INTRODUCTION

‘Of all the industrial pursuits of the sea. . . the whale fishery is the most valuable. Wherefore, in treating of the physical geography of the sea, a map for the whales would be useful.’ Maury (1855, pp. 179–80)

One hundred and fifty years ago a Navy lieutenant, Matthew Fontaine Maury, began the ambitious task of mapping the winds and currents of all the oceans. His method was to enroll the help of not only scientists and navy captains but all mariners, by requesting them to send him daily abstracts of their logs. In his words, ‘[b]y concert and with the most commendable spirit, sailors of all nations are engaged in conducting a most noble and ennobling system of philosophical inquiry’ (Maury, 1855, p.iii).

Shortly afterward, the first of many editions of his classic Wind and Current Charts appeared. Maury sought out the logbooks of whalers, who more than other mariners, ventured far away from the traditional trade routes. In 1847, ‘materials having been collected from the log-books of whalers for an investigation into the habits and places of resort of the whale,’ Maury (1855, p.252) assigned Lt. Wm. L. Herndon to commence construction of this Whale Chart.

Maury’s Whale Charts, published between 1851 and approximately 1853, continue to represent the single largest source of information about the abundance and distribution of the right whale in the North Pacific. This species has been so rare in the North Pacific since 1900, that the occurrence of even a single right whale is not predictable anywhere, except for possibly along the Kuril Islands and in the Sea of Okhotsk (Bersin and Doroshenko, 1981; IWC, 1986; Scarff, 1986a), limiting study of the species to rare opportunistic observations (Woodhouse and Strickley, 1982; Scarff, 1986b). It is not known whether there are three, two, or perhaps only one breeding stock in the North Pacific and adjacent seas (IWC, 1986). The breeding grounds, calving grounds and winter distribution of the species are almost completely unknown.

Consequently, the right whale in the North Pacific has been almost an invisible and forgotten species during the last century. Detailed scientific descriptions have only been published of about 50 whales (Omura, 1958; Klimov, 1962; Omura et al., 1969; Wang, 1978; Reeves et al., 1985; Brueggerman et al., 1986). Intensive aerial and ship surveys of coastal waters, particularly along the west coast of North America, have only rarely resulted in a sighting of even a single right whale (Leatherwood et al., 1983; Morris et al., 1983; Scarff, 1986a).

In contrast, prior to and during the initial years of pelagic whaling in the North Pacific, many observers reported right whales were common or abundant over wide areas (Webb, 1988). Analysis of historic data may provide critical clues on where to look for any remaining concentrations of right whales. Because of its potential usefulness, the IWC Scientific Committee has urged a more detailed study of the historic whaling record (IWC, 1986, p.12).

A particular issue where study of historic whaling records might help is in the determination of stock identity for right whales in the North Pacific. Townsend’s (1935) Chart C shows apparent concentrations of right whales in the Gulf of Alaska (Northwest Ground or Kodiak Ground), off both coasts of Kamchatka, around the Kuril Islands, in the southern and eastern Sea of Okhotsk, and in

ABSTRACT

This study tabulates approximately 8,000 sightings of right whales (Eubalaena glacialis) by American pelagic whalers made during approximately 47,000 searching days between 1835 and 1852 in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan reflected in the 1852 Maury Series F Whale Charts Numbers 1 and 2. The data are presented as indices of abundance and number of searching days by 5° of latitude and longitude by month.

The data show that during the 1840s, right whales were abundant in the Gulf of Alaska, southeastern Bering Sea, along the Aleutian Islands, along the Pacific and Sea of Okhotsk coasts of Kamchatka and in the Sea of Japan. The charts also show high indices of abundance of right whales in spring, summer and autumn in the mid-Pacific, although with small searching effort. In many areas, whales found right whales on 50% or more of the searching days, and in some areas such as the coasts of southern Kamchatka (50-55°N, 155–160°E) in August, whalers reported seeing right whales on over 90% of the searching days (110 out of 120). In the Gulf of Alaska, right whales were seen on 40-60% of the searching days in most sectors, and the samples of searching days (200–500+ days/sector) are sufficiently large to minimize the likelihood that these concentrations were atypical.

The indices of abundance reported here are comparable to, although higher than, indices derived from Maury’s charts for right whales off South Africa, and considerably higher than indices of sperm whales in the North Pacific. The historic indices of abundance and distribution are contrasted to the paucity and distribution of recent sightings.

The data support the conclusion that right whales may have been considerably more common in the North Pacific than previously thought, and consequently their current population size represents an even greater level of depletion. Given the very low level of recent sightings, the species should remain completely protected. Suggestions for further research and management are provided.

Historic Distribution and Abundance of the Right Whale (Eubalaena glacialis) in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury Whale Charts

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the Sea of Japan. This chart shows very few whale catches outside these areas, particularly in the mid-Pacific, where whaling effort was less.

This discontinuity in right whale distribution strongly suggests that right whales form at least two discrete stocks on the eastern and western sides of the North Pacific. However, Scarff (1986a) and others (IWC, 1986) noted that Townsend's geographic catch data were not controlled for searching effort, and that Maury's (1851) Preliminary Sketch showed a continuous distribution of right whales across the mid-Pacific at relatively uniform densities. Cursory review of the Maury (1852 et seq.) Charts 1 and 2 also suggested a more uniform density of right whales across the mid-Pacific than shown by Townsend (1935).

Kugler (1986) found the continuity of right whale distribution shown on the Maury charts' (most continuously on the 30, 35, 40 and 45° latitudes) difficult to explain and suggested that it may be the result of erroneous readings or recordings of data abstracted from the logbooks. In contrast, Scarff (1986a) was more willing to believe that Townsend's discontinuity was an artifact of the concentration of searching effort in these regions. A principal purpose of this study was to review this issue and to examine more rigorously Maury's apparently uniform distribution across the mid-Pacific.

History of pelagic whaling for right whales in the North Pacific
Prior to the arrival of the pelagic whalers in the early 19th century, right whales were taken by shore-based aboriginal and traditional fisheries. Aboriginal fisheries in the eastern North Pacific, along the Aleutians, and in northeastern Asia have been described by Mitchell (1979), O'Leary (1984), Krupnik (1984), Scarff (1986a), Webb (1988), and most comprehensively by Mitchell and Reeves (1991). Right whales do not appear to have been the primary target of any of these fisheries, and the number of right whales killed appears to have been very small.

