studies of population structure

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ABSTRACT—Whaling for humpback whales, *Megaptera novaeangliae*, in the North Atlantic Ocean has occurred in various forms (e.g. for local subsistence, for oil to be sold commercially, using hand harpoons and deck-mounted cannons, using oar-driven open boats and modern powered catcher boats) from the early 1600's to the present. Several previous attempts to estimate the total numbers of humpback whales removed were considered close to comprehensive, but some uncertainties remained. Moreover, the statistical uncertainty was not consistently presented with the previous estimates. Therefore, we have pursued several avenues of additional data collection and conducted further analyses to close outstanding data gaps and address remaining issues. Our new estimates of landings and total removals of humpback whales from the North Atlantic are 21,476 (SE=214) and 30,842 (SE=655), respectively. These results include statistical uncertainty, reflect new data and improved analysis methods, and take account of some fisheries for which estimates had not been made previously. The new estimates are not sufficiently different from previous ones to resolve the major inconsistencies and discrepancies encountered in efforts to determine the conservation status of humpback whale populations in the North Atlantic.

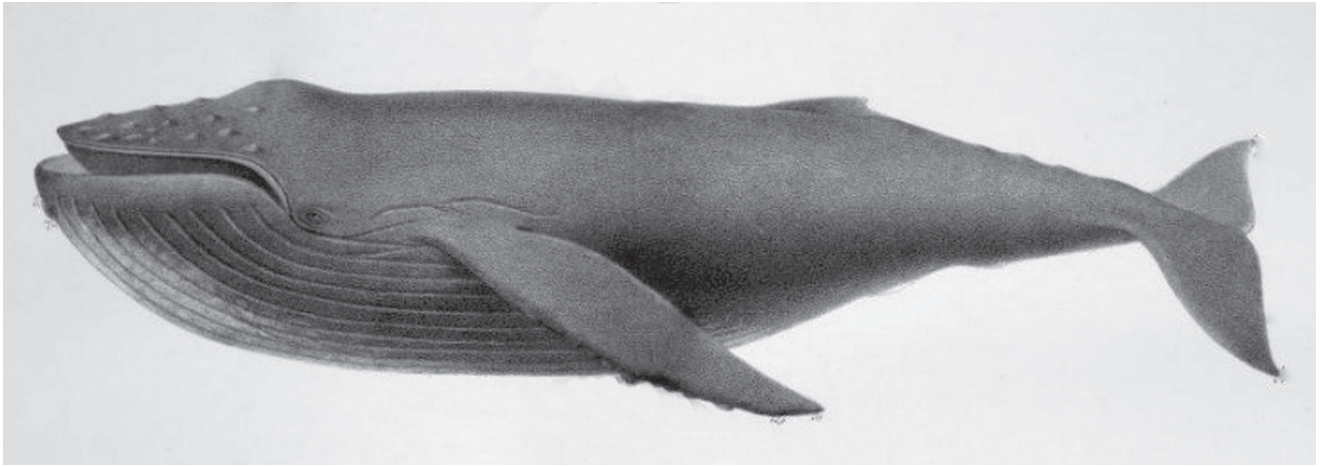
and distribution, social organization and behavior, abundance, and historical levels of removals. The Scientific Committee of the International Whaling Commission (IWC) began giving attention to the status of North Atlantic humpbacks in the 1970's, and during 2002–03 attempted to integrate what was known about the whales in this ocean basin using a population model-based approach. Population status was assessed primarily in terms of the ratio of present abundance to that prior to the beginning of commercial whaling in the 1600's, accounting for the existence of distinct breeding populations and the direct demographic effects of removals by whaling (IWC, 2003).

Although not generally viewed as one of the main target species of premodern whaling, the humpback was at least a secondary seasonal target of American shore-based and ship-based open-boat whalers in the late 18th century and much of the 19th century. Humpback whaling in the North Atlantic has been described by a series of papers, beginning with Mitchell and Reeves (1983:198), who noted, “Rather than experiencing a single, short, well documented period of intensive exploitation, the . . . [western] population . . . has been subjected to several centuries of hunting marked by at least three well documented peaks.”

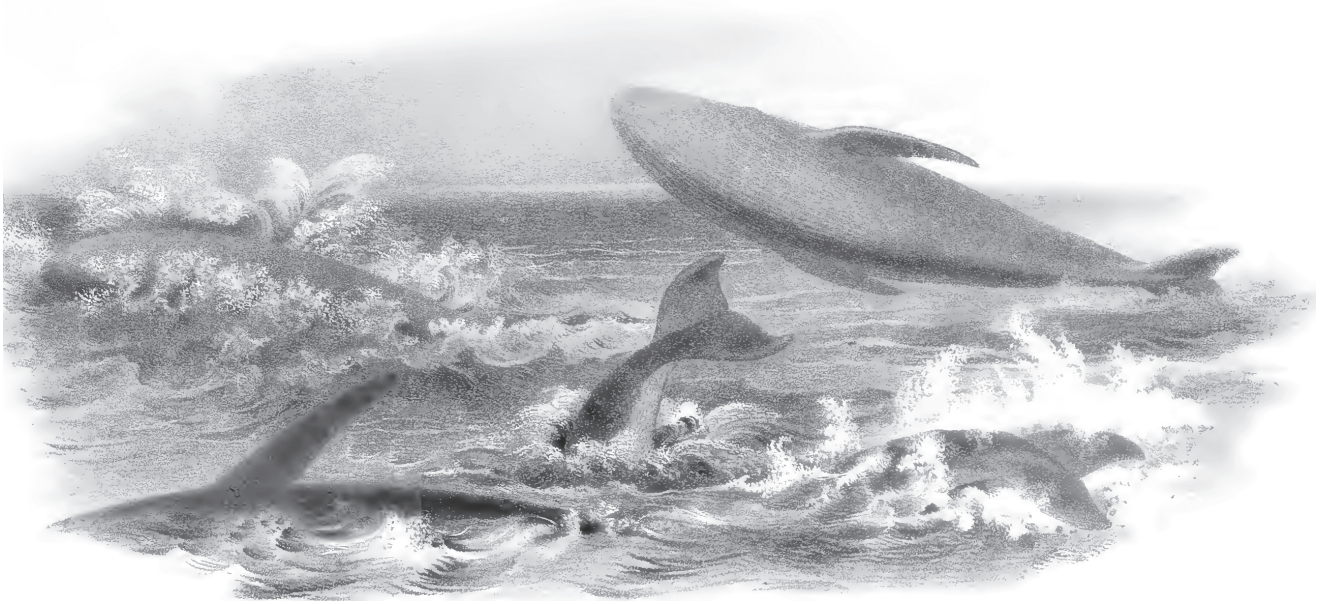
Subsequent work included the eastern and central North Atlantic and used 1) additional data sources (Reeves and Smith, 2002), 2) the results of various regional studies (Reeves et al., 2001a, 2001b, 2002a, 2002b, 2004, 2006), and 3) statistical sampling methods designed to obtain unbiased estimates of

total removals (e.g. Smith and Reeves, 2003b). In documents prepared for the IWC Scientific Committee (Smith and Reeves, 2002, 2003a), we estimated landings and removals for 13 regionally and operationally defined fisheries (Reeves and Smith, 2002: Table 1). To avoid forming an estimate that was a lower bound, the committee attempted to identify a best possible estimate for all years that each fishery was known to operate, even if that meant making substantial assumptions for some fisheries. Our work for the Scientific Committee resulted in an estimated total of roughly 29,000 humpback whales removed from the entire North Atlantic by whaling since 1616 (IWC, 2002, 2003).

That estimate is substantially higher than the lower bound of roughly 7,000 whales from Mitchell and Reeves (1983), which those authors used for a “conservative minimum estimate” of pre-whaling abundance in the western North Atlantic. Our 29,000 estimate for the Scientific Committee had a different purpose (population modeling) and was not intended to be a lower bound. Also, it took account of catches in other areas of the North Atlantic, particularly Norway, the Faroes, and the Cape Verde Islands. The Scientific Committee used the estimates from Smith and Reeves (2003a: Table 3), broken down by area, in a 2-population, spatially explicit population model to attempt to assess the status of humpbacks in the North Atlantic. All base-case models considered by Punt et al. (2007) in their analysis of the sensitivity of the assessment to various uncertainties suggested pre-whaling abundance levels in the range of 20,000–30,000.



Lithograph of a humpback whale, drawn by Charles M. Scammon (Scammon, 1874: Plate VII).



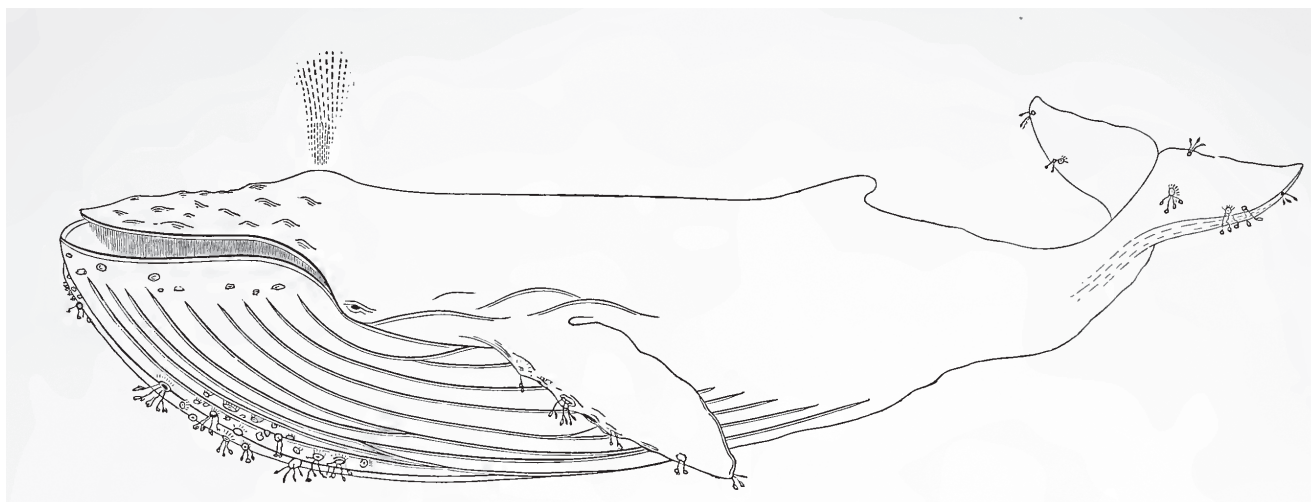
Lithograph entitled “Humpbacks lobsailing, bolting, breaching and finning,” drawn by Charles M. Scammon (Scammon, 1874: Plate VIII).

A critical review completed in 2007 (Smith and Pike, 2009) identified 7 specific areas of uncertainty surrounding the status of North Atlantic humpback whales. For example, it identified uncertainties concerning population structure, population size, and spatial mixing of individuals from different feeding or breeding areas. The review also highlighted the problem of lack

of fit of the population models and inconsistencies between catch-based estimates of pre-whaling abundance and genetics-based estimates of long-term historical abundance.

Those authors also identified several directions for research to address the uncertainties, one of which was to improve the catch history, specifically “filling in some residual uncertainties and

completing estimates of sampling uncertainty” (Smith and Pike, 2009:173). In this paper, we use new catch data for some fisheries and reanalyze previously available data for other fisheries to develop new estimates (with associated estimates of statistical precision) of humpback whale landings and removals for the entire North Atlantic from the early 17th century to the present.



“Outlines of a Humpback, with special reference to its short and broad pectorals, and to the parasites, commonly called barnacles, which adhere to the throat, pectorals, and caudal fin.” From Scammon (1874:47).

Table 1.—North Atlantic fisheries and sub-fisheries that took (or may have taken) humpback whales, following Reeves and Smith (2002), showing the numbering system used and the corresponding Eras and Operations, following Reeves and Smith (2006).

Fishery	Subfishery	Era	Operation
1. Norwegian mechanized shore	1. N. Norway	Norwegian-Style Shore	83
	2. W. Norway		83
	3. Svalbard		83
	4. Iceland		77
	5. Faroes		73
	6. British Isles		76
	7. Newfoundland		69
	8. Gulf of St. Lawrence		69
	9. Nova Scotia		69
	10. Grenada		83
	11. Spain-Portugal		86, 90
2. Norwegian mechanized offshore		Factory Ship	99, 101
3. Greenland nonmechanized shore		Arctic Aboriginal	9
4. Greenland mechanized shore		Norwegian-style Shore	72
5. Canada nonmechanized coastal		American-style Offshore (Pelagic)	52
6. Canada nonmechanized offshore		American-style Offshore (Pelagic)	52
7. American nonmechanized shore		American-style Shore	46
8. American mechanized coastal		American-style Offshore (Pelagic)	64
9. Bermuda nonmechanized shore		American-style Shore	30
10. West Indies nonmechanized shore	1. Barbados	American-style Shore	48
	2. St. Vincent and the Grenadines	American-style Shore	48
	3. Grenada	American-style Shore	48
	4. Trinidad	American-style Shore	48
	5. St. Lucia	American-style Shore	48
	6. Turks and Caicos	American-style Shore	48
11. American nonmechanized offshore	1. West Indies	American-style Offshore (Pelagic)	64
	2. Cape Verde Is.	American-style Offshore (Pelagic)	64
	3. Other areas	American-style Offshore (Pelagic)	64
12. Cape Verde Islands nonmechanized shore		American-style Shore	18
13. Madeira nonmechanized shore		American-style Shore	35

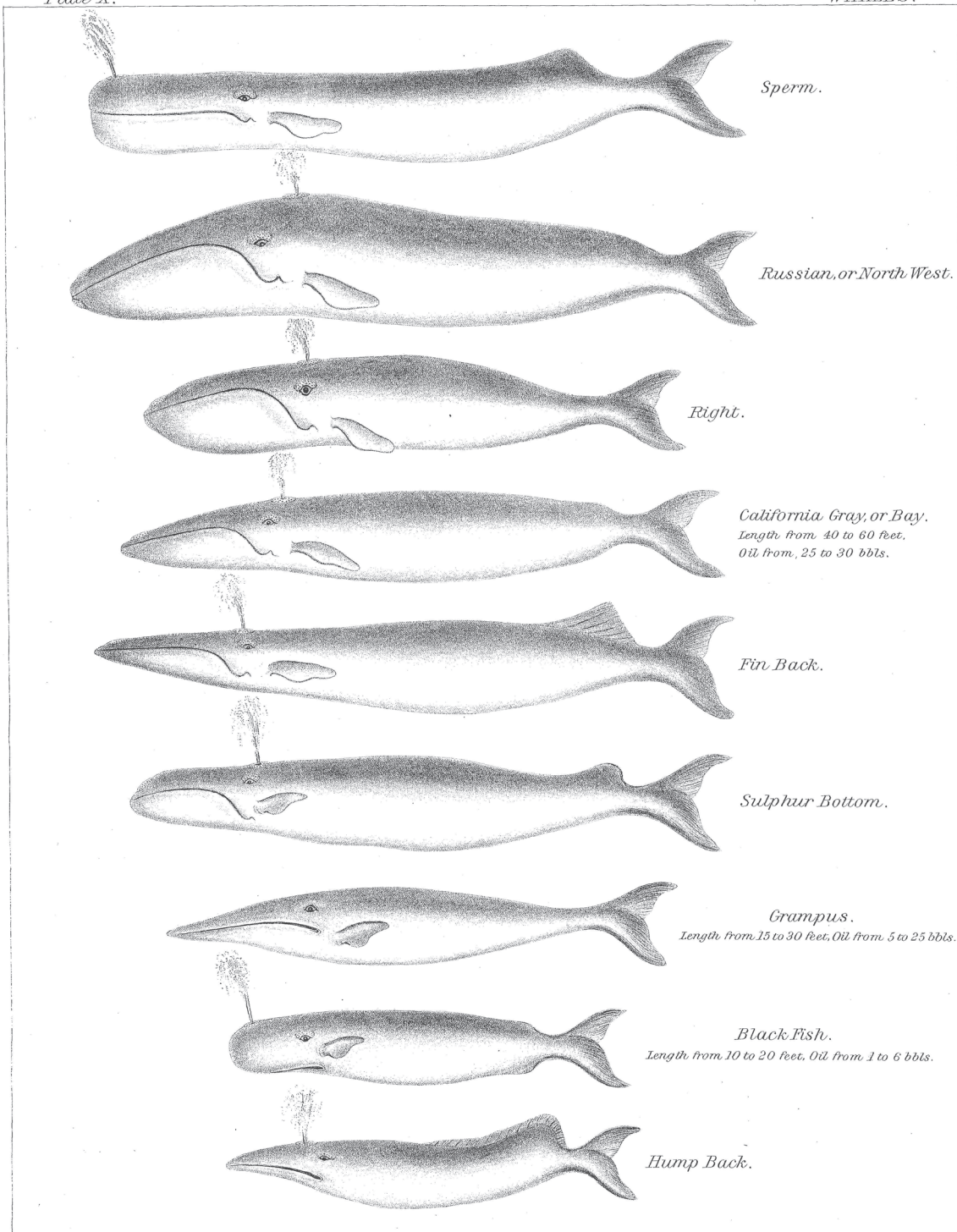
Materials and Methods

The analyses here were organized according to the same 13 fisheries as those defined by Reeves and Smith (2002). Based on improved understanding of whaling in the North Atlantic, however, some of the names of the fisheries (and their subfisheries) have been changed (Table 1). For

three ship-based fisheries (Fisheries 2, 6, and 11), we replaced the word “pelagic” with “offshore” to reflect their operations more accurately and to distinguish them from near-shore fisheries. We also redefined one fishery, previously termed American Nonmechanized Coastal. We divided it into shore-based and ship-based components. The shore-based compo-

nent is now included in the American Nonmechanized Shore fishery (Fishery 7). The vessel-based component is now included in the Other Areas subfishery of the American Nonmechanized Offshore fishery (Fishery 11).

The 13 fisheries were cross-referenced to the taxonomy of Reeves and Smith (2006), where global whaling was classified according to Operations



D.M. Clelland, Sc.

Stylized sketches of 9 types of whales known to 19th century American whalers, reportedly drawn from memory by a Mr. Conklin, an experienced whaleman. From Maury (1851).

and Eras (Table 1). Operations were defined by nation and by the nature of the whaling activities, and Eras according to the origin and nature of the whaling methods. Again, we substituted the term “offshore” for “pelagic” in the names of the Eras. Our definitions of fisheries and subfisheries for North Atlantic humpbacks, as explained in the preceding paragraph, are more spatially and temporally resolved and thus provide a more coherent basis for use in fishery-by-fishery catch estimation than does the global taxonomy. Therefore, in this paper we refer to North Atlantic fisheries according to the Reeves and Smith (2002) terminology and use the Operations/Eras terminology of Reeves and Smith (2006, as amended in Table 1) when referring to whaling in other parts of the world.