In Japan, traditional shore whaling for right whales began perhaps as early as the 10th century A.D. and continued through at least 1900 (Omura, 1986). Catch data of right whales taken in net-whaling at Kawajiri, Yamaguchi Prefecture from 1700 and in Kochi Prefecture since 1800 have been reported by Omura (1986). However, even in this directed fishery the level of take, dependent as the whalers were on the whales coming to them, was far smaller than what was to occur in the decades of pelagic whaling.

Pelagic whaling for right whales came late to the North Pacific. The whaling grounds were so remote from markets that whalers ventured there only after whaling grounds in the South Atlantic and South Pacific had been depleted. Although a few right whales may have been taken one or two years earlier, it was not until 1835 that the whaling industry began to consider North Pacific right whales as a potentially important resource. In that year, the French whaler Gange caught seven right whales probably around 50°N, 160°W, at the southern edge of what was to become known as 'the Northwest Ground' (Webb, 1988).

Reaction to the news of the Gange's catch was initially slow. Between 1835-40 few whalers went this far north (Webb, 1988), and those that did were captains primarily interested in finding sperm whales (Webb, pers. comm.). In 1839, only two American whaling ships were reported
north of 50°N (Starbuck, 1878, p.104). However, those few whalers who did go north of 50°N reported that right whales were abundant. The whalers were also impressed by the fact that the right whales they caught were significantly larger than the animals in the Southern Hemisphere (Webb, 1988, p.40; Best, 1987).

By 1841 more whalers began seriously to focus their attention on the Gulf of Alaska and the Pacific coast of Kamchatka (Webb, 1988). The rapid concentration of whaling effort in the North Pacific was extraordinary, even by 19th century whaling standards. The number of American whaling ships operating north of 50°N in the Pacific increased to 108 in 1843 and 292 in 1846 (Starbuck, 1878:104; Webb, 1988). By 1845, American whalers had even ventured into the Sea of Okhotsk.

To the number of ships listed above must be added the often overlooked whalers from other countries. Webb (1988) reports that of the 161 whaling ships that called at Honolulu in 1845, 21% were of non-US registry: 19 from France, 6 from Bremen, 3 from New Brunswick, 2 from Denmark, and 1 each from Hanover, Norway, Prussia, and Hamburg.

Although elsewhere many of these crews had focused on taking sperm whales (Physeter macrocephalus), north of 40°N in the North Pacific and Sea of Okhotsk the whalers hunted the right whale almost exclusively. Consequently, the whalers were familiar with right whales, capable of distinguishing the species from other whale species (at least after 1840), and always on the lookout for them. In contrast, the observers who have made a large proportion of the recent records in the North Pacific often lacked prior experience with right whales.

The impact of so many whalers on the right whale population was devastating. In the period between 1835–49, the American whaling fleet caught an estimated 10,958–11,455 right whales in the North Pacific, the Sea of Okhotsk and adjacent seas (Best, 1987). To this toll on the population must be added: (1) some of the many struck-but-lost animals that died and were not later recovered, (2) whales killed by foreign whalers and (3) whales not counted because neither the logbooks nor the cargo made it into the records, e.g. the ship sank, or sold its cargo at a port where it was not recorded (see Best, 1987, p.404).

By 1847, only four years after the first major effort to take right whales in the North Pacific, the whales were scarce, and from 1849 on the fishery was only a small fraction of its earlier effort and catch (Webb, 1988). The depletion of the right whales coincided with the discovery in 1848 of the more valuable and locally abundant bowhead whales (Balaena mysticetus) north of the Bering Straits. In 1849, almost the entire pelagic whale fishery in the North Pacific redirected its attention to the bowhead (Webb, 1988). In the period 1850–54 the catch of right whales by the American fleet dropped to an estimated 951–1,364 (Best, 1987). Pelagic whaling for right whales lingered on in the Sea of Okhotsk until 1857 (Kugler, 1986), when it was discontinued until the end of the century (D. Henderson, pers. comm.).

During the brief heyday of pelagic whaling for right whales (1840–8) hundreds of whaling ships, mainly of American registry, explored almost every area of the North Pacific and adjacent seas searching for right whales. Often these whalers’ logbooks contain detailed records of right whale sightings (Webb, 1988). These logbooks represent a treasure of information about historic right whale abundance and distribution and about the whaling industry that has barely been examined to date.

Many original logbooks have not survived. However, some information contained therein has survived indirectly in Starbuck’s (1878) history of the whaling industry and in various whaling charts. Most of these early charts described whale distribution very generally, and were also vague in describing the specific sources on which they were relying for their data. Among these, distribution of right whales in the North Pacific is described in Van Beneden (1868); Guerin (1874, Plates I and II); Van Beneden and Gervais (1880, textplate following p.630); and Clark (1887, plate 183). All these charts, other than Van Beneden (1868), have been reprinted at reduced scale in Reeves and Mitchell (1986b).

The best known of the charts showing historic right whale distribution are Townsend’s (1935). These maps show detailed locations for about 2,000 whales caught in the North Pacific and include the list of voyages for which the logbooks were reviewed.

However, of the historic right whale data in the North Pacific, Maury’s Whale Charts (1851; 1852 et seq.) provide the largest and most detailed sample. Less well-known and less accessible than the Townsend Charts, Maury’s (1852 et seq.) Series F Charts 1 and 2 contain four times as many right whale sightings, many from the early period of right whaling less well sampled by Townsend. More importantly, Maury’s charts include detailed monthly data on searching effort, allowing one to derive crude indices of abundance.

Yet, because of the rarity of these charts and the abstruse manner in which data are presented therein, until recently scientific understanding of right whale distribution in the North Pacific developed without reference to them (see Omura, 1958; Omura et al., 1969; Gilmore, 1978; Gaskin, 1987), or only mention Maury’s (1851) Preliminary Sketch in passing (Reeves and Brownell, 1982). Instead, our understanding was based on Townsend’s (1935) charts of historic whaling and the little recent information.

Only recently, have scientists begun to examine the data in Maury’s whaling charts (Bannister and Mitchell, 1980;
Best, 1981; Scarff, 1986a). This study seeks to make the data on North Pacific right whales in Maury's Charts more available.

**MATERIALS AND METHODS**

"But before I go on, I wish to announce a rule of conduct by which I have been guided from the commencement of this work, and by which I mean to be guided to the end; for not only has experience proved it wise, but it is in principle so good that it I attribute much of the success which has attended these labors. This rule has been to keep the mind unbiased by theories and speculations; never to have any wish that an investigation would result in favor of this view, in preference to that, and never to attempt by premature speculation to anticipate the results of investigation, but always to trust to the observations". M.F. Maury (1855, p. ii)

The Maury Charts

Maury prepared several related sets of Whale Charts during the period 1851-5 as part of his famous *Wind and Current Charts*. The information in these charts is derived from the logbooks of about 1,000 whaling voyages as explained more fully in Bannister and Mitchell (1980) and the references listed therein.2

The charts differ mainly in the amount of detail they provide. The first chart, entitled "Preliminary Sketch, Series F" (Maury, 1851), is a map of the world showing the distribution of right and sperm whales by 5° of latitude and longitude in the Southern Hemisphere and North Pacific. The occurrence of right and sperm whales in each quadrant and the species' relative abundance are depicted by pictorial symbols of the species with an indication by letter of their seasonal occurrence in the quadrant. A portion of this map has been reproduced in Scarff (1986a, Fig. 1), and the entire map has been republished at a much reduced scale in Whipple (1979 pp. 70–1) and as the endpapers in Starbuck (1878 [1964 ed.]).

Far more detailed than the Preliminary Chart are Maury's (1852 et seq.) Series F Whale Charts 1 (eastern North Pacific)(1852) and 2 (western North Pacific north of 20°N) (undated, but before 1855 since Maury [1855, p. 669] states that all four Whale Charts had been printed). Charts 3 and 4 map the South Pacific and South Atlantic. The charts show for each 5° of latitude and longitude by month (1) the number of days whaling ships spent in that quadrant, (2) the number of days on which right whales were seen (blue line) and (3) the number of days on which sperm whales were seen (red line). The data are displayed in histograms in each quadrant. Portions of Maps 1 and 2 are reproduced in Scarff (1986a) and Bannister and Mitchell (1980, Figs 3, 4). The data for this study were derived from the copies found at the Yale University library (see the bibliography in Bannister and Mitchell [1980] for the location and complex history of different variants of these Charts.)

Maury also prepared two more general charts. The first of these shows right and sperm whale distribution by simply shading the areas (Maury, 1853; reprinted in Reeves and Mitchell [1986a, Fig. 6]). Another chart, entitled "SEA DRIFT AND WHALES, on which the movements of the sea as indicated by the THERMOMETER are shown" (Maury, 1855, Plate XIX) is a map of the world that shows by a dashed line the 'Equatorial limits of Right Whale ground'.

The data on the number of days on which whaling ships were in the sector and the number of days right whales were seen in the sector were read off the Maury (1852 et seq.) Whale Charts 1 and 2 using a magnifying glass and put in tabular form. Bannister (Western Australia Museum) kindly shared with me his independent tabulations of some of these data. The closeness of our estimates suggests that the data can at least be read consistently, although it does not resolve all questions of the accuracy of the transcriptions of data from the logbooks to abstracts, to the printed charts and thence to our tabulations. Abstracts of the logbooks and journals used in the preparation of the Maury charts are available in the Maury Abstract Log Collection, National Archives and Records Service, Washington, D.C. (Reeves and Mitchell, 1986a).

The data from Charts 1 and 2 tabulated in this report should be interpreted with caution because of actual and potential biases in the data. First, the charts appear to have been produced by multiple printing runs of each chart through the printing press. The multiple runs raise the problem of non-precise register of the press during the separate printing runs of the grid and whaling ship searching data (black ink), the blue right whale line and the red sperm whale line. The press may have been slightly misaligned on subsequent printing runs of the same chart. This conclusion is suggested by the non-alignment of the right whale data line with the zero base line in those months where clearly no right whales were seen.

A second source of potential error in the transcription arises from the unusual scale of the histograms. Maury used a scale set in uniform vertical units of 10 days from 0 to 100; above 100 additional vertical units (of the same size) represent 100 days. For months where the number of searching days or whale sighting days exceeds 300, the histogram shows two peaks for that month that need to be added together to reach the total number for that month.

A third factor affecting the accuracy of the data transcriptions is the varying vertical scale at different latitudes on the map. The Maury Charts were superimposed on maps of the North Pacific to aid viewers in their interpretation. Due to the Mercator map projection used, the height of the quadrants increases from 36mm for the 20–25°N sectors to 62mm for the 65–70°N sectors. Maury increased the scale of the more northern histograms to fill the available space on the chart. Consequently it is more difficult to assure uniformity of the transcriptions across latitudes. For example, a one mm shift in the register of the printing press in one of the runs would bias the data differently at different latitudes.

Notwithstanding the transcription problems described above, I estimate that each transcription of the whale
The information contained in Maury's Preliminary Sketch is shown in Table 1. The total sightings and searching data by month from Maury's Charts 1 and 2 (Maury, 1852 et seq.) are shown in Table 2. The same data are presented detailed by month and location in Tables 3.1-3.12. Tables 3.1-3.12 show (1) the number of days whaling ships were in that sector that month and (2) the fraction of total search days on which right whales were seen. This fraction is shown, rather than the number of days on which right whales were seen (shown in Maury's Charts) because it is believed that these crude indices of abundance are more informative than the raw number of days with whales (Bannister and Mitchell, 1980). The number of days on which right whales were seen in that sector that month can be calculated by simply multiplying this fraction times the total number of sighting days. The number of searching days in each sector by month is a measure of the sample size to aid in the evaluation of the reliability of the index of abundance for that sector that month.

**Consistency of the Maury Charts**

The information in the Preliminary Sketch (Maury, 1851) and Charts 1 and 2 (Maury, 1852, et seq.) are not in complete agreement. The Preliminary Sketch does not show any right whales in the Sea of Japan or in the Sea of Okhotsk north of 55°N. The Preliminary Sketch extends south to 15°N and shows 'straggling' right whales in spring.
and summer between 15-20°N, 175°E-170°W. Charts 1 and 2 extend south only to 20°N.

As noted in Scarff (1986a), the Preliminary Sketch shows right whales occurring in the autumn off the coast of southern California near San Diego (20-35°N, 125-135°W) with 'straggling' occurring off Baja California (25-30°N, 130-135°W), and west of the Hawaiian Islands 20-25°N, 180-170°W. Maury Charts 1 and 2 (1852 et seq.) show no right whales in these regions, nor do his later, more general, charts (1853; 1855).