Data Sources

Various databases, lists, and summaries of data related to North Atlantic humpback whaling have been published or are otherwise available, and we assembled all of the relevant information of which we were aware. There are three general types of data, usually corresponding to the time period and nature of the fishery.

First, for many of the 20th century fisheries there are regular summary reports by national agencies and international bodies (e.g. the Bureau of International Whaling Statistics), usually giving the number of whales landed at shore stations or processed at sea by specific ships (Allison and Smith, 2004). Such summary reports are generally derived from more detailed records (e.g. daily station or vessel logs). In recent years, the IWC Secretariat has conducted inquiries into 20th century catches in the North Atlantic, particularly subfisheries of the Norwegian Mechanized Shore fishery in northern Norway (subfishery 1.1), in Iceland (subfishery 1.4), in the Faroe Islands (subfishery 1.5), and in Newfoundland (subfishery 1.7). The Secretariat¹ has kindly shared

¹Allison, C., International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, Cambridgeshire, U.K. CB24 9NP.

the results of those inquiries with us for the purposes of this paper.

In those instances where the species of some of the landed whales were not identified in the IWC data, we prorated the unidentified component according to the ratio of the total identified humpbacks landed to the total identified whales landed, pooling the data by decade and by fishery or subfishery. We estimated the standard errors by assuming a binomial model for the proportion of total identified landings that were humpbacks.

A second type of data consists of reports of catch and production by pre-20th century commercial shore whaling establishments. Such reports are usually preserved in company or government files or in newspapers. This type of data is highly variable in both content and completeness; rarely does it include numbers of whales landed. Most often, the catch is reported as product volumes (oil) or weight (baleen), in variable units, and sometimes it includes the monetary value of the products. For some whaling operations, the available information is very limited. For example, it may consist of nothing more than the number of boats, crews, or men employed or the number of stations active, possibly only for a few years over the life of the operation.

The third type of data consists of records on catch and production by pre-20th century whaling voyages. Such data come mainly from daily logbook entries, government reports (e.g. customs-house records), and newspapers. Reeves and Smith (2006) identified two operations in the American-style Offshore Era that took humpback whales in the North Atlantic, one from the United States (operation 64) and one from what is now Canada (operation 52). The former, here denoted as the American Nonmechanized Offshore fishery (Fishery 11) and the latter, here denoted as the Canada Nonmechanized Offshore fishery (Fishery 6), accounted for most of the 19th century landings of humpback whales in the North Atlantic.

We identified gaps in the available information for some fisheries, and as a result undertook to obtain additional

data on the Greenland Nonmechanized Shore fishery (Fishery 3), the Bermuda Nonmechanized Shore fishery (Fishery 9), several subfisheries of the West Indies Nonmechanized Shore fishery (Fishery 10), the American Nonmechanized Offshore Fishery in the Cape Verde Islands (subfishery 11.2), and the Cape Verde Islands Nonmechanized Shore fishery (Fishery 12).

With regard to the Greenland fishery (Fishery 3), it had long been recognized that Danish colonial records could be consulted for additional data on pre-1885 humpback catches, but this had not been done (Mitchell and Reeves, 1983; Reeves and Smith, 2002). We therefore arranged for Bo Poulsen, a professor at the University of Roskilde, to carry out a pilot study of Danish colonial records on our behalf. He examined a sample of “daybooks” of the Royal Greenland Trade Company kept at trading posts along the west coast of Greenland. The material was in the form of microfilms held by the IWC as a donation from Margaret Klinowska, who in the early 1980’s had initiated and then abandoned an archival study of bowhead whales, *Balaena mysticetus*, in Greenland using this material. Poulsen and his assistant examined the daybooks for reports of whaling during the months of July to September, when humpbacks were most likely to be in the area. They extracted information on specific references to whaling activity, whales caught, and the processing of whale products (Poulsen²).

Concerning the Bermuda fishery (Fishery 9), one of us (RRR) sampled some materials at the Public Record Office in London in October 2008 in addition to those that had already been examined by Mitchell and Reeves (1983) and Reeves et al. (2006). This included additional Blue Books (annual reports for U.K. Customs) for the years 1821, 1860, 1865, 1870, 1875, and

²Poulsen, B. 2010. Report covering the construction of dataset on Greenland humpback whaling from 1774-1886 based on ‘Daybooks of the Royal Greenland Trade’. Contributions to World Whaling History, No. 7. Available from the History of Marine Animal Populations at www.hmapcoml.org/publications/documents/Poulsen2010.pdf.

1880; Board of Trade correspondence (CO 41/18, 55, 60, 65, 70, 75; CO37/1, 2, 8, 22); and a mid-19th century run of Bermuda newspapers (CO 41/1 (1839–45) to 5 (1847–51)), specifically *The Royal Gazette: Bermuda Commercial and General Advertiser and Recorder* (1839–53) and *The Bermuda Herald* (1847–51).

Relative to the West Indies fishery (Fishery 10), one of us (RRR) searched trade records at the Public Record Office, with a particular focus on St. Lucia, Grenada, and the Turks and Caicos. The Grenada Blue Books were checked for the years 1821, 1822, 1830, 1840, and 1850, and for every year from 1856 to 1929, looking for information on whaling activity and whale products. The St. Lucia Blue Books were checked for the years 1825 to 1910. In the course of checking Bermuda newspapers (above) we also looked for evidence of shore whaling at Turks and Caicos during the middle of the 19th century.

Regarding the American Nonmechanized Offshore fishery in the Cape Verde Islands (subfishery 11.2), we suspected that this fishery had begun somewhat earlier than was assumed by Smith and Reeves (2003b). To explore this, we sampled additional logbooks for voyages beginning between 1850 and 1865.

With regard to the Cape Verde Islands (CVI) Nonmechanized Shore fishery (Fishery 12), we subcontracted two investigators to assist us in searching for archival source material. Cristina Brito (aided by Nina Vieira) carried out a search of libraries and archives in Lisbon, and Cornelius J. Hazevoet conducted a search of archives and libraries in the CVI. Brito attempted to identify and visit all libraries or historical archives in Lisbon related to the overseas colonies and their history and economics. Electronic and manual indexes were used in each institution, employing as search terms both the subject (e.g. and/or Cape Verde Islands, Portuguese overseas colonies; Fishing, Whaling; Natural History; Marine Animals, Commerce; Industry) and the time period (Cape Verde Islands and 1800 forward). The researchers exam-

ined all items that showed promise of containing relevant information.

Hazevoet's search of local archives and book repositories in the CVI covered 4 islands: Sal, Santiago (Praia), São Vicente, and São Nicolau. Various archives, museums, and relevant institutions were visited in Praia, the capital of the island of Santiago, and on São Vicente, but no useful information was found. A planned visit to the island of Maio, where a shore station operated until the early 20th century, had to be abandoned for logistical reasons.

Estimating Landings

For 20th century whaling, we assigned catches to fisheries and subfisheries based on the nations indicated and the descriptions of the shore stations provided by the IWC Secretariat. In consultation with the Secretariat, we supplemented and corrected the data for a few shore stations based on newly available sources. We evaluated the completeness of the data and concluded that the level of uncertainty was small relative to the total reported landings.

For pre-20th century shore whaling, we used the number of humpback whales taken when this was reported. More typically, we estimated the number of humpbacks taken as the total humpback whale oil production divided by the average amount of oil obtained per whale. We standardized the reported weight or volume of oil (to U.S. barrels, i.e. 31.5 American gallons). The unit definitions were not always clear from the source of the records (e.g. American vs. Imperial gallons). When possible, we used evidence within the same source or data series to infer which units were applicable. Failing that, we used conversion factors obtained from similar sub-fisheries or, if necessary, standard (albeit arbitrary) factors (e.g. Reeves et al., 2006).

The number of barrels obtained per whale varied with the location and timing of the whaling operation and the efficiency of the processing procedures. For example, whales at the end of the season on a breeding ground would be expected to produce less oil than whales just beginning to migrate from

a feeding ground. Also, shark damage to carcasses, and consequently reduced oil production, tended to be a much more serious problem at tropical stations. Thus, we tried to derive average oil yield per whale separately for each fishery or subfishery using the data for events or years when both the whale catch and the oil production were reported. For a few sub-fisheries where data were not available, we used summary statistics from a similar whaling operation as the basis for estimating catches. We estimated the standard errors of the various conversion factors and rates, and used these to calculate statistical uncertainty for catch estimates.

Although we estimated sampling uncertainty using parametric methods where possible, we often had no choice but to estimate the sampling uncertainty from the variance of a uniform distribution representing the range of values for selected time periods with observations. In particular, we used this latter approach to describe the statistical uncertainty of interpolated landings for years when reports were missing from the historical record (Reeves and Smith, 2010). This included interpolations over periods of several years or even decades. The method includes assigning average landings from adjacent years to years with no information, and assigning linearly interpolated values of mean landings to selected periods of years before and after a gap in reports. We estimated standard errors for these interpolations by assuming a uniform distribution estimated from the values being averaged. We report the overall uncertainty of our estimates as standard errors, recognizing that there is additional uncertainty that we are unable to measure. This applies especially to assumptions regarding completeness of records and the selection of time periods and geographic regions for pooling data.

With regard to pre-20th century offshore whaling, summary data for the American Nonmechanized Offshore fishery have been published documenting nearly all voyages made in the 19th century (Lund et al., 2010). These data include the names of vessels and captains, vessel characteristics, dates of

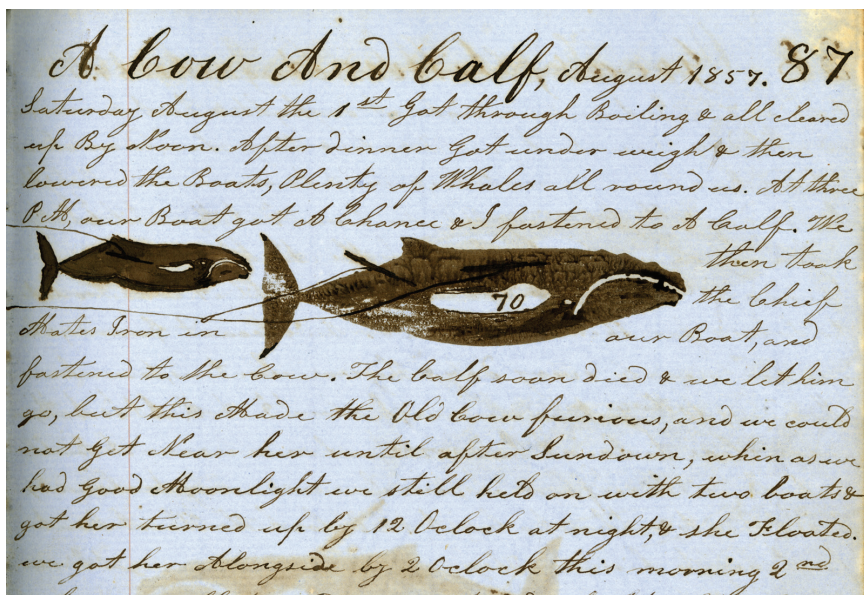
voyages, quantities of sperm oil, baleen whale oil, and whalebone (baleen) returned, and announced voyage destinations.

Further, we assembled logbook data from several sources, as follows: 1) logbooks read for our previous study (Smith and Reeves, 2003b), 2) a stratified random sample of logbooks read specifically for this study to cover the period 1850 to 1865, when we suspected the peak of vessel-based humpbacking in the Cape Verde Islands to have occurred, and 3) worksheets of data originally extracted from logbooks for the charts published by Townsend (1935). Although we used the methods of Smith and Reeves (2003b) for our recent logbook sampling (item 2, above), we also simplified the stratification procedures because several of the differences found previously between the mean number of whales landed per voyage and the proportion of Atlantic-bound voyages that whaled in the West Indies or Cape Verde Islands were not significant (Smith and Reeves, 2003b: Tables 2, 3).

The logbook data included numbers of whales secured and processed (“landed”), and, where possible, numbers of whales struck but not landed (“struck and lost”), all on a daily and location-specific basis. We assumed that the list of voyages in Lund et al. (2010) was complete and that the average number of humpback whales taken per voyage from our logbook sample was representative of all voyages. We estimated landings as the product of 1) the number of voyages identified in the summary voyage data, stratified by year and port of departure, 2) the proportion of those voyages that whaled in a given area judging by the geographic information in the logbooks sampled, and 3) the average number of humpback whales landed per voyage from the catch information in the logbook data.

Removals: Struck and Lost Rates

The estimates of landings derived from the general procedures outlined above do not account for whales that were struck and killed by harpoons or explosive devices but were not landed,



“The Humpback Whale” ink and watercolor drawings by Daniel C. Whitfield in his whaling journal kept aboard of the bark *Dr. Franklin* of Westport, David S. Russell, master, whaling in the North and South Atlantic, 1856–1859. This rendering apparently was produced in August 1857 while the crew of *Dr. Franklin* were engaged in a season of humpbacking in Ambriz Bay, West Africa. The whales taken on this ground during the Southern Hemisphere winter were part of a South Atlantic population that migrates to Antarctic and sub-Antarctic feeding grounds in the Southern Hemisphere summer. Courtesy: New Bedford Whaling Museum (KWM #1033).

Table 2.—Total humpback whales reported as tried out (i.e. “landed”); numbers reported as struck but not tried out, in 4 categories: killed, escaped carrying gear, escaped after the harpoon drew, and escaped in unknown circumstances; proportion of all killed whales that were lost (PL, with standard error); and loss rate factor (LRF, with standard error). Data are from 50 voyages.

Tried Out	Killed	Carrying Gear	Harpoon Drew	Unknown	PL	SE _{pl}	LRF	SE _{lrf}
226	61	47	39	64	0.41	0.025	1.71	0.073

the so-called struck and lost whales. The struck and lost component can be a significant fraction of the total mortality caused by whaling. The rate at which struck whales were lost and the rate at

which they died of their injuries undoubtedly varied according to a number of factors, including the species, the whaling methods, and the environmental conditions. Whaling catch data that

Table 3.—For all North Atlantic humpback whale fisheries and sub-fisheries (numbered as in Table 1, with abbreviated names), with non-zero estimates of landings, years whaling started (Yr.s) and ended (Yr.e), number of years operating (Yrs), estimated landings (L) with standard error (SE(L)), percent of total North Atlantic landings (%L), estimated removals (R) with standard error (SE(R)), and percent of total North Atlantic removals (%R).

Fishery	Yr.s	Yr.e	Yrs	L	SE(L)	%L	R	SE(R)	%R
1.1 NMS.NN	1864	1955	91	1,793	1	8.3	1,827	5	5.9
1.2 NMS.WN	1926	1950	24	13	0	0.1	13	0	0.0
1.3 NMS.S	1903	1926	23	54	1	0.3	55	1	0.2
1.4 NMS.I	1884	1954	70	2,200	5	10.2	2,242	8	7.3
1.5 NMS.F	1894	1964	70	737	24	3.4	751	25	2.4
1.6 NMS.BI	1903	1929	26	77	0	0.4	78	0	0.3
1.7 NMS.NF	1898	1971	73	1,593	6	7.4	1,623	8	5.3
1.9 NMS.NS	1969	1971	2	7	0	0.0	7	0	0.0
1.10 NMS.G	1925	1926	1	174	0	0.8	177	0	0.6
1.11 NMS.SP	1974	1976	2	2	0	0.0	2	0	0.0
2 NMO	1922	1977	55	453	0	2.1	462	1	1.5
3 GNMS	1750	1923	173	619	31	2.9	953	136	3.1
4 GMS	1924	2006	82	323	0	1.5	329	1	1.1
6 CNMO	1804	1888	84	1,401	34	6.5	2,158	292	7.0
7 ANMS	1805	1885	80	564	29	2.6	869	124	2.8
8 AMC	1883	1896	13	301	21	1.4	464	70	1.5
9 BNMS	1616	1942	326	1,497	50	7.0	2,305	317	7.5
10.1 WINMS.B	1868	1910	42	321	4	1.5	549	24	1.8
10.2 WINMS.SG	1878	2008	130	941	12	4.4	1,609	72	5.2
10.3 WINMS.G	1859	1924	65	271	5	1.3	463	22	1.5
10.4 WINMS.T	1826	1867	41	675	14	3.1	1,154	55	3.7
10.6 WINMS.TC	1846	1885	39	120	13	0.6	205	24	0.7
11.1 ANMO.WI	1850	1885	35	2,888	105	13.4	4,938	277	16.0
11.2 ANMO.CVI	1850	1885	35	1,787	93	8.3	3,056	206	9.9
11.3 ANMO.OA	1750	1900	150	1,323	83	6.2	2,262	172	7.3
12 CVINMS	1854	1900	46	1,337	110	6.2	2,286	212	7.4
13 MNMS	1957	1961	4	5	0	0.0	5	0	0.0
All Fisheries				21,476	214	100	30,842	655	100

include the struck and lost component are not common and generally are found only in logbooks (including personal journals) kept on board the vessels or in daily records kept at shore stations.

We identified data suitable for estimating the rate at which humpback whales were struck and lost for two fisheries, first in logbooks from the American Nonmechanized Offshore fishery (Fishery 11) and second in catcher boat log books from two land

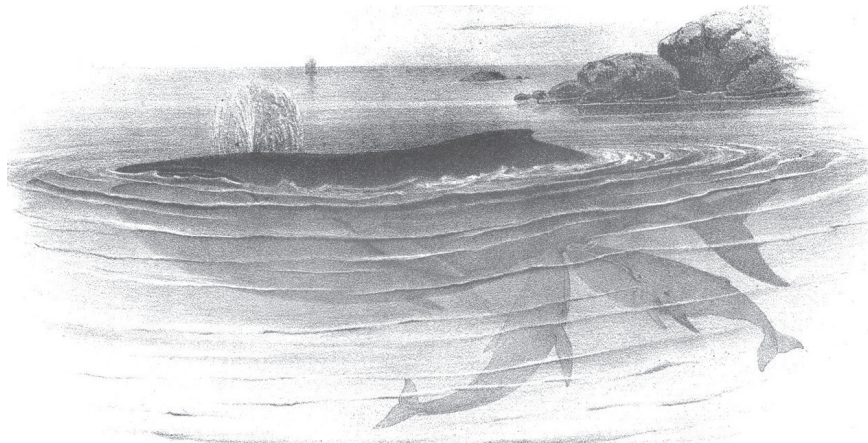
stations using Norwegian Mechanized Shore methods (Fishery 1). We used these data, supplemented by anecdotal observations from a range of whaling operations, to estimate loss rates.