The Preliminary Sketch also shows 'straggling' right whales occurring between 25-30°N during spring (170-175°E), summer 175-180°E, and autumn (180-175°W). Charts 1 and 2 show a different seasonal pattern of right whale sightings between 25-30°N. In the area 170-175°E, Chart 2 shows only two sighting-days in August, and none in spring. In the area 175-180°E, Chart 2 shows 2 records in April and 2 in September, but none in the middle of summer. In the area 180-175°W, Chart 1 does show 5 sighting-days in autumn (September), but also shows 3 sighting-days in February and 5 in April.

Maury (1855, p.256) comments that except for one sighting between 50-55°N, right whales had never been seen between latitudes 125-130°W in either the Northern Hemisphere (along the west coast of North America) or the Southern Hemisphere. In support of this statement, he refers to a tabulation of searching days and whale sightings between 125-130°W by month (Maury, 1855, Plate IX 'WHALE CHART') apparently prepared in connection with the Series F Whale Charts. This tabulation appears to be only a partial count of the data in Whale Chart 1. Chart 1 shows sightings on approximately 5 days in July (2 days at 50-55°N; 2 days at 45-50°N), and on approximately 3 days in August (50-55°N). In addition, Chart 1 shows somewhat more searching effort for some sectors than is reflected in the table in Maury (1855).

Biases in the data

Apparent patterns in the data should be interpreted with great caution. The crude indices of abundance I calculated from the Maury data reflect the numerous biases in the type of data recorded, the lack of controls for variability of sighting efficiency and the variability of the time periods when the data were collected.

First, the charts record the number of days on which right whales were seen by month. They do not record the number of right whales sighted or even the number of right whale sightings. Thus, the chart would show the same relative abundance if 1 right whale or 3 groups of 20 whales were reported in a logbook for a given day.

Second, there was no control for, or measure of, the number of resightings of whales in the same quadrant.

Third, the searching patterns of the whalers were of course highly nonrandom and variable. They deliberately sought to maximise time spent in areas where they believed whales would be. This bias occurred both between and within quadrants. In quadrants with significant geographical or ecological heterogeneity, for example near Akutan Pass in the Aleutians, the searching was probably particularly biased in favor of those areas within the quadrant where whalers believed whales would be found.

Fourth, Maury apparently made no attempt to standardize the length of a searching day. In the high latitudes where the whalers were operating there is considerable change in the number of hours of daylight by latitude and month over the year. In addition, the number of hours a whaling ship searched for whales was affected by the number and timing of whales it did catch. Webb (1988, p.32) reports that whalers often ignored other whales while the crew was processing a whale alongside the ship.

Fifth, there was no control for the differences in searching efficiency associated with the different sea conditions that were distributed nonrandomly by month and quadrant over the study area. Webb (1988, p.65) eloquently describes the importance of weather on the Northwest Ground:

Accounts of the Northwest Coast cruises are saturated with weather, often "rugged" with rain, sleet, fog, and snow, punctuated by living gales from the Arctic North and every other point on the compass. "Thick," they wrote. "Thick and rainy." "Thick, wet & disagreeable."

Coming with the fog, and sometimes apart from it, were the "strong breezes," gales, and "near hurricanes" which drove the seas to frothy crests and necessarily inhibited the whaling. The phrase "Too rugged to lower" pervades the journals; too rugged to chase whales, too rugged to start the tryworks, too rugged to make sail. And if a whale was somehow taken in such dismal conditions... [in] the deep Pacific swell, the rolling of the whale against the fluke chain and the hull often caused its body to part company with the ship.

Other factors that might have affected searching efficiency were described by Best (1983) for sperm whaling and may well also apply to right whaling. Such developments which may have occurred between 1835-51 include increases in whaling ship size, improvements in sailing rig, increase in size of whale boats and introduction of sail to whaleboats.

Sixth, the data represent nonsimultaneous samples of a population declining substantially during the sampling period. Data from different quadrants represent different combinations of voyages during different years. Over the period 1841-46 the whaling effort moved north each year.3 During the period covered by the Maury Charts there was a substantial decline in the right whale population in the North Pacific. Thus, to the extent that population levels in any quadrant were a direct function of population levels in other quadrants, quadrants searched more during later years would have already reflected a depleted population, and the data may underestimate the relative pre-pelagic whaling abundance of the species in these quadrants.

Sperm whaling and possible bias in reporting the more common whale

A striking feature of the Maury charts is the lack of sperm whales reported in northern latitudes. Maury's (1851) Preliminary Sketch shows sperm whales north of 40°N only along the west coast of North America between 40-50°N (see Bannister and Mitchell [1980], Fig. 2). Maury's (1852, et seq.) Charts 1 and 2 show no sightings of sperm whales north of 40°N, not even along the California coast (see Bannister & Mitchell [1980], Figs 5-6). The absence of sperm whales in the catch of whales north of 40°N is also reflected in Townsend's (1935) charts.

Yet sperm whales do occur in these northern latitudes (Bannister and Mitchell, 1980), and Yankee whalers did occasionally catch them. Webb (1988, p.51) reports the Orozimbo in 1841 taking three sperm whales north of 49°N at the southern edge of the Northwest Ground. Bowles (1845) wrote:

3 Webb (1988, p.54) states: 'In 1841, the first important year there, a considerable amount of whaling was conducted between 50° and 54°30'[N]; even in later seasons a few right whales continued to be taken south of 50°. But the right-whaling soon shifted to the upper curve of the Gulf of Alaska, excluding waters south of 54°. This became so much the case that whalermen began to refer to the northeastern Pacific as the 'Kodiak' or 'Kadiak' or 'Coodiac' ground.'
Whales were frequently reported as right whales and vice versa as revealed by detailed studies of logbooks from the North Atlantic (Reeves and Mitchell, 1986a), the Bering Sea (Bockstoce, 1980) and the Sea of Okhotsk (D. Henderson, pers. comm.). Another study shows apparent misidentification of right whales as humpback whales (Megaptera novaeangliae) in the Townsend's North Atlantic chart (Reeves and Mitchell, 1990).

**Chukchi and Bering Seas**

Maury's Charts show 160 sighting-days of right whales in the 65°-70°N quadrants between 180°-165°W (28 in May, 66 in June, 45 in July and 21 in August). The two quadrants between 175°-165°W represent the Chukchi Sea south to a line in the Bering Sea between King Island and Ostrov Arakamchechen, barely south of the Bering Straits. The quadrant of 65°-70°N, 175°-180°W covers part of the Chukchi Sea and part of the Gulf of Annadir (Anadyrsky Zaliv).