In their Table 10, Mitchell and Reeves (1983) presented logbook data on struck humpback whales. They classified struck and lost whales according to the circumstances under which they were lost, as follows: 1) sank, 2) escaped with gear attached, 3) escaped after the har-

poon pulled free or “drew,” 4) escaped in unknown condition, or 5) calves whose mothers were known killed. Those authors judged that all struck whales in the first, second, and fifth categories likely died of their injuries or in the case of calves due to orphaning, and that half of the whales in the other two categories likely died. Using those assumptions, Mitchell and Reeves estimated loss rate factors ranging from 1.86 to 2.12.

We extracted data on struck humpbacks from additional logbooks, and adopted the first four of the five categories of Mitchell and Reeves (1983). We concluded that the information in the logbooks on calf orphaning was too sporadic and sparse to allow reliable assignment of animals to the fifth category. Not all logbooks included records of struck and lost whales. Given the high rates of loss indicated in other logbooks, we assumed that the complete absence of loss information in some logbooks reflected incomplete reporting by the log keepers rather than 100% efficiency in landing struck whales.

To minimize bias from such incomplete reporting we selected for analysis only those logbooks with reports of at least one struck and lost whale of any species at some point during the voyage.



Lithograph entitled “Appearance of a female humpback suckling her young,” drawn by Charles M. Scammon (Scammon, 1874: Plate IX). Note: Twinning is very rare in humpback whales and other cetaceans.

We assumed that those data were representative of voyages that did not report struck and lost animals. We pooled our new data with the data from Mitchell and Reeves (1983), for a total of 50 voyages, as shown in Appendix 1. The number of struck and lost whales that likely died (L) was estimated following the method and assumptions of Mitchell and Reeves (1983) as summarized above, but without consideration for orphaned calves (those authors' category 5). The total of removals is L plus the number of whales tried out (T), and we calculated the loss rate as $L/(L+T)$.

We examined loss rates both geographically (e.g. for whales in the North and South Atlantic and the North and South Pacific) and temporally (e.g. to determine if changes in whaling methods and gear had any effect). The rates were not significantly different for any of the statistical tests carried out. Therefore, we used the pooled data (Table 2) to estimate a loss rate of 0.41 (SE=0.025) and a corresponding loss rate factor ($1/(1 \text{ minus the loss rate})$) of 1.71 (SE=0.073). The latter can be multiplied directly by the estimated landings to estimate total removals. This factor was applied to the American Nonmechanized Offshore fishery (Fishery 11), from which the data were drawn. It was also applied to the West Indies and Cape Verde Island Nonmechanized Shore fisheries (Fisheries 10 and 12, Table 1) because they were functionally similar to American Nonmechanized Offshore fisheries in their use of small open boats without engine power.

Information on struck and lost whales is also available for two American whaling operations in Alaska that used Norwegian-style Shore era methods. From a sample of logbooks kept by catcher boats operating out of Akutan and Port Hobron, Reeves et al. (1985) reported that 46 whales (blue, fin, humpback, right, and sperm) were struck but lost in the course of securing ("landing") 2,426 whales. Those data imply a loss rate of 0.0182 (SE=0.0027), which corresponds to a loss rate factor of 1.0185 (SE=0.0028). In the absence of any other information, we applied this factor to all of the mechanized fisheries, whether

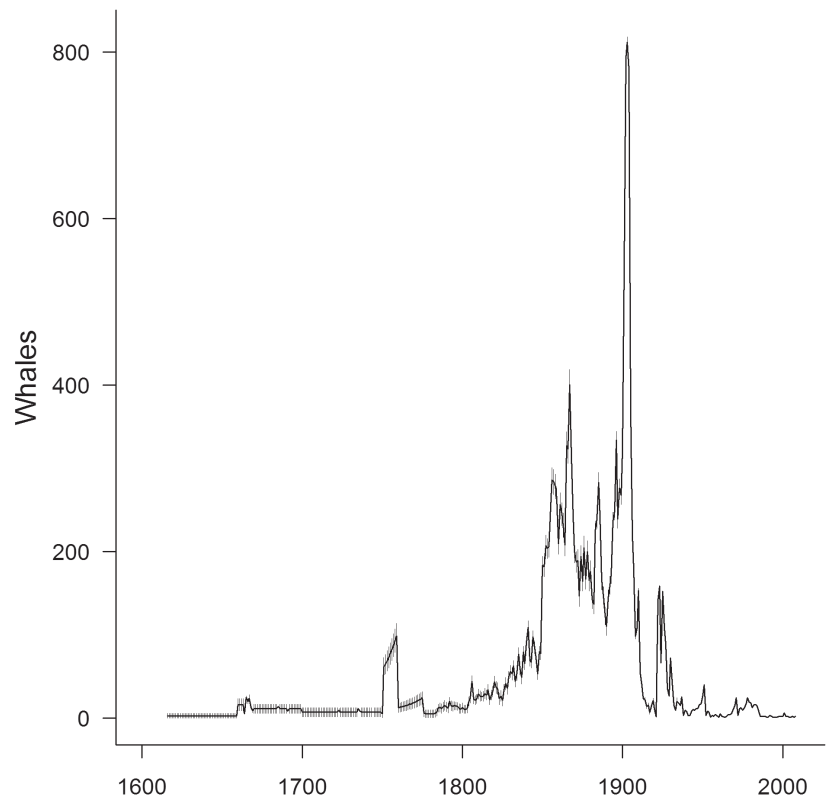


Figure 1.—Estimated number of humpback whales landed over time, totaling 21,476 whales, with 99% confidence intervals shown by vertical lines, for all 13 North Atlantic fisheries combined (see Tables 1 and 3).

from shore (Fisheries 1, 4) or offshore (Fishery 2). In the absence of any direct information and for completeness, we also applied this factor to the very minor late 20th century nonmechanized shore fishery in Madeira (Fishery 13).

Mitchell and Reeves (1983) also summarized anecdotal information on loss rates for pre-20th century humpback shore whaling outside the breeding grounds. They cited references suggesting loss rate factors ranging from 1.2 to 2.0, corresponding to loss rates between 0.2 and 0.5. We computed the mean of this interval (0.35) and assumed a standard error based on a uniform distribution over the range, 0.087. This corresponds to a loss rate factor of 1.54 with a standard error of 0.205. This rate was applied to the nonmechanized shore and offshore feeding ground fisheries (Fisheries 3, 6, 7, 8, and 9).

Results

Estimates of landings are given below for the 13 fisheries in three groups: 1) mechanized fisheries, 2) nonmechanized shore fisheries, and 3) nonmechanized offshore fisheries. For ease of comparison, the estimates of landings are summarized in Table 3, including for each fishery or subfishery the period of years for which landings were estimated, the total landings (with standard errors, SE), and the percentage these landings represent of the total humpback landings by all fisheries combined. Figure 1 shows the annual estimates of landings of humpback whales totaling 21,476 animals for the entire period of whaling, with vertical bars indicating 99% confidence intervals. The annual estimates of landings are included in Appendix 2. Estimated removals are summarized at the end of this section.

Mechanized Whaling

This category included whaling using methods developed in Norway and in America at widely dispersed shore stations and in offshore areas beginning in the late 19th century and continuing into the 20th century (Fisheries 1, 2, 4, and 8).

Norwegian and Greenland Fisheries (Fisheries 1, 2, and 4)

The data for these three fisheries were reported in numbers of whales landed, and therefore estimation was unnecessary. Proration to account for catches reported only as “whales” was necessary for a few of the subfisheries, primarily in the period from the late 1800’s to the early 1900’s.

American Coastal Fishery (Fishery 8)

Reeves et al. (2002b) described this fishery in the Gulf of Maine, which lasted for less than 2 decades. The fleet of steam-powered vessels fishing for menhaden, *Brevoortia* spp., shifted to whales, including humpback whales, in 1880. The numbers of vessels and whales landed are available for several years (Reeves et al., 2002b: Table 3). Landed whales were estimated for years when landings were not reported by multiplying the number of vessels by the mean whales per vessel from years when these were available. The likely proportion of the landings that were humpbacks was one-quarter to one-half, judging by anecdotal comments noted in Reeves et al. (2002b). Therefore, we estimated humpback landings by multiplying the total landings by 0.375, the average of the values 0.25 and 0.50, and assigned a standard error based on a uniform distribution over that range.

Summary of Mechanized Whaling

The landings by the 4 mechanized fisheries totaled 7,727 humpback whales (Table 3, Fig. 2A), over one-third of the North Atlantic total. The Norwegian Mechanized Shore fishery was by far the largest of these, accounting for 31% of the total estimated land-

Table 4.—Humpback whales landed by the Greenland Non-mechanized Shore Fishery (Fishery 3) based on the read sample of Danish colonial “Daybooks” (Poulsen, text footnote 2).

Year	Humpbacks	Year	Humpbacks	Year	Humpbacks	Year	Humpbacks
1774	0	1808	0	1826	3	1862	0
1787	0	1809	1	1828	0	1864	0
1788	0	1810	3	1834	0	1866	0
1789	0	1811	1	1836	2	1868	0
1790	0	1812	2	1838	3	1870	3
1794	0	1813	1	1840	2	1872	5
1799	0	1814	4	1842	1	1874	1
1800	0	1815	0	1844	1	1876	2
1801	1	1816	4	1846	0	1878	1
1802	0	1817	0	1848	0	1880	0
1803	1	1818	0	1850	2	1882	1
1804	1	1819	0	1854	0	1886	3
1805	1	1820	7	1856	3		
1806	16	1822	2	1858	0		
1807	1	1824	6	1860	0		

ings (Fig. 2B). It peaked (with respect to humpback catches) around 1900. The Norwegian Mechanized Offshore fishery and the Greenland Mechanized Shore fishery operated only in the 20th century, and neither fishery accounted for more than a few percent of the North Atlantic total. The American Mechanized Coastal fishery operated for only a short time in the late 19th century, and landings were relatively few.

Within the Norwegian Mechanized Shore fishery, 10 of the 11 subfisheries (Table 1) took humpback whales, and the annual landings for the 9 largest (with respect to humpback catches) are shown in Figure 3. The subfisheries varied greatly in their timing, duration, and magnitude of humpback catches.

Nonmechanized Shore Whaling

Nonmechanized shore whaling occurred off Greenland, Canada, the United States, Bermuda, the West Indies, and the Cape Verde Islands (Fisheries 3, 5, 7, 9, 10, 12, and 13), spanning nearly 4 centuries, from the 17th century to the present day.

Greenland Shore Fishery (Fishery 3)

Shore whaling for humpback whales was already well developed in West Greenland by the late 1700’s and it continued (in nonmechanized form) until the 1920’s (Reeves and Smith, 2002). Although Reeves and Smith (2002) surmised that annual catches generally were fewer than 20 whales, the published data for years before 1886, prior to the time series of Kapel (1979),

are sporadic and sketchy. The study by Poulsen on our behalf, described earlier, provided additional information.

Poulsen examined Danish daybooks for all years available from 1774 to 1820 and for even-numbered years from 1822 to 1882, as well as 1886 (Table 4). The number of references in a given daybook to humpback whales taken ranged from zero to 16, although in some instances the daybook entry was too ambiguous to determine if more than one whale was involved. We constructed a time series of humpback whale landings for this fishery up to 1885 by interpolation, using the data for years with daybook sampling to infer landings for the unsampled years in-between. This pre-1886 time series was then linked to the series of landings reported by Kapel (1979) for 1886 forward. We assumed that the Kapel series was unbiased, and multiplied our pre-1886 values by the ratio between the Kapel (1979) number for 1886 and the daybook number for that year.

We readily acknowledge that this procedure has at least two major drawbacks. First, as just mentioned, the conversion factor between the Poulsen time series and the Kapel time series is based on only one overlap year. Given the data available, we cannot improve upon this procedure at present. Second, again as just mentioned, we assumed that the Kapel time series was unbiased. This assumption rests on several things. Kapel is a true expert on the subject of Greenlandic hunting, with extensive first-hand experience both as a biologist-observer

Figure 2.—A. Estimated number of humpback whales landed over time, totaling 7,727 whales representing 36% of the total, with 99% confidence intervals shown by vertical lines, for all mechanized North Atlantic fisheries combined (Fisheries 1, 2, 4, and 8). B. Estimated number of humpback whales landed over time, totaling 7,727 whales representing 36% of the total, with 99% confidence intervals shown by vertical lines, for the four mechanized fisheries (Fisheries 1, 2, 4, and 8).

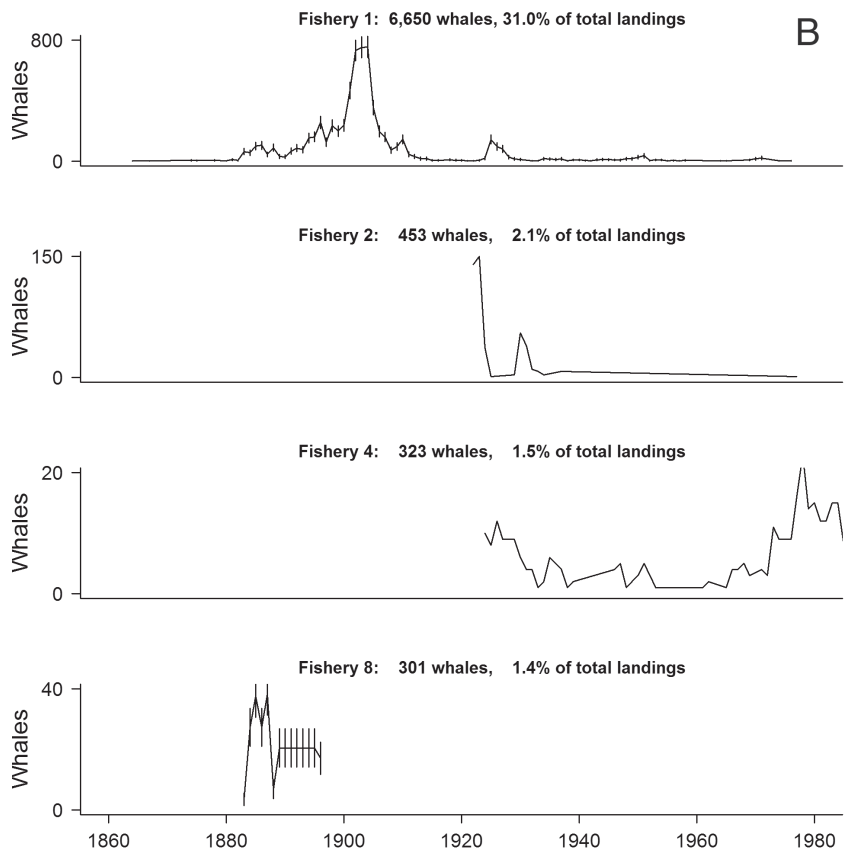
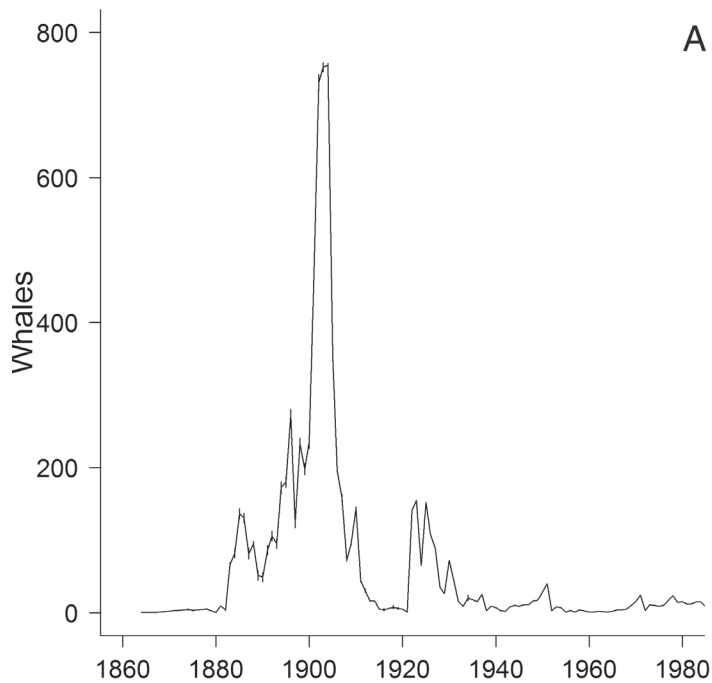
and as a historian (e.g. Kapel and Petersen, 1982; Kapel, 2005). In his 1979 paper, he notes that although the “yearly reports from the colonies in Greenland” that served as the basis for the catch record from 1886 to 1923 contained information on catches of large whales only for Frederikshåb district, only “a few whales had previously been caught in other districts.” Therefore, although we certainly cannot rule out that the Kapel time series is somewhat negatively biased, it is likely that the magnitude of that bias would be small.

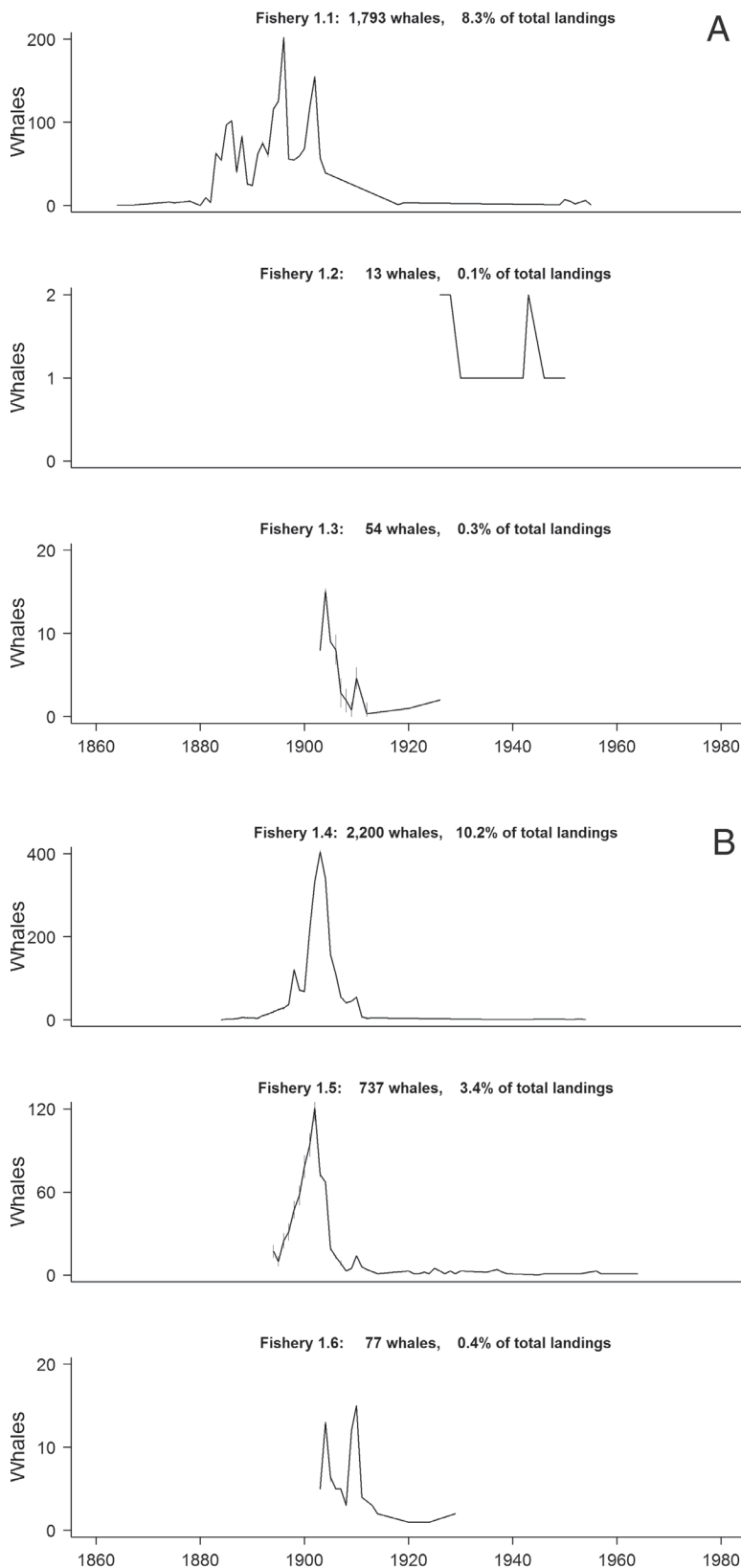
*Canada Shore
Fishery (Fishery 5)*

Large quantities of oil were exported to the United Kingdom from Newfoundland between 1696 and 1734, apparently mostly from seals (Reeves et al., 1999). Although some whalebone (baleen) was also exported, suggesting that some of the oil was from baleen whales, we found no basis for determining if any of the products were from humpbacks. In the absence of any clear evidence of shore-based humpback whaling in what is now eastern Canada, we attributed no catch of humpback whales to this fishery.

*American Shore
Fishery (Fishery 7)*

Reeves et al. (2002b) described humpback whaling in the Gulf of Maine, including that by this shore fishery as well as that by the American Mechanized Coastal fishery (see below). The information on this fishery is very sparse and consists only of the identification of





several shore stations and their periods of operation as well as reports on long-term average landings at three of the stations. The annual catches at those stations reportedly ranged from 1 to 7 whales and apparently consisted mostly of humpbacks. We estimated landings for years when stations were known to have been operating by multiplying the number of stations by the average number of whales per year (3 whales), assuming a standard error based on a uniform distribution from 1 to 7. We interpolated values for some years.

*Bermuda Shore
Fishery (Fishery 9)*

This was the earliest North Atlantic humpback fishery, and it continued at a highly variable scale for more than 3 centuries. Besides characterizing the fishery and updating data presented by Mitchell and Reeves (1983), Reeves et al. (2006) identified a number of potentially useful primary sources of additional information. Our exploration of those sources (see Materials and Methods) provided new information on the fishery (Table 5), which generally confirmed the conclusions of Reeves et al. (2006). Especially useful information for the period 1839 to 1853 was obtained from the newspaper search.

Some additional data on whaling effort and catches is available from recent papers by Romero (2006, 2007). In 1723, “a typical year in terms of whal-

Figure 3.— A. Estimated number of humpback whales landed over time, totaling 1,860 whales representing 8.6% of the total, with 99% confidence intervals shown by barely visible vertical lines, for three Norwegian Mechanized Shore sub-fisheries (Fisheries 1.1, 1.2, and 1.3). B. Estimated number of humpback whales landed over time, totaling 3,014 whales representing 14.0% of the total, with 99% confidence intervals shown by barely visible vertical lines, for three Norwegian Mechanized Shore sub-fisheries (Fisheries 1.4, 1.5, and 1.6). C. Estimated number of humpback whales landed over time, totaling 1,774 whales representing 8.3% of the total, with 99% confidence intervals shown by barely visible vertical lines, for three Norwegian Mechanized Shore sub-fisheries (Fisheries 1.7, 1.9, and 1.10).

ing,” 5,792 gal of whale oil, worth £600, was exported to London, Liverpool, and Barbados (Romero, 2007). In 1734, 7 or 8 boats belonging to 2 whaling companies were actively whaling near the islands, and 11 whales were landed in 1735 and 8 in 1736 (Romero, 2007). Apparently no catch was made in 1744. Two companies were active in 1759, one of them deploying 3 boats. However, little reliable information is available on catches after 1736. According to Romero (2006), only 2 whales were taken in 31 days of whaling in 1767, only 1 in 23 days in 1768, and only 1 in 31 days of whaling in 1769 (this last being a “young bone whale,” and thus possibly a right whale, yielding 29 bbl of oil).

We estimated landings from our previously published data combined with the new data from the Public Record Office and from Romero (2006, 2007) (Table 5). Oil landings were standardized using the conversion factors in Reeves et al. (2006). We estimated barrels per whale from the data for years

when both quantity of oil produced and number of whales landed were both reported for this fishery.

Because the intensity of shore whaling appears to have varied substantially over time, with no obvious pattern of growth or decline, we interpolated landings within time periods during which whaling effort appeared to be more or less consistent. Such periods were defined on the basis of the history of the fishery as described by Reeves et al. (2006), with the goal of minimizing the bias from interpolation over times when conditions were changing. The periods were 1616–49, 1650–69, 1670–99, 1700–49, 1750–84, 1785–1819, 1820–54, and 1855 forward.

Some information on annual landings is available for all of those periods except the first. For each period, we interpolated values for years with no data based on the average landings for years with data and assigned standard errors as described in the Materials and Methods section. For the first period (1616–49), there is evidence that a

number of whales were harpooned and lost, but there is no direct information on landings. We assumed, somewhat arbitrarily, that between 0 and 5 whales were taken annually, with a standard error equal to the standard deviation of a uniform distribution over that range. For the last period, from 1860 onward, whaling was small-scale and relatively well documented by newspaper and literature accounts, so we assumed that the few reports of landings after 1865 represented a complete record.

West Indies Shore Fishery (Fishery 10)

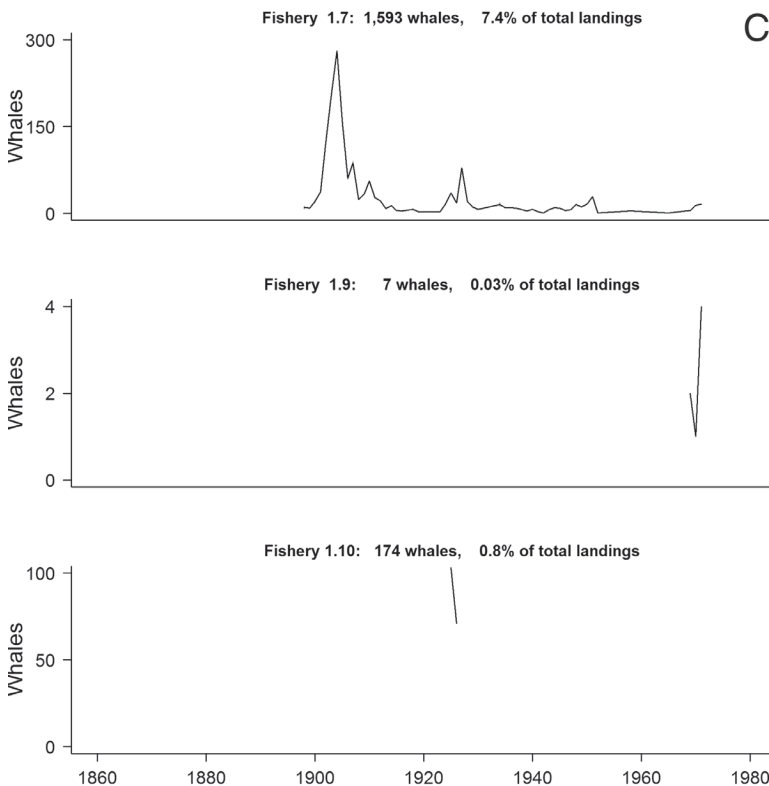
Six low-latitude islands or island groups in the West Indies are known to have initiated shore whaling operations, primarily in the last half of the 19th century. We estimated landings for each subfishery by combining previously published data with the new data obtained from materials in the Public Record Office (see Materials and Methods). Here we first describe the data and analysis methods used for each subfishery, and then summarize the results for the entire fishery.

Barbados (subfishery 10.1)

Barbados was the easternmost of the West Indies subfisheries. It was documented in Mitchell and Reeves (1983:Table 13) for the earlier years (1869–78) and in Reeves and Smith (2002:Table 2) for the later years (1879–1910). We standardized oil production reported in casks or in gallons to barrels using the approach described for the St. Vincent and Grenadines subfishery (see below). We used an estimate of barrels per whale based on landings data from Trinidad, which we judged to be more nearly complete (see below).

St. Vincent and the Grenadines (subfishery 10.2)

Situated at the northern end of the Grenadine Island group, this was the longest-lasting subfishery in the West Indies. Although it began later than some of the others, it continued, apparently without interruption, from the 1870’s to the present day. Data on landings through 1920 were docu-





No 3. Flensing (cutting up) a Kepokak-whale.

Lithograph published in 1877 showing Greenlanders processing a humpback whale on shore: “Flensing (cutting up) a Kepokak-whale.” It is one of several described by Rink (1877:268) as “exact copies of partially coloured drawings executed by natives entirely after their own ideas, and without any information or guidance whatever in the arts of drawing and painting.” Rink’s account of this image is as follows (p. 271): “Having towed it as close to the shore as possible when the tide was in, they are now busy cutting it up at low tide, and obtaining the blubber as well as the flesh.... A pretty large quantity of blubber has already been cut out to be brought to the nearest trading-station for sale, and with this prospect of soon being able to acquire a new supply of various articles of luxury they have thought it needless any longer to save their store of coffee. One of the women is busy with her kettle, sharing its contents out in the only three cups they possess, while another in the background has taken upon herself the more serious task of preparing a substantial meal out of the kepokak [humpback]-beef.”

mented by Mitchell and Reeves (1983: Table 15).

Catch in numbers of whales landed for more recent years were obtained from the Secretariat of the International Whaling Commission in June 2009. Landings for 1920 and earlier were reported as volume (gal) and value (£) of oil, which we standardized to U.S. barrels using the ratio of the mean number of barrels per £ and the mean number of £ per gallon reported in the St. Vincent data. This conversion corresponds to 28.8 gallons per barrel (SE=4.29).

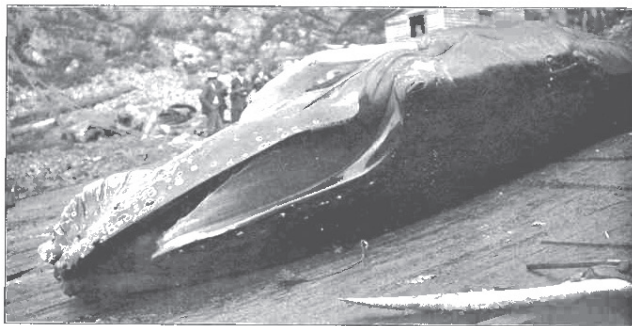
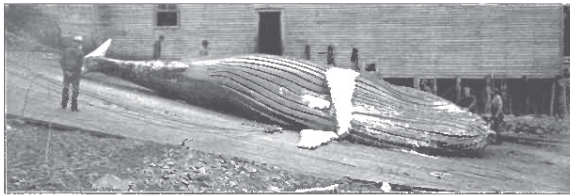
Similarly, if landings were reported in casks and £, we ignored the casks (because they were variable in volume;

Ashley, 1926). In such cases, we converted the landings to U.S. barrels by multiplying the £ by 0.74 barrels per £ (SE 0.40). This was computed as the product of the mean £ per gallon and mean barrels per £. When landings were reported in casks and the £ value was not reported, we estimated the barrels landed as the product of the number of casks and 2.90 barrels per cask (SE=0.28). This was computed as the product of the mean barrels per £ and the mean £ per cask.

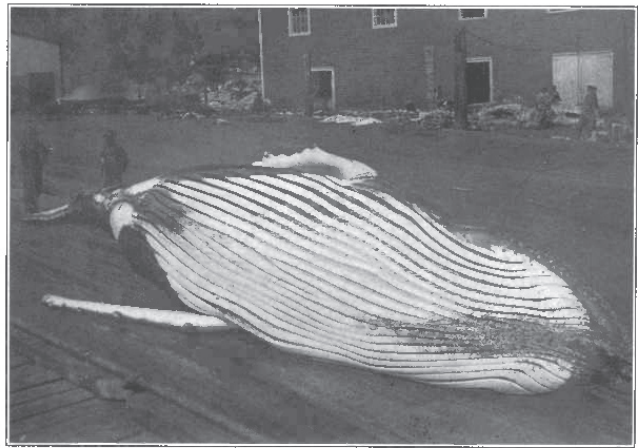
We used an estimate of barrels per whale based on landings data from Trinidad, which we judged to be more nearly complete (see below).

Grenada (subfishery 10.3)

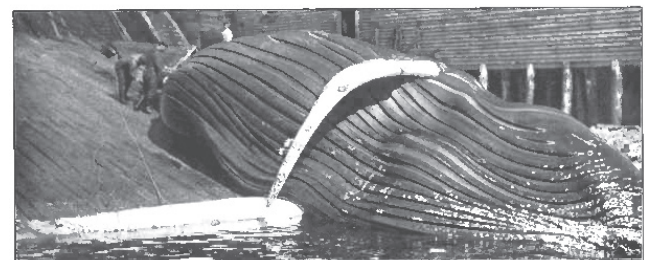
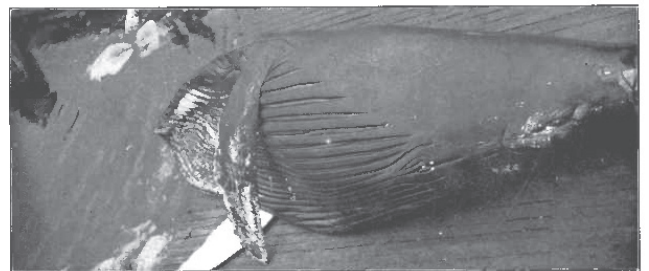
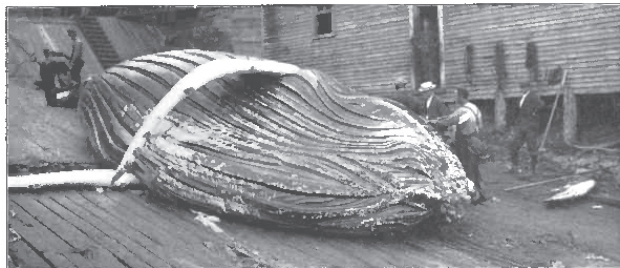
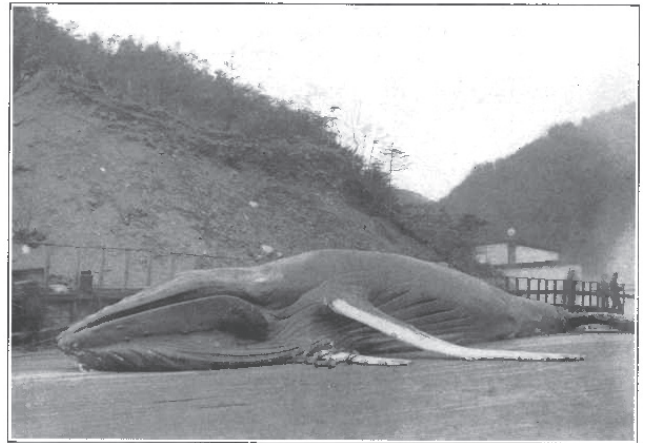
This subfishery, at the southernmost of the Grenadine Island group, had not been well documented previously. The report by Romero and Hayford (2000) summarized information on whaling at Grenada in the 1920’s but provided no data for earlier years. In our search of trade records at the Public Record Office (see earlier), we found no reference to whales or whaling until 1859 (Table 6). In that year, a ship with 3 boats was reported to have produced 301 bbl of whale oil. The next year, a ship and 8 boats reportedly produced 370 bbl. Without more information, we assume



Three views of a male humpback whale at Snook's Arm Station, Notre Dame Bay, Newfoundland, 9 August 1899. From True (1904: Plate 37).



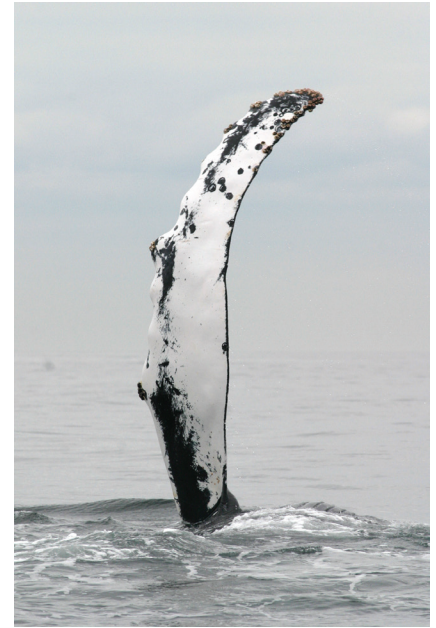
Humpback whales at Balaena Station, Hermitage Bay, Newfoundland, 1903. The animal in the upper frame was described as "an unusually white specimen." From True (1904: Plate 38).



Four views of 3 different humpback whales at Snook's Arm Station, Notre Dame Bay, Newfoundland, in 1899 – a male on 9 August (left top), a female on 6 August (left bottom and right top), and a female on 18 August (right bottom). From True (1904: Plate 39).



Humpback whales “lunge feeding” off Cape Cod, Massachusetts. Photo: Provincetown Center for Coastal Studies (NOAA permit#633-1778).



Flipper of a humpback whale in the Gulf of Maine. Photo: Provincetown Center for Coastal Studies (NOAA permit#633-1778).

Mother humpback whale with calf on Platt Bank, Gulf of Maine, July 2005. Photo: New England Aquarium/Peter Stevick.