The records on the Maury Charts north of 65°N and in the quadrant 180°-175°W, 60°-65°N are further north or west than recent sightings of right whales and all but a few anomalous historic records of Townsend (1935) discussed below. It is probable that Maury's records are either inaccurate recordings or transcriptions of ship locations, or are records of bowhead or possibly gray whales (Eschrichtius robustus) rather than right whales. Accordingly, these data from the Maury Chart have been displayed in Tables 3.5-3.8 in parentheses and both the effort and whale sighting data excluded from Table 2.

In the eastern Bering Sea, the vast majority of the right whale records in Townsend's (1935) Chart C are located southeast of the line between Atka, St. Matthew and Nunivak Islands. The main concentrations of records are around the Pribilof Islands east to Bristol Bay and southeast toward Unimak Pass. Townsend's records north or west of this area are so few and anomalous that they probably are records of bowheads or gray whales erroneously recorded as right whales. For example, Townsend shows five records of right whales in July in the Bering Straits. He also shows 2 records in June and 4 in July at, or west of, St. Lawrence Island (63°N). Four other June records (57-60°N) are anomalous in being west of 175°W, the only records of right whales this far west. The more northern records are consistent with historic bowhead distribution, and the more southern consistent with gray whale distribution in the Bering Sea (Braham, 1984b; Yablokov and Bogoslovskaya, 1984).

Recent studies suggest that the right whale's range currently extends northwards only into the southeastern portion of the Bering Sea, and not north of the Bering Straits into the Chukchi Sea. Berzin and Rovnin (1982) stated that the range of right whales included only the southeastern section of the Bering Sea, a region limited approximately by a line connecting Atka, St. Matthew and Nunivak Islands, an area of relatively shallow water over the continental shelf. Brueggeman et al. (1984) sighted two right whales in 1982 slightly northwest of St. Matthew Island between 20 July and 19 August. Nasu (1960) reported sightings of a 'right whale' at approximately 68°25'N, 172°W in the Chukchi Sea and a second 'right whale' at 63°40'N, 172°W, 40 n.miles northeast of St Lawrence Island. Nasu provides no details to support in the identification of the species. The report is also apparently based on a misconception of the right whale's range as discussed in Braham (1986, p.70). Given the lack of detail in this report, it is difficult to say what species were sighted by Nasu (1960).
### Table 3

**SCARFF: DISTRIBUTION AND ABUNDANCE OF THE RIGHT WHALE**

**Frequency of right whale sightings and number of searching days by month for the North Pacific from the Heavy (1832 et seq) Whole Chart No. 1, 2. Key: Top no. is the fraction of total sightings by month; bottom line is the total no. of searching days.**

| Month     | 40°-70°N | 30°-35°N | 25°-30°N | 20°-25°N | 15°-20°N | 10°-15°N | 5°-10°N | 0°-5°N | 0°-4.5°N | 0°-4°N | 0°-3°N | 0°-2°N | 3°-3° | 3°-2° | 2°-2° | 1°-1° | 0°-9° | 0°-8° | 0°-7° | 0°-6° | 0°-5° | 0°-4° | 0°-3° | 0°-2° | 0°-1° | 0°-0° |
|-----------|----------|----------|----------|----------|----------|----------|--------|--------|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| January   |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | |
| 40°-70°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 30°-35°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 25°-30°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 20°-25°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 15°-20°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 10°-15°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 5°-10°N   |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-5°N    |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-4.5°N  |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-4°N    |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-3°N    |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-2°N    |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 3°-3°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 3°-2°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 2°-2°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 1°-1°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-9°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-8°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-7°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-6°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-5°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-4°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-3°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-2°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-1°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |
| 0°-0°     |          |          |          |          |          |          |        |        |          |        |        |          |        | | | | | | | | | | | | | | | | | | |

### ERRATA

**51°-55°N**

- The 1st column of the table should be read as 0.00, not 0.47.

**55°-60°N**

- The 2nd column of the table should be read as 0.00, not 0.14.

**56°-60°N**

- The 3rd column of the table should be read as 0.00, not 1.00.

**61°-65°N**

- The 4th column of the table should be read as 0.00, not 0.00.

**65°-70°N**

- The 5th column of the table should be read as 0.50, not 0.00.

**71°-75°N**

- The 6th column of the table should be read as 0.50, not 0.00.

**76°-80°N**

- The 7th column of the table should be read as 0.50, not 0.00.

**81°-85°N**

- The 8th column of the table should be read as 0.50, not 0.00.

**86°-90°N**

- The 9th column of the table should be read as 0.50, not 0.00.

**91°-95°N**

- The 10th column of the table should be read as 0.50, not 0.00.

**96°-100°N**

- The 11th column of the table should be read as 0.50, not 0.00.

**101°-105°N**

- The 12th column of the table should be read as 0.50, not 0.00.

**106°-110°N**

- The 13th column of the table should be read as 0.50, not 0.00.

**111°-115°N**

- The 14th column of the table should be read as 0.50, not 0.00.

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*Note: The table contains data on the distribution and abundance of the right whale in the North Pacific, with sightings recorded from 40°-70°N latitude. The table indicates the fraction of total sightings in each degree band and the number of searching days in each band.*
### Table 3 continued

|------------|------------------|-----------------|------------|------------|----------|-----------|------------|-------------|

### Table 4

|------------|------------------|-----------------|------------|------------|----------|-----------|------------|-------------|
Omura (1958) reported very few recent sightings of right whales in the Bering Sea; all occurred in July and were clustered around 170°W; none were north of 55°N. Omura et al. (1969) reported the location of six right whales taken during July and August of 1962 and 1963 in the Bering Sea. All were between 170° and 173°W and none were further north than 55°N. Most of the sightings are centered on 170°W. In June, the northernmost sightings were around 57°N, although there were records of right whales in the Bering Sea at 180°W.

The distribution of right whales in the Bering Sea differs from that of bowhead not only in its location, but also in its timing. At least in the eastern Bering Sea, right whales do not appear to overwinter but enter the Sea through passes in the Aleutians in early summer. Omura et al. (1969) reported sightings data from Japanese and Russian catcher boats during the 1950s and 1960s. The earliest month right whales were seen in the Bering Sea was June and the latest month was August.