Humpback whale raising its head above the sea surface off Nova Scotia, Canada. Photo: Provincetown Center for Coastal Studies (NOAA permit#633-1778).

Humpback whale foraging in the Gulf of Maine. Photo: Provincetown Center for Coastal Studies (NOAA permit#633-1778).

Table 5.—Information on Bermuda Non-mechanized Shore Whaling (Fishery 9) supplemental to that in Reeves et al. (2006: Table 2), by year or other time period, obtained from the Bermuda Blue Books (BB), Bermuda newspapers (RG= *Royal Gazette*, BH = *Bermuda Herald*), and published sources.

Year or Period	Information	Source
1723	"A typical year in terms of whaling," 5,792 gal of whale oil, worth £600, exported to London, Liverpool, and Barbados.	Romero, 2007
1734	7 or 8 boats belonging to 2 whaling companies actively whaling near the islands.	Romero, 2007
1735	11 whales landed.	Romero, 2007
1736	8 whales landed.	Romero, 2007
1744	No catch.	Romero, 2007
1759	2 companies active, one of them deploying 3 boats.	Romero, 2007
1767	2 whales taken in 31 days of whaling.	Romero, 2006
1768	1 whale taken in 23 days of whaling.	Romero, 2006
1769	1 whale taken (a "young bone whale," 29 bbl, possibly a right whale) in 31 days of whaling.	Romero, 2006
1st wk May 1839	3 "fine" whales taken, 2 at Port Royal, 1 at Devonshire (assisted by East End boats).	RG, 7 May 1839
21 May 1839	Sperm whale taken at Devonshire, first taken by Bermuda shore whalers "for many years"; 40 ft, produced 1 8–20 bbl sperm oil and 40 bbl "common" oil.	RG, 28 May 1839
May 1839	Newspaper advertisement, Bermuda Yard requesting 150 imp. gal. whale oil, ready to pay 4 s., 2 d. per gal.	RG, 28 May 1839
June 1839	Statement referring to demands against whaling establishment at Southampton, calling for a settlement.	
12 May 1840	The "Number of Barrels of Oil, advertised in the Bermudian [on 8 June], it is a mistake, no such number of barrels is on hand."	RG, 18 June 1839
June 1840	Sperm whale ("very fine", 70 ft) taken at Tucker's Town; would have been worth £1,000 but the whalers did not have what they needed to process it properly.	RG, 19 May 1840
March 1841	Advertisements, Bermuda Yard requesting 250 imp. gal. whale oil at 4 s., 2 d. per gal.; Commissariat Magazines, St. Georges, requesting 240 imp. gal. of "lamp oil" at same price.	RG, 9 June 1840
30 March 1841	Newspaper advertisement to sell "A Whale-Boat, with a Set of Warps, Irons and Lances."	RG, 23 March 1841
13–20 April 1841	Whale taken at St. David's Island.	RG, 6 April 1841
21–27 April 1841	6 whales taken, 4 at St. David's Island, 1 at Tucker's Town, 1 at Port Royal.	RG, 20 April 1841
1–10 May 1841	4 whales taken, 2 at Somerset, 1 at St. David's Island, 1 at Tucker's Town.	RG, 27 April 1841
11 May 1841	A "large" whale taken at St. David's Island.	RG, 11 May 1841
April 1842	A whale taken at St. David's.	RG, 18 May 1841
26 March 1842	4 "distinct Establishments" active in shore whaling: Smith's Island, St. David's Island, Tucker's Town, Port Royal	RG, 5 April 1842
7, 11 April 1842	First whale of year taken at St. David's, expected to yield "upwards of 30 bbl."	RG, 5 April 1842
11 May 1842	2 whales taken at Port Royal (a "small" one on 7 April).	RG, 12 April 1842
13 May 1842	2 whales "of the description, known as Cape Whales [i.e. likely Nordcapers or right whales]" taken at St. David's, one of them "unusually large."	RG, 17 May 1842
3 April 1843	Whale taken at Somerset.	RG, 17 May 1842
11–16 May 1843	First whale of year taken at St. David's, a "fine large old" one.	RG, 4 April 1843
May 1843	4 whales taken, 2 at Tucker's Town, 1 at Somerset, 1 at Port Royal.	RG, 16 May 1843
Late March to 2 April 1844	More newspaper advertisements requesting whale oil—Bermuda Yard (250 imp. gal.), Convict Establishment (1,200 imp. gal.), Commissariat (356 imp. gal.), prices quoted as either 4 s. 2 d. or 50 dollars per gal.	RG, 30 May 1843
9–16 April 1844	2 whales taken, an "old" one at Tucker's Town, a "young" one at Somerset.	RG, 2 April 1844
16–23 April 1844	3 whales taken, 1 at Smith's Island, 2 at St. David's.	RG, 16 April 1844
23–30 April 1844	5 whales taken, 1 at Somerset, 2 at Tucker's Town (expected to yield 70 bbl), 2 at St. David's.	RG, 23 April 1844
7–14 May 1844	3 whales taken, 2 at Port Royal, 1 at St. David's.	RG, 30 April 1844
14–21 May 1844	3 whales taken, 2 at Smith's Island, 1 at Tucker's Town.	RG, 7 May 1844
May 1844	1 whale taken, Smith's Island.	RG, 21 May 1844
24 March 1845	Newspaper advertisement requesting 356 imp. gal. whale oil at Commissariat.	RG, 23 May 1844
March 1845	First whale of season taken at St. David's. 5 whaling establishments active: Somerset, Port Royal, Tucker's Town, 2 at East End.	RG, 25 March 1845
30 March 1845	Report from London House of Commons (per Royal Exchange, London, 3 March 1845): "Duties are to cease on the following imports after the dates mentioned: Spermaceti Jan 1 1849; Train Oil, or Blubber of Foreign Fishing, Jan 1 1847; Sperm Oil of Foreign Fishing Jan 1 1849; Whales Fins of Foreign Taking and not prohibited Jan 1 1849."	RG, 25 March 1845
15–22 April 1845	Whale (47 ft, expected to yield 40 bbl) taken at Port Royal; another struck but lost.	RG, 3 April 1845
29 April – 6 May 1845	2 whales taken, 1 at Smith's Island, 1 at Tucker's Town.	RG, 22 April 1845
12 May 1845	4 whales taken, 2 at Smith's Island, 1 at St. David's, 1 at Tucker's Town.	RG, 6 May 1845
9 June 1845	2 whales taken at Port Royal, the "old" one was "brought in, the young one was moored off; another whale taken at Somerset. A sperm whale in a "large shoal" was struck and lanced off Tucker's Town, boat stove and line cut, whale escaped with "two spears and several lances fast in him." "Sperm Whales are not often seen near these Islands: the last one captured, we believe, was by the Smiths ... about three years ago."	RG, 13 May 1845
June 1845	Newspaper advertisement requesting 400 imp. gal. whale oil for Naval Storekeeper at Bermuda Yard, offering 4 s. 2 d. per gal.	RG, 17 June 1845
24 March 1846	Boats are "quite prepared, and will go out as soon as the weather moderates. As yet there have been but few whales seen in this neighbourhood."	RG, 18 June 1845
Early April 1846	No whales taken through 7 April but 2 struck and lost: 1 at St. David's escaped "taking the harpoon and warp with it," 1 at Tucker's Town "taking with it the Harpoon, and most of the warp."	RG, 24 March 1846
8–11 April 1846	2 "fine" whales taken, one at Somerset, one at Tucker's Town. Also, a harpooner at St. David's was killed while trying to harpoon a whale.	RG, 7 April 1846
2nd week of May 1846	3 whales taken, 1 at Somerset, 1 at Port Royal, 1 at St. David's.	RG, 14 April 1846
6 June 1846	Sperm whale (72 bbl) taken "off the lighthouse" by a Nantucket brig; St. George's crew planning to go out whaling.	RG, 12 May 1846
30 June 1846	3 American vessels (schooner, brig, ship) seen whaling off Bermuda, writer complains that Bermudians should learn by observing as they use line "unnecessarily thick, whilst the length is much too short" (meaning they have to cut the line and lose the whale too often).	RG, 16 June 1846
1 April 1847	First whale of season taken at St. David's.	RG, 30 June 1846
9 April 1847	2 whales taken off East End, but the long towing distance and fresh winds meant that "the sharks attacked the carcasses, and so destroyed them that the boats eventually cast them off."	RG, 6 April 1847
10 April 1847	A whale struck but crew "was obliged to cut the warp, the boat being nearly swamped by the whale."	RG, 13 April 1847
14 April 1847	2 whales taken at Tucker's Town; a third whale picked up dead by St. David's crew who expected to produce 10 bbl from the carcass.	RG, 20 April 1847
15, 17 April 1847	2 whales taken at St. David's.	RG, 20 April 1847
22 June 1847	3 American whaling vessels (schooner, brig, ship) seen cruising near the islands for the past 2–3 weeks, the brig "clean," the schooner having taken 4 whales.	RG, 22 June 1847
8 April 1848	A whale taken at Tucker's Town.	RG, 11 April 1848
By 5 May 1848	6 whales taken thus far in season, 5 at East End, 1 at Somerset.	BH, 5 May 1848
20 April 1849	A "fine" (40 bbl) whale found in a West End channel, apparently stranded; tried out at Somerset.	RG, 24 April 1849;
23 April 1849	2 whales (young and old) taken at St. David's.	BH, 26 April 1849;
		BH, 24 April 1849;
		BH, 26 April 1849

continued

Table 5.— (continued) Information on Bermuda Non-mechanized Shore Whaling (Fishery 9) supplemental to that in Reeves et al. (2006: Table 2), by year or other time period, obtained from the Bermuda Blue Books (BB), Bermuda newspapers (RG= *Royal Gazette*, BH = *Bermuda Herald*), and published sources.

Year or Period	Information	Source
4 May 1849	A whale taken at St. David's—the third of the season there.	RG, 8 May 1849; BH, 10 May 1849
1 June 1849	A sperm whale found dead near Port Royal whaling station, a third of it destroyed by sharks so expected yield only 25–30 bbl.	RG, 5 June 1849
mid-March 1850	2 American steersmen and 2 harpooners arrived to assist the Whaling Company in the upcoming season.	BH, 14 March 1850
2 April 1850	A "black whale" taken at Tucker's Town, expected to give a "fair return." Judging by the context of the article, which refers to signaling procedures and mentions "the Black or common Whale," the implication is that this meant the humpback, as opposed to the sperm.	RG, 9 April 1850
9 April 1850	For a month the schooner <i>Brilliant</i> of Bermuda had been trying to whale but stormy weather had repeatedly forced it to "make a harbour."	RG, 9 April 1850
10 April 1850	A whale taken at Smith's Island; "... but the second one taken this season—though the outfit exceeds that of any previous year."	RG, 16 April 1850; BH, 11 April 1850
24, 29 April 1850	3 whales taken, 1 at Tucker's Town and 2 at Smith's Island.	RG, 30 April 1850
1st week of May 1850	3 whales taken, 2 at Smith's Island, 1 at Tucker's Town.	RG, 7 May 1850
4 June 1850	Bermuda Whaling Company "have been wholly unsuccessful in their experiment of employing a vessel to cruise around the Island in search of whales, instead of pursuing the old plan of having an Establishment on shore. They have not taken a single Whale." The shareholders decided to abandon the project, the <i>Brilliant</i> was brought in and stripped of gear, and the boats were hauled up.	RG, 4 June 1850
25 March 1851	Boats from Bermuda Whaling Company have been out "for some days," but no whales taken. Other boats out from the Ferry, Tucker's Town, St. David's, Smith's Island, Somerset.	RG, 25 March 1851
1st week of April 1851	2 whales taken, 1 at the Ferry, 1 at Port Royal, both expected to yield 30 bbl. "These being the first taken this season, the demand for the flesh was very great." Within 4 hr from the start of cutting, everything was gone. "The flesh of it is said to have been very delicate and sweet. The good resulting among the poor people from the capture of a whale is incalculable."	RG, 8 April 1851
9 April 1851	Third whale of season taken at St. David's.	BH, 10 April 1851
Mid April 1851	4 whales taken at Tucker's Town (<i>Herald</i>) and perhaps 1 more at Smith's Island (<i>Gazette</i>).	RG, 15 April 1851; BH, 17 April 1851
16 April 1851	2 whales taken, 1 at St. David's, 1 at Smith's Island.	RG, 22 April 1851
Mid April 1851	A "portion of a whale" was salvaged near one of the West End channels, yielded 12 bbl.	RG, 29 April 1851
24 June 1851	American vessels seen whaling offshore for sperm whales.	RG, 24 June 1851
Last week of June 1851	A sperm whale taken at St. David's, expected to yield 15–16 bbl (30 ft).	RG, 1 July 1851
1 April 1852	First whale of season struck, but lost, at St. David's—a "large" animal.	RG, 6 April 1852
6 April 1853	First whale of season taken at Smith's Island. Port Royal boats struck but lost 2 whales (with harpoon and warp in one instance).	RG, 12 April 1853
Mid April 1853	"The crew of the gun-boat has not yet had an opportunity of testing the effect of this newly invented instrument."	RG, 12 April 1853
12–19 April 1853	3 whales taken, 1 at Tucker's Town, 1 at Smith's Island, 1 at Port Royal (25 bbl, killed with gun-harpoon). 1 additional whale struck but lost at Smith's Island.	RG, 19 April 1853
3–10 May 1853	3 whales taken by Port Royal and East End crews; also a shark "which had the temerity to follow the carcass of the whale thither [in the bay]."	RG, 10 May 1853
Last week of May 1853	A "young" whale taken at Smith's Island, and "old" one struck but lost after "knocking the boat to pieces."	RG, 31 May 1853
1865	"The once flourishing Whale fishery of these Islands has declined a long time since. It was a profitable employment, and may yet be pursued with advantage by employment of persons skilled in the Trade."	BB 1865 (CO 41/60)
1875	"There was a time when Whale fishery was pursued in Bermuda to advantage and the oil thereby obtained met with a ready sale for home consumption; but the pursuit of this industry has long since declined, and is only occasionally revived, and even then the small quantity of Oil derived is unsaleable therefrom—Kerosene having superseded the use of Whale Oil for domestic purposes, and the high protective duty imposed on this article in the United States of America precludes the disposal of it there, so that it has become rather a drug than otherwise in the Market."	BB 1875 (CO 41/70)

that the ships were part of the American whaling fleet and therefore that their catches for those years would have been subsumed within estimates of landings for the West Indies subfishery of the American Nonmechanized Offshore fishery (see below). There is no further reference to ship whaling in the Grenada Blue Books.

Beginning in 1861, there are regular references to boats and shore whaling stations at Grenada. During the 1860's, up to 3 stations are mentioned, 2 on Grenada and 1 on Carriacou, with anywhere from 9 to 20 boats all told. From 1871 to 1878, it appears that only 6 boats were active and only the 2 Grenada stations are listed. In most years, catch information consists only of quantities of whale oil produced and/or exported. Substantial amounts of whalebone

(baleen) were also exported during the 1860's and 1870's, ranging as high as 10+ tons (>10,000 kg) in 1863. In the 3 years from 1876 to 1878, the number of whales secured is recorded: 8, 13, and 6, respectively.

The rote statement that "Whale fishing is ... carried on" appears in the Blue Books from 1881 to 1902, but explicit listings of boats and whaling stations end in 1878, and the reported quantities of whale oil are relatively trivial after that year (maximum 2,610 gal) and until 1925 when a short-lived subfishery of the Norwegian Mechanized Shore fishery began operating in Grenada (Mitchell and Reeves, 1983; Romero and Hayford, 2000). The landings from that subfishery are included in the Grenada subfishery of the Norwegian Mechanized Shore fishery (Fishery 1.10, above).

We estimated annual landings for subfishery 10.3 using the data in Table 6. We standardized the oil quantities to U.S. barrels using information from the St. Vincent and Grenadines subfishery. We used an estimate of barrels per whale based on landings data from Trinidad, which we judged to be more nearly complete (see below).

Trinidad (subfishery 10.4)

Shore whaling was conducted in Trinidad from the 1820's to the 1870's. Reeves et al. (2001a) summarized information on the value and quantity of oil landed, numbers of shore stations and boats, and, for some years, the number of humpback whales landed. We standardized oil landed to U.S. barrels using information from the St. Vincent subfishery, and estimated number of barrels per whale from this subfishery.

For years when only the number of boats was known, we estimated landings by multiplying the number of boats by the mean of whales/boat calculated from the years when both number of boats active and number of whales landed were reported.

St. Lucia (subfishery 10.5)

Mitchell and Reeves (1983) referred to a whaling station at Pigeon Island near St. Lucia, and Reeves and Smith (2002) suggested that the St. Lucia Blue Books should be checked for data. In our search of trade records, the earliest reference to whales or whaling was in 1876 (Table 7), when it was reported that foreign vessels whaling in local waters were subject to a tax. Although modest quantities of whale oil were exported regularly between 1879 and 1888, this appears to have been the produce of ship-based foreign whalers. There is nothing in the Blue Books to suggest that shore whaling occurred at this island. Thus, we conclude that any shore whaling in St. Lucia must have been extremely limited and we assume that there was no catch.

Turks and Caicos (subfishery 10.6)

Reeves and Smith (2002) found no certain evidence of shore-based whaling in the Turks and Caicos, an island group located far to the north and west of the other Caribbean sites. Based on a single, vague reference to the closing of a shore station there in the 1880's, they had checked the Turks and Caicos Blue Books for 1870, 1875, 1880, 1882, 1884, 1886, and 1888, but found "no reference of any kind ... to local whaling in the Turks and Caicos." Our study of Bermuda newspapers (above) provided confirmation that whaling did take place as well as a few details on the scale and duration of the Turks and Caicos subfishery.

In early 1846, it was reported, "The Turks' Island Whaling Company have commenced operations, and ... they had within the period of one month taken four fine Whales" (*The Royal Gazette*, 24 March 1846). A whale had also been taken by a boat "indifferently fitted

out" at Salt Cay (*The Royal Gazette*, 24 March 1846). By the third week of April 1846, 2 more whales had been taken by the Turks' Island Whaling Company (*The Royal Gazette*, 19 May 1846). The next year, 1 whale was taken before 23 February (*The Royal Gazette*, 9 March 1847) and apparently it remained the only one captured (a "young one") through the third week of April (*The Bermuda Herald*, 27 May 1847). The "leading Whaleman," Captain Morell, was injured during the capture of that whale (*The Bermuda Herald*, 27 May 1847).

In 1848, the company's schooner, *Ambassador*, went to sea on 1 February (*The Bermuda Herald*, 10 March 1848) and had taken 2 whales by early March; it was under the management of a Bermudian recruited by Captain Morell to "lead in this ... enterprise" (*The Royal Gazette*, 7 March 1848; *The Bermuda Herald*, 10 March 1848). In 1849, the newspapers contained news of political activities in the Turks Islands but no mention of whaling. It is nonetheless clear that some effort continued for at least a few more years: in 1851, as of mid April, 2 whales (expected to yield 60 bbl) had been taken and whaling effort was continuing (*The Royal Gazette*, 6 May 1851).

In summary, we can now confirm that humpback whaling occurred at the Turks and Caicos from 1846 until at least the early 1850's, with annual landings ranging between zero and 7 whales. We estimated total landings as 3.5 per year, with sampling uncertainty based on a uniform distribution from zero to 7, and we extrapolated that level forward to the mid 1850's.

Cape Verde Islands Shore Fishery (Fishery 12)

Reeves and Smith (2002) found little direct evidence of nonmechanized shore whaling at the Cape Verde Islands (CVI) although they cited the reports of Reiner et al. (1996) and Hazevoet and Wenzel (2000) indicating that some type of shore whaling had been practiced there between the late 18th century and the early 20th century. Reeves and Smith (2002) also acknowledged, but dismissed as "meager," the evidence of CVI shore

whaling found by Reeves et al. (2002a) in a study of American ship-based whaling for humpback whales around the islands. That evidence consisted of references to one shore-based crew active at Sal in March 1854 and "quite a number" of shore-based boats active there in March 1866. Moreover, Reeves et al. (2002a) found evidence to suggest shore whaling at Boa Vista in March 1866 and April 1876, as well as at Tarrafal Bay in February 1886. The Cape Verde Islands Nonmechanized Shore fishery was among the few fisheries or subfisheries that Reeves and Smith (2002:232) considered in need of further study. The results of the studies on our behalf by Brito and Hazevoet (see Materials and Methods) had disappointing results.

Bruto's search in Lisbon located some references to whale hunting in the CVI region in the late 17th century (Anonymous, 1985) as well as the mid 18th century (Colecção de Leis³), but it is not until the second half of the 19th century that there are unequivocal references to shore-based whaling. Junior (1896) specifically mentioned whale hunting at two sites on São Nicolau (Tarrafal [Passapel's Harbour] and Carriçal [Carriçal's Cove]) and noted that two Azoreans had come there and stayed, "teaching the natives" whaling skills.

A published record of 1,500 gallons of whale oil being exported from São Nicolau to the Portugal mainland and other Portuguese colonies in 1874–75 (Anonymous, 1875) strengthens the likelihood that shore whaling was active there at the time. Friedlaender (1913, 1914), however, who visited the CVI in 1912, claimed that the whale fishery there had "lost all its relevance," that the stations at Tarrafal and Carriçal would soon be gone, and that a station on Maio was well-equipped but no longer profitable (also see Vasconcellos, 1916). In his opinion (Friedlander, 1913:32), the decline was due to the fact that the whales "had been driven to extinction by the American whalers."

Statistical information on exports of small quantities of whale oil and blub-

³Colecção de Leis. 1768. Cartas e documentos reais. (Christina Brito personal communication; not seen by the authors).



Left: Low-angle breach by a humpback whale calf on Silver Bank. Photo: NOAA/NMFS MONAH Project

Below: Two humpback whales cruising at the sea surface on Silver Bank. The animal in the foreground has finished respiring, its back arched to dive, while the animal in the background is in the midst of respiring, with only its blowholes, a small portion of its back, and the upper portion of its dorsal fin evident. Photo: NOAA/NMFS MONAH Project



Group of male humpback whales competing for access to a mature female on the West Indies breeding ground, Silver Bank. Photo: NOAA/NMFS MONAH Project



Two humpback whales breaching simultaneously on Silver Bank. Photo: NOAA/NMFS MONAH Project



Humpback whale about to re-enter the water after a breach, framed by the enormous splash of a second humpback as it smacks the sea surface. Silver Bank. Photo: NOAA/NMFS MONAH Project



The flukes of a mother humpback whale dwarf the body of her young calf, breaching close by, on Silver Bank. Photo: NOAA/NMFS MONAH Project

Table 6.—Information on the Grenada Non-mechanized Shore sub-fishery (Fishery 10.3) extracted from Grenada Blue Books for years checked, showing activity in terms of numbers of vessels (S=ship, B=boat) and land stations (G = Grenada, C= Carriacou), showing landings as numbers of humpback whales (assumed in the few years where not explicitly indicated as such), oil in volume (in gallons, or if indicated, barrels (bbl)) and value (£ Sterling: pounds/shillings/pence), and exports in volume and value. Prior to 1900 oil was exported to British West Indies, Trinidad, and United Kingdom.

Year	Vessels	Stations	Production			Exported			Comments
			Whales	Oil	Oil Value	Oil	Oil Value	Per Unit	
1821									Whaling not mentioned
1822									Whaling not mentioned
1830									Whaling not mentioned
1840						1 bbl			
1850									Whaling not mentioned
1856									Whaling not mentioned
1857									Whaling not mentioned
1858									Whaling not mentioned
1859	1 S, 3 B			301 bbl		7,260	1,053/10/0	0/2/0	
1860	1 S, 8 B			370 bbl	1110/0/0	Unclear	Unclear		exported 6,498 gal of Fish Oil to BWI (@ 0/3/6 per gal)
1861	9 B	2 G, 1 C		17,423	207/19/2	17,423	2,071/9/2	0/2/4	exported as "Fish Oil"
1862	20 B	2 G, 1 C		13,323	1322/2/6	13,323	1,322/2/6	0/1/11.75	
1863	20 B	Illegible		4,975	320/0/0	4975	520/0/0	0/2/1	
1864	20 B	2 G		8,668	941/10/0	394 bbl	941/10/0	0/2/2	
1865	ca 12 B	2 G, 1 C		8,221	894/15/2	8,221	894/15/2	0/2/2	
1866				7,927	990/17/10	7,927	990/17/10	0/2/6	
1867	ca 12 B	2 G, 1 C		12,624	1374/6/8	12,624	1374/6/8	0/2/2	
1868	ca 12 B	2 G, 1 C		14,574	1643/0/6	14,574	1643/0/6	0/2/2	an additional 150 gal of whale oil produced by British, foreign, or other colonial vessels
1869	ca 12 B	2 G, 1 C		7226	845/11/0	7,226	845/11/0	0/2/4	
1870	ca 12 B	2 G, 1 C		11520	1296/0/0	11520	1296/0/0	0/2/3	
1871	ca 6 B	2 G		10550	1186/17/6	10550	1186/17/6	0/2/3	
1872	ca 6 B	2 G		2325	190/12/6	2325	190/12/6	0/2/6	
1873	ca 6 B	2 G		4125	515/12/6	4125	515/12/6	0/2/6	
1874	ca 6 B			8175	1021/17/6	8175	1021/17/6	0/2/6	
1875	ca 6 B			3210	401/5/0	3210	401/5/0	0/2/6	
1876	ca 6 B		8	3840	480/0/0	3840	480/0/0	0/2/6	
1877	ca 6 B		13	6720	840/0/0	6720	840/0/0	0/2/6	
1878	ca 6 B		6	7680	960/0/0	7680	960/0/0	0/2/6	
1879						2610	326/5/0	0/2/6	2,430 gal oil exported to BWI I and 180 gal to UK
1880						620	77/10/0	0/2/6	
1881						1890	230/8/0	0/2/6	"Whale fishing is ... carried on"; 1,290 gal oil exported to UK and 600 gal to BWI
1882						2350	293/15/0	0/2/6	"Whale fishing is ... carried on"
1883						250	031/5/0	0/2/6	"Whale fishing is ... carried on"
1884									"Whale fishing is ... carried on"
1885						1300	162/10/0	0/2/6	"Whale fishing is ... carried on"
1886									"Whale fishing is ... carried on"
1887									"Whale fishing is ... carried on"
1888									"Whale fishing is ... carried on"
1889						280	28/0/0	0/2/0	"Whale fishing is ... carried on"
1890						342	42/15/0	0/2/6	"Whale fishing is ... carried on"
1891									"Whale fishing is ... carried on"
1892						1179	184/17/6		"Whale fishing is ... carried on"
1893						562.5			"Whale fishing is ... carried on"
1894			0						"Whale fishing is ... carried on but no whales were taken in 1894"
1895			4	75 bbl		1723	139/5/9		"Whale fishing is ... carried on..."; 1,083 gal oil to BWI, 640 to UK
1896			3	35 bbl		900	24/13/8		"Whale fishing is ... carried on ..."; 700 gal oil to UK, 200 to BWI
1897			0						"Whale fishing is ... carried on ..."
1898			2			170	7/10/0		"Whale fishing is ... carried on ..."
1899			0						"Whale fishing is ... carried on ..."
1900			2	60 bbl		1381	55/2/4		"Whale fishing is ... carried on ..."
1901									"Whale fishing is ... carried on"
1902									"Whale fishing is ... carried on"; petroleum oil exported to Venezuela and Dutch West Indies, plus "other" oils to BWI (47 1/2 gal worth 9/11/4) and Venezuela (127 1/6 gal worth 18/18/8)
1903									54 1/2 gal "other" oils (i.e. not petroleum) exported to Venezuela
1904									237 gal "other" oils exported to Venezuela (worth 11/5/5)
1905									136 2/3 gal "other" oils exported to Venezuela (11/5/5)
1906									5 gal "other" oils exported to Venezuela (0/8/6)
1907									51 gal "other" oils exported: 7 1/2 to BWI, 43 1/2 to Venezuela (worth 7/7/9 all told)
1908									3 gal "other" oils exported to BWI (0/10/0)
1909									93 2/3 gal "other" oils exported to BWI (10/8/4)
1910									15 gal "other" oils exported to United States, 83 1/3 to BWI, 5 to Venezuela (worth 13/6/1 all told)
1911									1,726 gal "other" oils exported to UK (283/16/0), 1022 1/3 to BWI (96/4/0); total of 2748 1/3 gal (480/0/0)
1912									480 gal "other kinds" of oil exported to UK (101/3/6), 5 to United States (1/7/6), 47 to Venezuela (8/17/17)

continued

Table 6.—(continued) Information on the Grenada Non-mechanized Shore sub-fishery (Fishery 10.3) extracted from Grenada Blue Books for years checked, showing activity in terms of numbers of vessels (S=ship, B=boat) and land stations (G = Grenada, C= Carriacou), showing landings as numbers of humpback whales (assumed in the few years where not explicitly indicated as such), oil in volume (in gallons, or if indicated, barrels (bbl)) and value (£ Sterling: pounds/shillings/pence), and exports in volume and value. Prior to 1900 oil was exported to British West Indies, Trinidad, and United Kingdom.

Year	Vessels	Stations	Production			Exported			Comments
			Whales	Oil	Oil Value	Oil	Oil Value	Per Unit	
1913									3 gal "other kinds" of oil exported to UK (0/16/8), 20 to United States (4/2/6), 2 to BWI (0/5/3)
1914									5 gal "other kinds" of oil (besides kerosene) exported to Venezuela (1/5/0), 13 1/6 to BWI (5/4/2); total of 18 1/16 gal (6/9/2)
1915									2 gal "other kinds" of oil exported to UK (10/0/0; sic)
1916									10 gal "other kinds" of oil exported, recipient country not indicated (2/17/6)
1917									2 gal "other kinds" of oil exported to Venezuela (0/14/0)
1918									112 gal "other kinds" of oil exported to UK (40/13/4)
1919									20 gal "other kinds" of oil exported to Great Britain "from this colony" (16/0/0), 16 gal from "other produce" to United States (13/0/0), plus 3 pounds worth to BWI also from "other produce"
1920						1620	461/0/0		"There is a small whaling industry"
1921						160	50/0/0		"There is a small whaling industry"
1922									"There is a small whaling industry"
1923						2110	295/0/0		"There is a small whaling industry"; 1,760 gal whale oil exported to UK (233/0/0), 350 to Barbados (62/0/0)

ber from the CVI during the first two decades of the 20th century is difficult to interpret because much or most of the oil appears to have been imported (possibly from American whaling vessels working in the area) and then reexported. There are, however, definite (albeit sporadic) references in the Cape Verdes customs and statistical records to shore whaling at Tarrafal between ca. 1912 and 1920, with about 12 men engaged (thus presumably two boat crews). The production in 1918 amounted to 2,000 l of oil and in 1919 no whales were taken.

During Hazevoet's visit to Sal, where shore whaling certainly took place to some extent in the 19th century (e.g. Cardoso, 1896; Carreira, 1983; Reeves et al., 2002a), it proved impossible to obtain useful information. Hazevoet concluded that all archives and administrative records pertaining to the Sal tuna factory and its whaling-station predecessor had been lost, destroyed, or deliberately discarded upon the tuna factory's closure about 15 years previously.

On São Nicolau, Hazevoet met with Joaquim Pinheiro, director of the tuna factory (Sociedade Ultramarino de Conservas Lda.) in Tarrafal, which was built at the same site as the old whaling station there and even partly used the same premises. Pinheiro confirmed that the Empresa da Pesca da Balaeia do

Carrical e do Tarrafal was established around 1870 (Hazevoet and Wenzel (2000) gave this as 1874). Later, the company was owned by José Gaspar da Conceição and operated under that name, with 'Herdeiras' (Heirs) added after the first owner's death. Pinheiro advised Hazevoet that all of the company archives had been destroyed by a fire in the 1960's and therefore that no documentation remained. From his memory, Pinheiro said that during an average season (January–May) about 2 whales a month were caught at the Tarrafal station, but that operations ceased during the early 1920's due to the scarcity of whales. Hazevoet inferred that the whales hunted were primarily humpbacks, not sperms, as it was said that the whales often entered Tarrafal Bay and surroundings and were accompanied by calves.

Another of Hazevoet's informants at São Nicolau (José Cabral, a civil servant at the Camara Municipal of Tarrafal with a special interest in island history) told him that there had been 3 whaling stations on São Nicolau: one at Tarrafal, one at Baía de Barreiros (east of Carrical), and another at Graça (west of Carrical). He stated that he had visited and photographed the ruins of the latter 2 stations and also that he had photographed the last whale ever caught at Tarrafal. This was shortly after the Cape Verdes gained indepen-

dence in 1975, and Hazevoet surmised that the whale could have been the humpback whale taken in 1977, as reported by the IWC. Cabral explained that the hunt on that occasion had been opportunistic and carried out by people who were unaware of, or unconcerned with, its illegality. He regarded it as an isolated event.

The additional archival investigations conducted for this study confirm the non-availability of quantitative data on catches by CVI shore whaling and clarify the possible number of islands involved. Following the approach used by Reeves and Smith (2010) for 19th century shore whaling in California, we projected levels of landings in the CVI fishery by using what we inferred to have been a similar fishery in the West Indies. Thus, we assumed that the scale, methods, and equipment at CVI shore whaling stations were the same as in the West Indies, and we used the pooled summary statistics (Table 3) for all of the West Indies subfisheries (except the St. Vincent and the Grenadines subfishery) as the basis for estimating annual landings. We omitted the St. Vincent subfishery because it differs from the others by virtue of its continuity to the present. The underlying assumption of our approach was not necessarily that the same number or density of whales was available to be caught in the Cape Verdes as in the West Indies, but rather

Table 7.—Information on the St. Lucia Non-mechanized shore sub-fishery (Fishery 10.5) from the St. Lucia Blue Books showing, for each year checked, the exported volume of whale oil (gallons or if indicated, barrels (bbl) or “packages” (pkgs)), the value of exported oil (£ sterling: pounds/shillings/pence), and where exported.

Year	Oil	Value	Exported to	Comments
1825				Whaling not mentioned
1829				Whaling not mentioned
1835				Whaling not mentioned
1840				Whaling not mentioned
1845				Whaling not mentioned
1850				Whaling not mentioned
1855				Whaling not mentioned
1860				Whaling not mentioned; 75 “packages” of oil exported to Barbados (worth 75/0/0) but no suggestion this was whale oil
1865				Whaling not mentioned; 360 gal of “fish oil” exported to Great Britain (worth 36/0/0) but no suggestion this was whale oil
1870				Whaling not mentioned; olive and “fish” oil exported but no suggestion of any whale oil
1873				Whaling not mentioned; kerosene and “fish” oil exported but no suggestion of any whale oil
1876				“Vessels of any size employed in Whale fishing off the Coasts of St. Lucia” are taxed at 1 shilling per ton, “payable once a year on first arrival”
1879	6,200	620/0/0	United States	“Whale-fishing is carried on by foreign vessels in the waters of and adjacent to St. Lucia”; tax now 1 shilling and 8 pence per ton
1882	1,440	144/0/0	United States	“Whale-fishing is carried on by foreign vessels in the waters of and adjacent to St. Lucia”
1885	7,120	153/0/0	Barbados, Dominica	
1886	7,365	458/6/8	United States	
1887	9,661	1425/10/5	United States	
1888	3,445	416/13/4	United States	
1889				Whaling not mentioned
1890				6 packages of unspecified oils exported to British Guiana (17/0/0) and French West Indies (4/8/8)
1891				Whaling not mentioned
1892				Whaling not mentioned
1893	9 pkgs	10/4/2000	St. Vincent	The exported whale oil described not as “Produce ... of the Colony” but instead as “British, Foreign and other Colonial Produce...”
1894				Whaling not mentioned
1895				Whaling not mentioned
1896				Whaling not mentioned
1897				Whaling not mentioned
1898				Whaling not mentioned
1899	5 bbl	8/0/0	UK	The exported whale oil described not as “Produce ... of the Colony” but instead as “British, Foreign and other Colonial Produce...”
1900	250	10/0/0	UK	
1901	15 pkgs	32/14/0	United States (14), Montserrat (1)	The exported whale oil described not as “Produce ... of the Colony” but instead as “British, Foreign and other Colonial Produce...”
1902				Whaling not mentioned
1903				Whaling not mentioned
1904				Whaling not mentioned
1905				Whaling not mentioned
1906				Whaling not mentioned
1908				Whaling not mentioned
1910				2 1/2 tons of “Whale Bone” exported to Barbados (worth 6/5/0)

that the nature, scale, and operations of the shore fisheries in the two regions were sufficiently similar to justify this crude type of extrapolation.