A June arrival in the Bering Sea is consistent with data from other studies as well. Townsend (1935) shows no records of right whales in the Bering Sea prior to June, approximately 9 records in June, 31 in July, 43 in August, 52 in September and 7 in October. Reeves et al. (1985) and Brueggeman et al. (1986) reviewed data on the catch and sightings of right whales at the shore whaling station on Akutan Island (53°N, 166°W) in the Aleutians between 1917 and 1933. Of the 9 right whales caught and 6 sighted, the earliest was 3 June and the latest 3 September (7 records in June, 31 in July, 43 in August, and 1 in September). All but one of these records are from the Pacific side of the Aleutians, the exception being a sighting in the Bering Sea near Akutan Pass. The season at this station typically lasted from mid- to late May to early October.

The data in Maury’s Chart 1 shows an earlier arrival of right whales in the Bering Sea as well. Townsend (1935) shows no records of right whales in the Bering Sea prior to June, approximately 9 records in June, 31 in July, 43 in August, 52 in September and 7 in October. Reeves et al. (1985) and Brueggeman et al. (1986) reviewed data on the catch and sightings of right whales at the shore whaling station on Akutan Island (53°N, 166°W) in the Aleutians between 1917 and 1933. Of the 9 right whales caught and 6 sighted, the earliest was 3 June and the latest 3 September (7 records in June, 31 in July, 43 in August, and 1 in September). All but one of these records are from the Pacific side of the Aleutians, the exception being a sighting in the Bering Sea near Akutan Pass. The season at this station typically lasted from mid- to late May to early October.

The data in Maury’s Chart 1 shows an earlier arrival of right whales in the Bering Sea, suggesting that the pattern revealed by these other studies may be an artifact of the absence of searching effort earlier in the season. Maury’s Chart 1 shows about nine sightings of right whales (based on only 27 searching days) in the southeastern Bering Sea in April. In May, his chart shows that right whales (and/or
bowheads) were found throughout the eastern Bering Sea at high indices of abundance (see Table 3.5).

Recent studies of the bowhead's current range reveal a substantially different seasonal distribution in the Bering Sea. Bowheads are found almost entirely in the western part of the Bering Sea during winter and early spring at the edge of, or inside, the pack ice. By late spring the whales have migrated north through the Bering Strait into the Chukchi Sea (Braham et al., 1980a). Braham et al. (1980b) and Brueggeman (1982) found that bowheads overwintered in the area from St. Lawrence Island (64°N, 171°W) south and west to the pack ice. They noted that bowheads had seldom been seen in the eastern Bering Sea. Their aerial surveys supported the hypothesis that bowheads congregate in late winter near St. Matthew (60°N, 173°W) and St. Lawrence islands waiting for the leads north to open up. Braham et al. (1980a) noted that during years when the pack ice is extensive, bowheads wintering at the edge of the pack ice may be as far south as the Pribilof Islands.

Results of four vessel surveys led Dahlheim et al. (1980) to conclude that by summer few, if any, bowheads remained in the area south of the ice front in the Bering and Chukchi Seas. They reviewed information from aerial surveys and interviews with Inuit whalemen and hunters that support this conclusion.

At the time Maury prepared his whale charts it is probable that the distribution of bowheads in the Bering Sea was more extensive (Dahlheim et al., 1980; Braham, 1984a). Analysis of historic whaling data for bowheads suggests a contraction of the species' range in the Bering Sea northward as the population size decreased due to whaling (Braham, 1984a; see also Webb, 1988, p.317 n.168). Dahlheim et al. (1980) replotted Townsend's (1935) data on bowhead distribution disaggregated by month. These data are consistent with the current distribution of bowheads to the extent that they show the whales in the western and northern parts of the Bering Sea, with almost no bowheads reported in the southeastern portion of the sea. However, the data are different in showing many bowheads along the coast of Kamchatka almost as far south as the Commander Islands (55°N) in May and June, many bowheads in the Gulf of Annadir from May through August and a small number being near the Pribilofs in August and September.

**Sea of Okhotsk**

Maury's data for the Sea of Okhotsk also might reflect sightings of both bowhead and right whales since both species occurred in this sea. Data from quadrants 55-60°N, 140-160°E and 50-55°N, 145-155°E are in the Sea of Okhotsk. Additional quadrants cover both the Sea of Okhotsk and the Pacific side of the Kuril Islands (45-50°N, 145-155°E and 50-55°N, 150-160°E).

As for the Bering Sea, Maury's data for the Sea of Okhotsk can largely be separated into sightings of either bowhead or right whales based on the discrete distributions of the two species. The most detailed and comprehensive review of historic whaling in the Sea of Okhotsk has been conducted by David Henderson of the New Bedford Whaling Museum. Pending publication of his book on this subject, he has graciously allowed me to report some of his conclusions here.

Henderson found that two American whalers entered the Sea of Okhotsk in 1845, but that it was not until 1847 that additional American whalers entered the sea. Between 1845-8, most whalers remained in the southern portion of the Sea and took just right whales. The peak of the right whale catch was probably in 1848 when approximately 500 right whales were taken. The total catch of right whales in the five years from 1847-51 was probably about 1,350 (Henderson, pers. comm.). The first bowhead was taken in 1847, and from 1849 on bowhead catches far exceeded right whale catches as the whales moved further north and west in the Sea.

Henderson found that right whales were sighted generally south and east of a line drawn between Mys Yelizavaty (Cape Elizabeth) at the north end of Sakhalin Island northeast to Ostrov Iony (St. Jona Island) (57°N, 143°E) then due east to the Kamchatka Peninsula.

In contrast, Henderson found that bowheads were taken north and west of this line. In particular, the balaenid whales caught in the intensive whaling that occurred in Academy Bay (Zaliv Akademii), Shantar Bay (Tagurskiy Zaliv) and Big Shantar Island (Ostrov Bol'shoy Shantar) (43-45°N, 135-140°E) in the western Sea of Okhotsk were nearly all bowheads. This conclusion is consistent with Scammon (1874) who describes the Yankee fishery for bowheads in the western Sea of Okhotsk in some detail from first-hand observations made apparently around 1862 (fn. p. 61). By that time the hunt for right whales in the Sea was apparently largely over since it is barely mentioned (p. 68).

Henderson's allopatric distribution of the two species contrasts with earlier Soviet studies (Tomilin, 1957; Klumov, 1962), but is in broad agreement with the findings of more recent studies. Although Tomilin (1957) and Klumov (1962) wrongly assumed that bowhead whales did not summer in the Sea of Okhotsk, and thus believed that all reports of bowhead whales in the Sea of Okhotsk must be of right whales, more recent Soviet surveys have shown that both species still occur in the Sea of Okhotsk during the summer with the same geographic segregation described by Henderson. Berzin and Doroshenko (1981) found bowheads, but not right whales, in August in the western Sea of Okhotsk in the bays south of Ostrov Shantar (55°N, 138°E), where bowheads had been hunted heavily in the 19th century. The occurrence of bowheads, but not right whales, along the western and northwestern coasts of the Sea was reaffirmed recently by Berzin et al. (1986).