The earliest mention of shore whaling in the CVI refers to the island of Sal in 1854. The mean duration of the West Indies subfisheries was 46 years, so we assumed the CVI fishery was active from 1854 to 1900. Although some whaling took place in the early 20th century, we disregarded it on the assumption that it was inconsequential, as some of the information above suggests. Whaling stations were identified on 6 islands in the CVI, although the scale and duration of the whaling activity undoubtedly varied considerably among them. To account for this variability, we assumed that whaling occurred in a manner parallel to that in the West Indies, i.e. on an average (at any one time) of 3.5 islands (mean of 1 to 6), with a standard error based

on the uniform distribution from 1 to 6. We assigned an average number of humpbacks landed per year by CVI stations based on the average of the landings per year by West Indies stations. To estimate annual landings for the CVI overall, we multiplied that average of landings by the number of islands assumed to have active whaling stations.

Madeira Shore Fishery (Fishery 13)

As noted by Reeves and Smith (2002), humpbacks were taken occasionally in this fishery. The 20th century data from the IWC indicate a total of 5 landed, all in the period 1957–61 (Table 3).

Summary of Nonmechanized Shore Whaling

Nonmechanized shore whaling accounted for nearly 30% of the estimated

total North Atlantic landings of humpback whales (Fig. 4). Nonmechanized shore whaling began in the 17th century, and landings were variable until the 19th century. Whaling for humpbacks peaked in the 19th century, dropped to very low levels in the 20th century, and continue to the present day at only one site (sub-fishery 10.2). The earliest catches were in Bermuda and Greenland. Landings for 8 fisheries and subfisheries are shown in Figure 5, the first frame (5A) includes feeding ground or migratory route (e.g. Bermuda) fisheries and the CVI breeding ground fishery, and the second (5B) the West Indies breeding ground fisheries. Whaling for humpback whales on the feeding grounds declined to negligible levels in the early 20th century (Fig. 5B). On the breeding grounds, whaling began and peaked in the 19th century, and continued at low levels throughout the 20th century (Fig. 5A, B).

Nonmechanized Offshore Whaling

Nonmechanized offshore whaling for humpback whales was conducted by both Canadian and American whalers in the North Atlantic feeding grounds but only by Americans in the breeding grounds.

American Offshore Fishery (Fishery 11)

Reeves and Smith (2002) summarized the broad outlines of this fishery, drawing especially on Mitchell and Reeves (1983). They distinguished three North Atlantic sub-fisheries, two when vessels operated in the principal breeding grounds in the West Indies and the Cape Verde Islands and a third when vessels operated outside those breeding grounds. The two breeding ground subfisheries were active primarily in the latter half of the 19th century. They were geographically distinct, with few instances where a vessel hunted humpback whales in both North Atlantic breeding grounds during the same voyage (Smith and Reeves, 2003b). The third subfishery (“Other Areas”) includes instances when the ship-based whalers attempted to take humpback whales in North American coastal waters and across the North Atlantic from 1750 to 1900.

West Indies and Cape Verde Islands (subfisheries 11.1 and 11.2)

The summary data on number of voyages (Lund et al., 2010) and the augmented sample of logbook data including that collected since 2003 showed the same general patterns as described by Smith and Reeves (2003b). One primary difference was, as expected, that the fishery began earlier than we previously thought and was active in the Cape Verde Islands in the period 1850 to 1865. The humpback landings from the sampled logbooks are listed by voyage in Appendix 3.

Other Areas (subfishery 11.3)

Reeves and Smith (2002) characterized this subfishery as being primarily opportunistic, i.e. humpbacks were taken during voyages focused on other

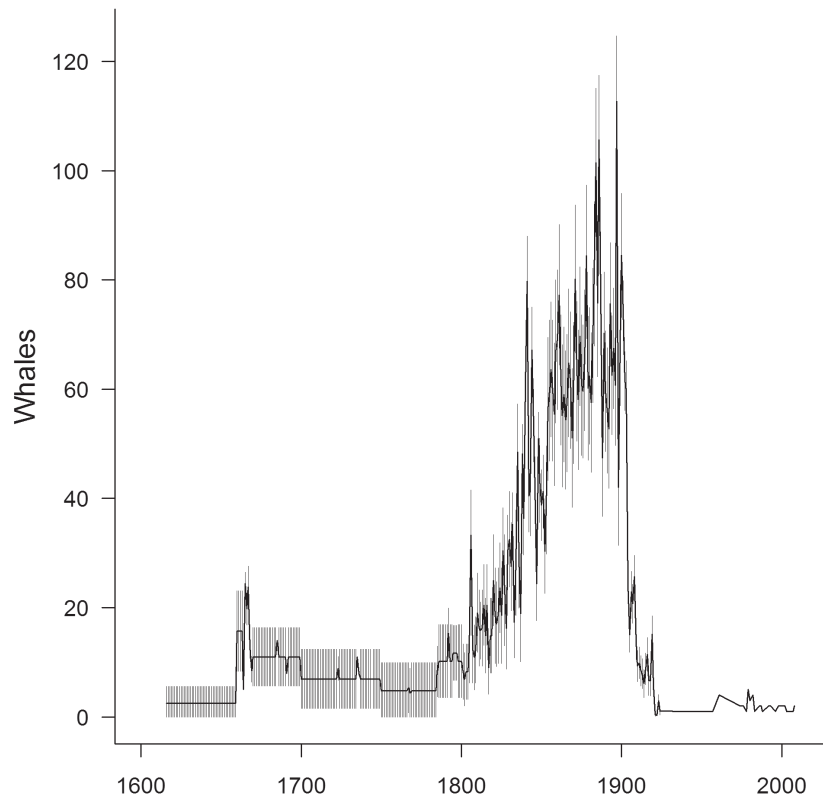
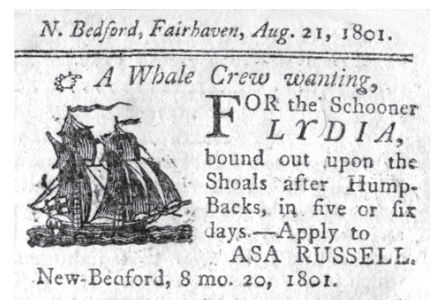


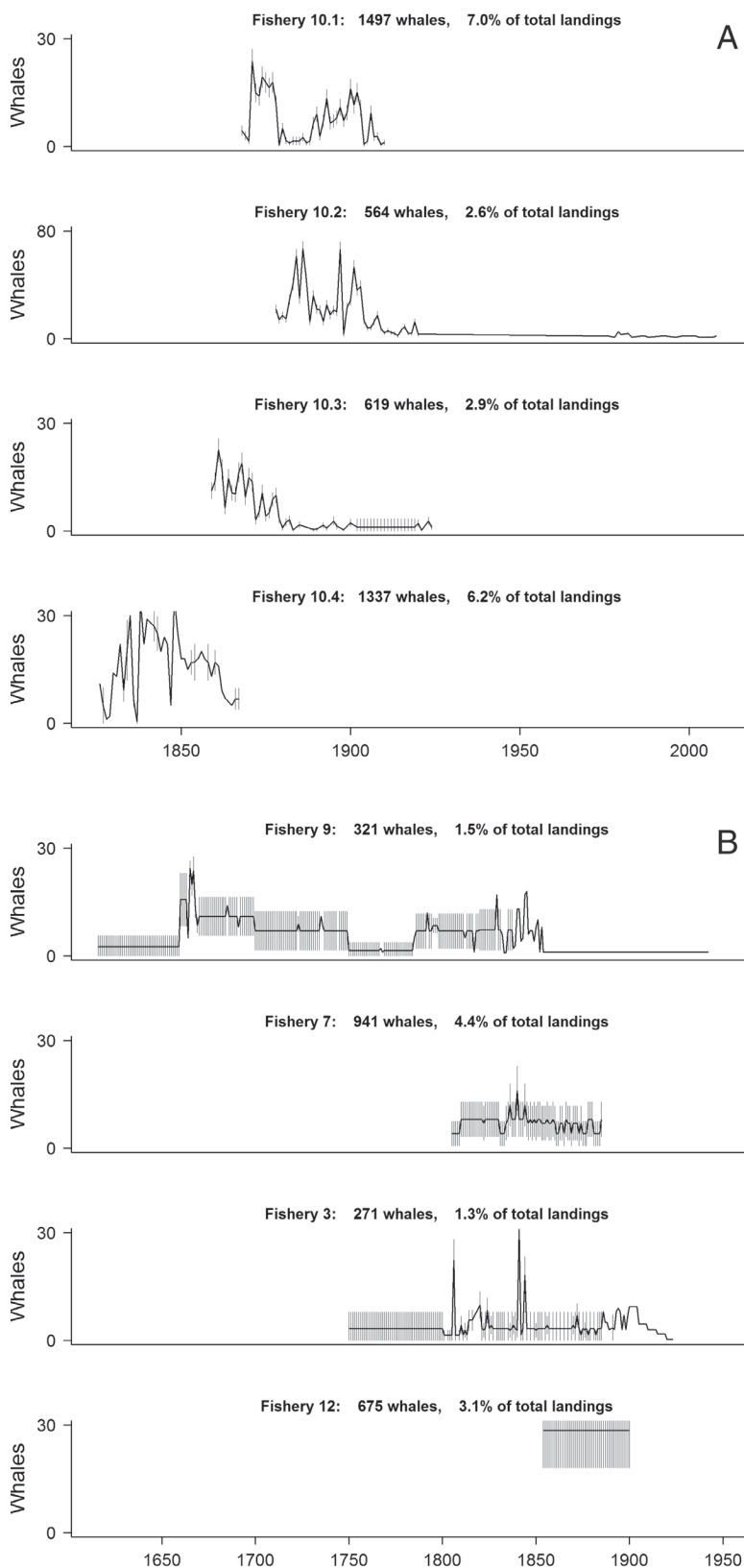
Figure 4.—Estimated number of humpback whales landed over time, totaling 6,349 whales representing 29.6% of the total, with 99% confidence intervals shown by vertical lines, for 6 nonmechanized shore fisheries combined (Fisheries 3, 7, 9, 10, 12 and 13).

species. They made no effort to estimate the magnitude of landings and concluded that the pursuit and killing of humpback whales by the 19th century ship-based whalers in areas outside the breeding grounds were “exceptional rather than common.” However, in this study we reconsidered the value and feasibility of estimating the catches by the Other Areas subfishery.

For the second half of the 18th century, we examined logbook data from 45 voyages between 1751 and 1790 (Mitchell and Reeves, 1983:182; Reeves and Mitchell, 1986:248–249). Notable in those data were the following: 1) in 1752 the sloop *Seaflower* of Nantucket sailed to Newfoundland “to kill Some Humps” and its logbook reported that *Seaflower* and six other vessels returned with “Something better than 100 barrels apiece of Humpback oyl”; 2) in 1765 the sloop *Diamond* of Nantucket reported



Advertisement from the New Bedford, Massachusetts newspaper, *Columbian Courier*, Vol. 3, No. 38 (21 Aug. 1801). The “shoals” to which the schooner was bound were the Nantucket Shoals. Asa Russell was a New Bedford merchant who owned shares in whaling voyages and other merchant vessels outright. The schooner *Lydia*, Obed Pinkham, master, returned to New Bedford 14 Sept. 1801 having taken no oil. Courtesy of the New Bedford Whaling Museum.



while on the Grand Banks of Newfoundland that another vessel had taken a humpback whale; 3) the sloop *Olive* of Nantucket in 1764 and *Diamond* in 1765 made efforts to catch humpbacks on the Grand Banks; and 4) several sloops reportedly sighted but did not attempt to catch humpbacks—*Greyhound* of Nantucket in 1753 in Davis Strait, *Reliance* of Dartmouth in 1768 in the Strait of Belle Isle, and *Frances* of Nantucket in 1758, *Endeavor* of Nantucket in 1761, *Dolphin* of Nantucket in 1763, and *Olive* of Nantucket in 1765 on the Grand Banks.

Based on information in Starbuck (1878) and Dolin (2007) concerning hostile interactions of American whalers with French privateers and later British administrators in Newfoundland and Labrador, we assumed that voyages like *Seaflower's* in 1752 would have become less frequent by the end of that decade. Therefore, we stratified the logbook sample of 45 voyages into two strata—one of 28 voyages from 1751 to 1759 and the other of 17 voyages from 1760 to 1790. Using an average of 25 bbl/whale to convert the oil returns reported by *Seaflower* in 1752, about 4 humpbacks were taken by each of the 7 sloops known to have gone that year to Newfoundland with the explicit intention of humpbacking. This results in an average of 1.0 whale per voyage (SE=0.33) for the 28 voyages in the 1751–59 stratum.

We combined the data from the second stratum (1760–90) with 19th century logbook data for all Atlantic whaling voyages that departed before the beginning of the breeding ground subfisheries (1850) or that departed

Figure 5.—A. Estimated number of humpback whales landed over time, totaling 2,208 whales representing 10.3% of the total, with 99% confidence intervals shown by vertical lines, for four subfisheries of the West Indies Nonmechanized Shore Fishery (Fisheries 10.1, 10.2, 10.3, and 10.4). B. Estimated number of humpback whales landed over time, totaling 4,017 whales representing 18.7% of the total, with 99% confidence intervals shown by vertical lines, for 4 nonmechanized shore fisheries (Fisheries 9, 7, 3, and 12).

after that year but did not participate in either of those two subfisheries. The average number of humpbacks landed by those 110 voyages was 0.072 (SE=0.031).

To estimate the total number of voyages departing per year for the latter half of the 18th century, we used the method of Reeves et al. (2007:64), which combined Lund et al.'s (2010) summary voyage list for the years 1776–91 with the results of an exponential model fitted to the number of voyages mentioned by Starbuck (1878) for the period 1751–75. These results were combined with the numbers of Atlantic-bound voyages departing in the 19th century.

Canada Offshore Fishery (Fishery 6)

This fishery involved schooners that operated throughout most of the 19th century, based primarily in the Gaspé region of southern Quebec (along the south shore of the Gulf of St. Lawrence). Humpbacks are thought to have been the main species targeted, especially after mid century, although this was certainly a multispecies fishery. Annual catches were estimated from data on the numbers of schooners active and the numbers of whales and amounts of oil landed (Mitchell and Reeves, 1983: Table 3).

For years with landings reported as whales, we assumed these were accurate. For years when the catch was reported as oil we converted oil to barrels and estimated barrels per whale from data for years in which both oil and whales were reported. When neither the whale number nor the oil amount was reported, we estimated the number of whales by multiplying the number of schooners active by the mean number of whales per schooner for years when both whales and schooners were reported. In this latter case, for years prior to 1865 when the number of schooners was not reported, we interpolated that number by assuming an exponential increase from the reported numbers from 1834 to 1859, assuming 1 schooner in 1804 (as reported by Mitchell and Reeves, 1983: Table 3). We interpolated the number

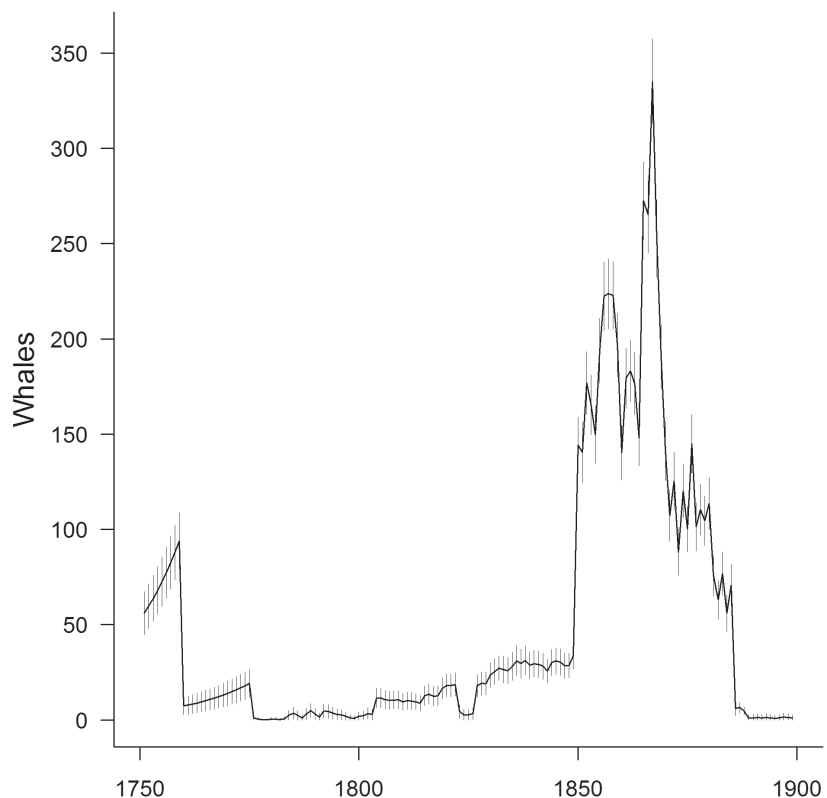


Figure 6. — Estimated number of humpback whales landed over time, totaling 7,400 whales representing 34.5% of the total, with 99% confidence intervals shown by vertical lines, for the Canada and the American Nonmechanized Offshore fisheries combined (Fisheries 6 and 11).

of whales for the few years without schooner reports after 1865. Finally, we assumed that between one-half and three-quarters of the whales taken were humpback whales based on anecdotal reports (Mitchell and Reeves, 1983).

Summary of Nonmechanized Offshore Whaling

Nonmechanized offshore whaling accounted for nearly 35% of the total North Atlantic humpback landings (Fig. 6). The 4 fisheries and subfisheries each accounted for 6 to 13% of the total landings (Fig. 7A, B). The annual landings of both the West Indies and CVI sub-fisheries peaked between 1865 and 1870, with the latter's dropping substantially after 1870. The annual landings by the Other Areas subfishery peaked between 1750 and 1760, collapsed with the U.S. War of Independence, and continued at very low

levels throughout the 19th century. The annual landings of the Canada fishery peaked around 1860.

Total Estimated Removals

Estimates of total landings for the various fisheries and subfisheries are summarized in Table 3 (as described at the beginning of Results), with the percentage that each subtotal represents of the total humpback landings by all fisheries combined. Estimates of total removals are also summarized in Table 3 on the same basis as for landings. Removals were estimated by multiplying the landings by the appropriate loss rate factors.