Soviet surveys reported by Slepelev (1955), Klumov (1962) and Rovnin (1970) made sightings of right whales, but not bowheads, along the west side of southern Kamchatka, in Zaliv Terpeniya in southeastern Sakhalin Island, and on both sides of the Kuril Islands (45-55°N, 140-144°E).

One area where the allopatry of the two species has not been established clearly is in Zaliv Shelikova (60°N, 155-160°E) in the extreme northeast of the Sea of Okhotsk. Berzin and Doroshenko (1981) cite Slepeslev (1955) for observations of black right whales 'in the northeastern Okhotsk Sea,' and cite Rovnin (1970) who 'found large groups of black right whales in the vicinity of Zaliv Shelikova' during the cruise of the R/V Vityaz in 1967. Berzin et al. (1986) found neither species in this area.

Another location of particular note is the area NNE of Mys Yelizavaty at the northeast of Sakhalin Island. This area includes Ostrov Iony and Banka Kashevarova. Berzin and Doroshenko (1981) report that up to 100 whaling ships operated off Ostrov Iony during the middle of the 19th century. Tomilin (1957) states that right whales occurred mainly 100 miles north of Ostrov Iony. He provides no details, and his comments must be interpreted in the
context of his incorrect belief that bowheads were absent from the sea in summer. Berzin and Doroshenko (1981) cite Kuzmin and Berzin (1975) for the sighting of 40–45 right whales northeast of Khashevarov Bank during the 1974 cruise of the RV Tamango. A helicopter survey in early April 1982 that included Banka Khashevarova did not result in any sightings of either species (Berzin et al., 1986).

The above segregated distribution disagrees slightly with that reported in Townsend’s (1935) separate maps for bowheads (Chart D) and right whales (Chart C) in the Sea of Okhotsk. Chart D shows bowheads were found in the Sea of Okhotsk between May and September in the northcentral and northwestern portions of the Sea and in Zaliv Shelikova in the extreme northeastern part of the Sea. Most of the records are north of 55°N and west of 150°E. There are no records south of about 53°N, close to the west shore of Kamchatka, or along the Kuril Islands. Dahlheim et al. (1980) show Townsend’s (1935) data on bowhead distribution in the Sea of Okhotsk disaggregated by month.

In contrast, Townsend (1935) shows right whales in the southern Sea of Okhotsk south of 50°N, along the southwest and southeast coast of Kamchatka and on both sides of the Kuril Islands. The only areas of overlap of the two species are some records from June and July in the northcentral Sea of Okhotsk (145–155°E) and along the east shore of Zaliv Shelikova. Having reviewed Townsend’s records, Henderson concludes that some of Townsend’s records of right whales in the western Sea and north of 57°N in Zaliv Shelikova were misidentified bowheads.

Maury’s data in Chart 2 reflect the early focus on the southern Sea of Okhotsk. He shows no searching effort north of 60°N in Zaliv Shelikova, no searching effort west of 140°E and only four days west of 145°E north of 50°N in what were to become a major bowhead whaling grounds at Academy Bay, Shantar Bay and Shantar Island.

Given the predominance of bowhead whales and the relative scarcity of right whales in the quadrant 55–60°N and 145–150°E in other reports, I have considered the 19 records in Maury’s Chart 2 in this quadrant to be of bowhead whales, shown them in parentheses in Tables 3.7 and 3.8, and excluded them from Table 2. The records in the Maury Chart from 55–60°N, 155–160°E could be right whales from the northern edge of their range along Kamchatka, bowheads or a combination of both.

**DISCUSSION**

**Abundance of right whales**

The most striking feature of the Maury Charts is the widespread abundance of right whales during the period 1835–1850. For example, Table 3.7 (July) shows 14 quadrants where right whales were seen on 50% or more of the searching days. In August, right whales were seen on approximately 110 out of 120 searching days between 50–55°N, 155–160°E (the southern part of Kamchatka including both the Pacific and Sea of Okhotsk) and on 29 out of 32 days in the western Sea of Japan. In the Gulf of Alaska, right whales were seen on 40–60% of the searching days in most sectors. In many of these sectors the samples of searching days (200–500 days/sector) are so large that the apparent abundance is a reliable conclusion. The former abundance is even more impressive when one considers that the sighting frequency from the early logbooks was diluted in the later years (1846–51) by the depleted state of the right whale stocks.

Perspective on the historic abundance of right whales shown in the Maury’s North Pacific Charts can be obtained by comparing these indices with those of right whales in other oceans or those of North Pacific sperm whales, both also derived from Maury’s (1852 et seq.) Series F Whale Charts. The indices of right whale abundance in the North Pacific reflected in Tables 3.1–3.12 are comparable to, although higher than, indices of right whales (0.0–0.50) for the area 10–50°S, 0–50°E off South Africa (Best, 1981, Fig. 5). The North Pacific right whale indices are considerably higher than the aggregated reported abundance of sperm whales in the North Pacific (0.0–0.31) (Bannister and Mitchell, 1980, Figs 5–6). Using these other relative abundances as a guide, combined with refined estimates of the historic catch discussed below, it may be possible to develop better estimates of the historic population sizes of right whales in the North Pacific and adjacent seas.

Published estimates of historic population levels of right whales in the North Pacific and adjacent seas show a wide range, are not rigorous and are hard to justify. Unless noted below, the following estimates appear to refer to populations around 1830 (before Yankee pelagic whaling, but after years of aboriginal and traditional coastal whaling) and to the combined populations of the North Pacific and adjacent seas, including particularly the Sea of Okhotsk. Berzin and Vladimirov (1981) estimated the ‘pre-exploitation’ number of right whales in the region as about 10,000. Braham and Rice (1984) estimate that the combined initial North Atlantic and North Pacific populations were between 30,000–100,000. Neuhauser et al. (1990) state that the initial North Pacific population level was probably at least 10,000. The 1983 IWC Workshop made no estimate of initial populations of any stock of right whales due to the incomplete nature of the catch data (IWC, 1986).

Recently, Kraus et al. (1988:685) commented that ‘there is no evidence to indicate that the eastern North Pacific population was ever abundant.’ Given the high indices of abundance shown in the Maury Charts for the Gulf of Alaska and eastern Aleutian Islands, this statement should be qualified to refer only to right whales south of 50°N along the coast of North America (Scarff, 1986a).