Discussion and Conclusions

Over the past 3 centuries, North Atlantic humpback whales have been pursued in at least 27 fisheries and subfisheries (Table 3). The estimated

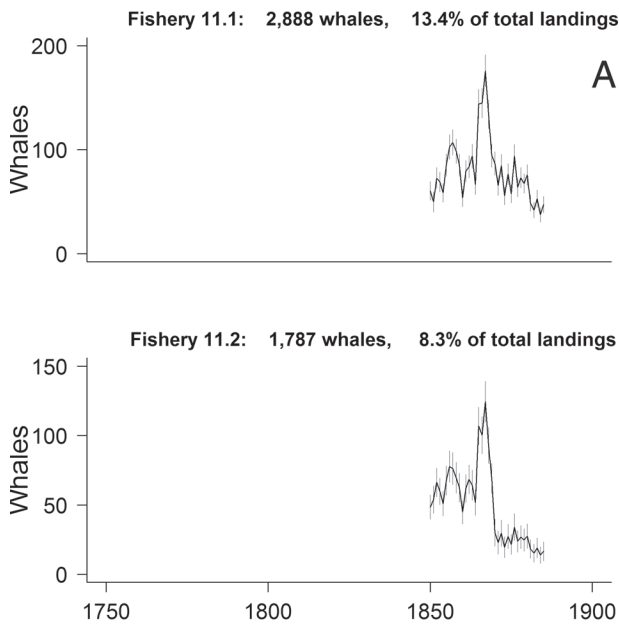


Figure 7A.—Estimated number of humpback whales landed over time, totaling 4,675 whales representing 21.7% of the total, with 99% confidence intervals shown by vertical lines, for the West Indies and Cape Verde Island subfisheries of the American Nonmechanized Offshore Fishery (Fisheries 11.1 and 11.2).

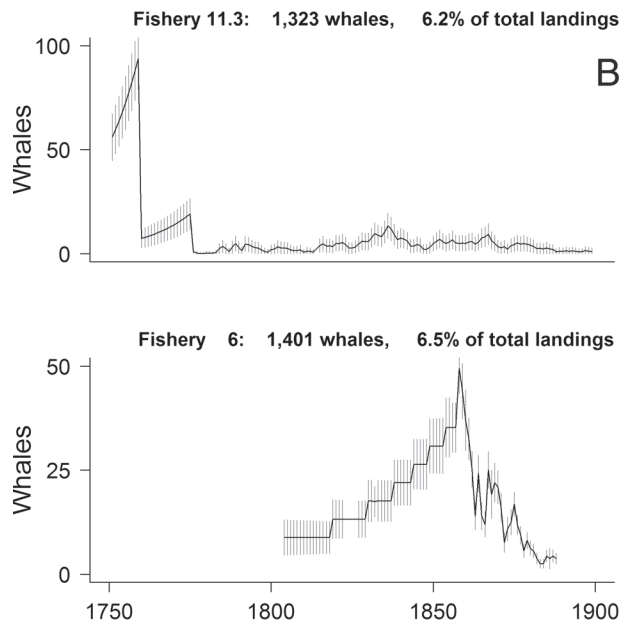


Figure 7B.—Estimated number of humpback whales landed over time, totaling 2,723 whales representing 12.7% of the total, with 99% confidence intervals shown by vertical lines, for the American Nonmechanized Offshore Fishery's Other Areas subfishery and the Canada Nonmechanized Offshore Fishery (Fisheries 11.3 and 6).

total of whales landed was 21,476 (SE=214). The time series of aggregate landings (Fig. 1) shows the changing intensity of humpback whaling over the centuries, as well as the varying statistical uncertainty as indicated by the vertical bars. The estimate of total removals was 30,852 (SE=655), roughly 45% greater than total landings. The general pattern of removals over time was similar to that of landings (Fig. 1), although a greater proportion of the removals occurred in earlier years when the loss rates were higher. Whaling intensity increased gradually, from initially low levels in the 17th and early 18th centuries, primarily in Bermuda, to much higher levels from the mid 1800's to early 1900's. Levels declined rapidly after the early years of the 20th century. The individual fisheries and subfisheries operated over different periods and at highly varying scales (Fig. 2–7). Whaling for humpbacks continues in the North Atlantic only in St. Vincent and the Grenadines and in Greenland.

Historical fisheries information is always subject to concerns about the completeness of reporting and the bias and precision of estimates. In this paper, we have identified previously used sources of information and sought additional data from archives to fill gaps in understanding of North Atlantic humpback whaling. To the extent possible, we have checked the reports on landings for completeness and adopted or, if necessary, developed methods to account for missing data in order to avoid underestimation.

Our new overall estimate of total removals is roughly 6% higher than that used previously by the IWC Scientific Committee. However, such an increase is not nearly enough to achieve the kind of reconciliation between a catch-based and a DNA-based approach to estimation of historical abundance envisioned by Palumbi and Roman (2006). Even after accounting for statistical uncertainty and the effects of potential biases, our reconstruction of removals by whaling fails to resolve

the two outstanding issues: the poor fit of the population assessment models and the inconsistency between the catch history and the estimate of long-term average humpback whale abundance based on genetic variability. The three base-case models considered by Punt et al. (2006: Table 7) resulted in estimates of pre-whaling abundance of between 22,100 and 25,800 whales for the West Indies and the Cape Verde Island populations combined. Their sensitivity tests included alternative catch series with total cumulative removals ranging from 11% to 135% higher than those used in the IWC modeling (IWC, 2002, 2003). While some of the sensitivity tests improved the fit of the models, none of them resulted in pre-whaling abundance estimates even remotely approaching the genetics-based estimate of average long-term abundance of 240,000 by Roman and Palumbi (2003). The size, statistical precision, and sensitivity to possible biases of our new removal estimate are well within the ranges considered by Punt et al. (2006).

Acknowledgments

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Appendix 1.—For 50 voyages by vessels in the American Non-mechanized Offshore fishery (Fishery 11) where reporting in the logbook was judged complete, the vessel name, voyage identification number (VID; Lund et al., 2010), number of humpback whales reported as landed (i.e. “tried out”) or struck and lost, in 4 categories: killed, escaped carrying gear, escaped after the harpoon drew, and escaped in unknown condition.

Vessel Name	VID	Landed (tried out)	Known killed but lost	Escaped carrying gear	Escaped after harpoon drew	Escaped In unknown condition
<i>Adeline Gibbs</i>	59	38	2	2	6	3
<i>Admiral Blake</i>	64	2	0	0	0	1
<i>Alcyone</i>	77	2	0	0	0	0
<i>Ann Maria</i>	1	0	0	0	1	1
<i>Annawan</i>	6	1	0	0	0	1
<i>Arthur Clifford</i>	1267	7	1	1	1	2
<i>Arthur Clifford</i>	1268	9	2	3	0	2
<i>Arthur Clifford</i>	1270	10	2	2	1	2
<i>Asia</i>	28	9	2	0	0	1
<i>Barclay</i>	43	3	1	1	1	2
<i>Bark Midas</i>	125	2	0	0	0	0
<i>Bark Roscoe</i>	26	16	5	7	3	2
<i>Benjamin Franklin</i>	46	3	0	1	1	0
<i>By Chance</i>	51	1	0	1	0	0
<i>Charleston Packet</i>	60	1	2	0	0	1
<i>Cicero</i>	62	0	0	0	1	0
<i>Cicero</i>	63	4	0	2	0	0
<i>David A. Small</i>	3627	12	5	1	0	2
<i>E. Nickerson</i>	3941	17	8	7	8	6
<i>Edward Quesnal</i>	69	4	2	2	0	1
<i>Elizabeth</i>	71	0	0	0	1	0
<i>Europa</i>	81	5	2	2	4	1
<i>Exchange</i>	82	1	1	0	0	0
<i>Fortune</i>	85	0	0	0	0	1
<i>Franklin</i>	5240	9	4	0	0	3
<i>George Washington</i>	90	0	3	0	0	0
<i>Golden City</i>	5851	3	0	1	0	1
<i>Halcyon</i>	94	0	0	1	0	0
<i>Homer</i>	99	1	0	1	1	1
<i>Imogene</i>	104	3	0	0	0	0
<i>Industry</i>	106	1	0	1	0	0
<i>Josephine</i>	113	2	0	0	0	2
<i>Kathleen</i>	116	4	0	1	0	1
<i>Milwood</i>	126	0	1	0	0	0
<i>Nellie F. Putnam</i>	10347	8	1	2	1	3
<i>Nellie F. Putnam</i>	10348	6	2	1	0	1
<i>Noble</i>	7	1	1	0	0	0
<i>Oliver Crocker</i>	11	5	0	0	0	0
<i>Osceola</i>	13	2	0	0	0	0
<i>Pearl Nelson</i>	18	2	0	0	0	0
<i>Petrel</i>	20	3	1	2	3	6
<i>Ploughboy</i>	21	1	1	0	0	0
<i>Quickstep</i>	12015	4	2	0	1	2
<i>Quito</i>	22	1	0	0	0	0
<i>Rodman</i>	24	0	0	1	1	1
<i>Solon</i>	13224	1	1	1	1	2
<i>Union</i>	14283	7	3	1	1	1
<i>Washington</i>	39	2	0	0	0	0
<i>William and Eliza</i>	40	1	1	1	1	2
<i>William Lee</i>	15671	12	5	1	1	9

Appendix 2 is on the following facing pages.

Appendix 3.—For 163 voyages by vessels in the American Non-mechanized Offshore fishery (Fishery 11), the vessel name, voyage identification number (VID; Lund et al., 2010), year the voyage began (Year), area whaled (CVI, WI, Other), and number of humpback whales tried out (i.e. Landed).

Vessel	VID	Year	Area	Landed
<i>A. L. Putnam</i>	16	1866	CVI	0
<i>A. R. Tucker</i>	48	1868	CVI	6
<i>Adeline Gibbs</i>	272	1875	Other	0
<i>Adeline Gibbs</i>	273	1878	Other	0
<i>Admiral Blake</i>	277	1868	Other	0
<i>Admiral Blake</i>	305	1865	CVI	6
<i>Agate</i>	344	1869	WI	13
<i>Agate</i>	345	1871	WI	10
<i>Agate</i>	346	1872	WI	10
<i>Albert Clarence</i>	393	1868	CVI	4
<i>Alcyone</i>	435	1890	WI	2
<i>Alice Knowles</i>	555	1883	Other	0
<i>Alleghania</i>	616	1868	WI	1
<i>Alleghania</i>	617	1869	WI	3
<i>Alleghania</i>	618	1870	WI	0
<i>Amelia</i>	776	1877	WI	1
<i>Andrew Hicks</i>	905	1881	Other	0
<i>Ann Maria</i>	1014	1837	CVI	0
<i>Annawan</i>	1044	1836	WI	1
<i>Annawan II</i>	1059	1859	WI	2
<i>Ansel Gibbs</i>	1087	1867	Other	0
<i>Ansel Gibbs</i>	1089	1869	Other	0
<i>Arthur Clifford</i>	1267	1866	WI	7
<i>Arthur Clifford</i>	1268	1867	WI	7
<i>Arthur Clifford</i>	1269	1867	WI	5
<i>Arthur Clifford</i>	1270	1868	WI	10
<i>Attleboro</i>	1402	1880	Other	0
<i>Aurora</i>	1423	1884	WI	3
<i>Benjamin Franklin</i>	1760	1866	Other	0
<i>By Chance</i>	2118	1826	CVI	2
<i>Catalpa</i>	2446	1875	Other	0
<i>Charles H. Cook</i>	2679	1867	Other	0
<i>Charles W. Morgan</i>	2721	1867	WI	1
<i>Charles W. Morgan</i>	2724	1878	Other	0
<i>Cicero</i>	2886	1870	WI	8
<i>Cicero</i>	2889	1879	Other	0
<i>Clara L. Sparks</i>	2920	1876	CVI	5
<i>Clara L. Sparks</i>	2921	1878	Other	0
<i>Clara L. Sparks</i>	2922	1879	WI	0
<i>Clarice</i>	2932	1875	Other	0
<i>Cornelia</i>	3394	1866	Other	0
<i>David A. Small</i>	3621	1875	Other	0
<i>David A. Small</i>	3627	1886	WI	17
<i>Desdemona</i>	3715	1873	Other	0
<i>Desdemona</i>	3716	1876	Other	0
<i>Draco</i>	3835	1866	Other	0
<i>Draco</i>	3836	1868	Other	0
<i>Draco</i>	3837	1872	Other	0
<i>Draco</i>	3839	1878	Other	0
<i>E. H. Hatfield</i>	3915	1880	CVI	1
<i>E. H. Hatfield</i>	3919	1861	CVI	8
<i>E. H. Hatfield</i>	3923	1865	CVI	0
<i>E. H. Hatfield</i>	3924	1867	Other	0
<i>E. H. Hatfield</i>	3931	1876	WI	1
<i>E. H. Hatfield</i>	3932	1876	CVI	1
<i>E. Nickerson</i>	3937	1850	CVI	2
<i>Edith May</i>	3998	1867	Other	0
<i>Eleanor B. Conwell</i>	4069	1880	Other	0
<i>Eleanor B. Conwell</i>	4071	1884	Other	0
<i>Eleanor B. Conwell</i>	4072	1885	Other	0
<i>Eleanor B. Conwell</i>	4073	1885	Other	0
<i>Ellen Rizpah</i>	4311	1875	WI	8
<i>Emma Jane</i>	4446	1879	Other	0
<i>Emma Jane</i>	4448	1882	Other	0
<i>Eschol</i>	4599	1869	Other	0
<i>Eschol</i>	4600	1871	WI	2
<i>Eschol</i>	4601	1873	Other	0
<i>Eunice H. Adams</i>	4664	1885	CVI	3
<i>Exchange</i>	4726	1847	Other	1
<i>Express</i>	4757	1878	CVI	8
<i>F. H. Moore</i>	4767	1868	WI	1
<i>Falcon</i>	4837	1865	Other	0
<i>Frank Bunchinia</i>	5195	1856	CVI	1
<i>Franklin</i>	5236	1880	Other	0
<i>Franklin</i>	5238	1883	WI	7
<i>Franklin</i>	5240	1885	WI	13
<i>Gage H. Phillips</i>	5347	1878	Other	0
<i>Gage H. Phillips</i>	5348	1881	Other	0
<i>George and Mary</i>	5620	1877	Other	0
<i>Golden City</i>	5847	1878	Other	0

Continued

Appendix 3.—(Continued).

Vessel	VID	Year	Area	Landed
<i>Golden City</i>	5848	1880	Other	0
<i>Golden City</i>	5850	1881	Other	0
<i>Golden City</i>	5851	1882	CVI	9
<i>Greyhound</i>	6019	1885	Other	0
<i>Greyhound</i>	6022	1898	WI	1
<i>Henry Taber</i>	6445	1866	Other	0
<i>Homer</i>	6720	1855	CVI	1
<i>Hope On</i>	6787	1881	Other	0
<i>Industry</i>	7074	1828	WI	1
<i>J. Taylor</i>	7222	1866	WI	10
<i>J. Taylor</i>	7223	1867	WI	3
<i>Janet</i>	7356	1875	Other	0
<i>Janet</i>	7357	1877	Other	0
<i>Lizzie P. Simmons</i>	8513	1868	Other	0
<i>Lottie E. Cook</i>	8564	1885	Other	0
<i>Louisa</i>	8587	1878	Other	0
<i>Mattapoisett</i>	9465	1866	Other	0
<i>Mattapoisett</i>	9467	1871	Other	0
<i>Merlin</i>	9625	1881	Other	0
<i>Mermaid</i>	9630	1880	Other	0
<i>Mermaid</i>	9632	1883	Other	0
<i>Nellie F. Putnam</i>	10346	1867	WI	0
<i>Nellie F. Putnam</i>	10347	1868	WI	8
<i>Nellie F. Putnam</i>	10348	1869	CVI	6
<i>Ohio</i>	17040	1872	WI	0
<i>Ohio II</i>	10799	1875	Other	0
<i>Osceola III</i>	11052	1865	CVI	2
<i>Osceola III</i>	11053	1866	Other	0
<i>Ospray</i>	11073	1868	Other	0
<i>Ospray</i>	11077	1877	Other	0
<i>Pacific</i>	11150	1865	Other	0
<i>Pacific</i>	11151	1867	WI	1
<i>Pacific</i>	11152	1868	Other	0
<i>Pearl Nelson</i>	11347	1896	CVI	2
<i>Pedro Varela</i>	11352	1881	Other	0
<i>Pedro Varela</i>	11354	1885	Other	0
<i>Perry</i>	11410	1874	CVI	3
<i>Perry</i>	11411	1877	Other	0
<i>Petrel</i>	11476	1865	CVI	3
<i>Pioneer</i>	11691	1877	Other	0
<i>President</i>	11930	1875	Other	0
<i>President II</i>	11962	1875	Other	0
<i>Quickstep</i>	12017	1871	Other	0
<i>Quickstep</i>	12018	1873	CVI	1
<i>Quito</i>	12040	1842	WI	2
<i>Rainbow</i>	12078	1866	WI	4
<i>Rainbow</i>	12079	1867	Other	0
<i>Rainbow</i>	12081	1869	Other	0
<i>Rising Sun</i>	12367	1875	WI	2
<i>Rising Sun</i>	12369	1877	WI	3
<i>Rising Sun</i>	12370	1878	WI	2
<i>Rising Sun</i>	12372	1879	WI	0
<i>Rising Sun</i>	12373	1879	WI	5
<i>Rising Sun</i>	12375	1881	Other	0
<i>Rising Sun</i>	12377	1883	WI	14
<i>Rising Sun</i>	17019	1876	WI	5
<i>S. R. Soper</i>	12702	1865	Other	0
<i>Sarah</i>	12877	1873	Other	0
<i>Sarah</i>	12878	1876	Other	0
<i>Sarah B. Hale</i>	12891	1877	Other	0
<i>Sea Ranger</i>	13071	1876	Other	0
<i>Solon</i>	13217	1865	CVI	3
<i>Stafford</i>	13384	1865	CVI	5
<i>Star Castle</i>	13421	1867	WI	9
<i>Tamerlane</i>	13700	1877	Other	0
<i>Triton</i>	14088	1868	Other	0
<i>Tropic Bird</i>	14134	1867	Other	0
<i>Tropic Bird</i>	14136	1876	Other	0
<i>Tropic Bird</i>	14137	1878	Other	0
<i>Union</i>	14277	1874	Other	0
<i>Union</i>	14278	1875	Other	0
<i>Union</i>	14283	1882	WI	7
<i>Vigilant</i>	15164	1865	Other	0
<i>Walter Irving</i>	15268	1865	CVI	2
<i>Washington</i>	15357	1858	WI	2
<i>Washington Freeman</i>	15402	1868	CVI	2
<i>Wave</i>	15452	1867	Other	0
<i>Wave</i>	15455	1871	Other	0
<i>Wave</i>	15456	1874	Other	0
<i>Wave</i>	15457	1876	Other	0
<i>William A. Grozier</i>	15525	1866	WI	2
<i>Willis</i>	15784	1861	CVI	4
<i>Winged Racer</i>	15804	1868	WI	4