The high levels of abundance shown in the Maury Charts are consistent with contemporary anecdotal observations. Scammon (1874, p.68) reported right whales occurring on the Northwest Coast ‘in pairs, or triplets, and scattered over the surface of the water as far as the eye can discern from the mast-head.’ One merchant noted in his ledger that the American whaleship Ganges in 1835–36 saw ‘millions of right whales’ on the Northwest Ground (Webb, 1988, p.43). The whaleship Superior struck 58 right whales between 11 May and 19 August 1841 and saw whales almost every day while cruising in the area 51–54°N, 148–154°W (Webb, 1988).

The contrast is astounding between this historic abundance and the paucity of recent sightings. For example, Japanese scouting boats operating over the entire North Pacific between 1965–79 encountered only 1 right whale per 14,000 miles of searching effort (Scarff, 1986a). Braham (1986) concludes that between 1958–82 there were only about 149–163 sightings of right whales in the entire North Pacific and Sea of Okhotsk reported in the literature. Of these, 42 were from Japan-northwest Pacific waters, 54–59 from the Sea of Okhotsk, 32–36 from the central North Pacific-Bering Sea, and 21–26 from the west cost of North America south of Kodiak, Alaska.

Several scientists have made guesses regarding the

Wada (1980; 1981) stated that the Japanese sighting data for right whales in the North Pacific were too few to allow estimation of population size or trends. Brahman (1986, p.65) also concluded that 'The size of the North Pacific population(s) is unknown and no statistically reliable estimate is possible given the limited sighting information.' He went on to comment that the sighting records suggest a population of only a few hundred whales.

Estimates of numbers of right whales in local areas have also been made. Brueggeman et al. (1984) estimated 57 right whales ±118 in the Navarin Basin of the Bering Sea, but this estimate was extrapolated from sightings of only 2 individuals. Ivashin (1988) estimated that there are about 150–200 right whales in the Sea of Okhotsk, citing Berzin (1985) and providing no other details.

The 1983 IWC Workshop made no estimate of current population levels in any area of the North Pacific. Instead, they simply listed the maximum number of individual whales seen in one day as eight (IWC, 1986, p.9). This is a reference to 1–2 sightings reported in Ficus and Niggol (1965) and reviewed in Brahman (Brahman, 1986) and Scarff (1986a). There are other reports of larger numbers of right whales, but no supporting information has been provided. For example, Berzin and Doroshenko (1982:383) report that in 1963 Soviet research vessels 'observed about 200 right whales at 51°N, 145°W'. This may be a reference to 200 sightings and resightings of an unknown number of right whales, rather than a sighting of 200 right whales. Berzin and Doroshenko (1982) provide no details.

Estimates of the historic catch

Best (1986) initially estimated the total catch of right whales in the North Pacific by only the American whaling fleet between 1840 and 1909 as 15,244 based on his review of the total US import figures for whale oil and baleen and the proportion of species and yield/whale in Townsend's (1935) data. He subsequently refined this estimate to 14,480–15,374 (Best, 1987).

Of this catch, a significant portion was taken in the Sea of Okhotsk/Kuril Island area. The published descriptions are often vague as to the geographic area included, and may often include right whales taken on the Pacific side of the Kuril Islands and off the east coast of Kamchatka. The IWC Workshop estimated that 2,027 right whales were taken and processed in the Sea of Okhotsk between 1845–1899 (IWC, 1986:Appendix 7). This number is being revised upwards: to 2,400 (Henderson pers. comm. cited in Kugler, 1984), and perhaps higher yet (Henderson, pers. comm.).

The numbers shown in Best (1987) and IWC (1986:Appendix 7) are based on landings of whale oil in the United States. These figures underestimate the mortality in the right whale population(s) by failing to include (1) struck-but-lost whales which died and were not recovered later, (2) whales whose oil never reached the US market because the oil went directly to non-US markets or the ship sank prior to making port.

The former abundance of right whales in the North Pacific and adjacent seas reflected in Tables 3.1–3.12 and the species' current scarcity suggests that the kill of right whales by Yankee whalers may have been larger than previously thought. Key factors which may have been underestimated are the percentage of whales struck-but-lost, and the percentage of those that died and were not later recovered in this open sea whaling. Some data on struck-but-lost whales in the 19th century pelagic right whale fishery reported in Webb (1988) and Reeves and Mitchell (1986a; b) suggest that both these percentages were underestimated. This question is being investigated in a separate study.

Summer distribution (June through September)

Over 80% of the right whale sightings and nearly 65% of the searching days in the Maury Charts 1 and 2 are from the months of June–September (see Table 1). As shown in Tables 3.6–3.9, the effort in summer for right whales was concentrated in the Gulf of Alaska (Northwest or Kodiak Ground), off both coasts of Kamchatka and around the Kuril Islands.

For June, Maury's (1852 et seq.) Charts show right whales distributed over a larger area than shown in Townsend's (1935) or Omura et al.'s (1969) charts. The differences are most easily pointed out by first describing the distribution shown in the latter charts.

Townsend's (1935) Chart C shows about 25 records of right whales in June in the central Sea of Japan around 45°N. It also shows about 20 records in the northeastern portion of the Sea of Okhotsk (57°N, 150°E), about the same number off the Pacific coast of Kuril Islands and southern Kamchatka, some far off-shore, north to about 55°N. Townsend shows right whales in the entire Gulf of Alaska from the Queen Charlotte Islands west and north. His chart shows only about 7 records from the southern Bering Sea (plus 2 west of St. Lawrence Island that may be bowheads).

The largest quantity of recent North Pacific right whale sightings are those described in Omura (1958), Klumov (1962) and Omura et al. (1969). These have been combined and plotted by month in Omura et al.'s (1969) figs 13.1–13.7. Their fig. 13.4 shows right whales as being found in June just east of the southern Kuril Islands, along the southern edge of the Aleutian Islands, in the south central Bering Sea and in the western part of the Gulf of Alaska. With the exception of the whales west of 160°E, nearly all these sightings are north of 50°N.

As seen in Table 3.6, Maury's Charts show right whales in June in all the same regions as Townsend (1935) and Omura et al. (Omura et al., 1969). However, Table 3.6 also shows high indices of abundance for right whales in the northeastern Sea of Japan, east of the Kuril Islands and in the central and western Gulf of Alaska. Right whales were seen between 40–45°N at fairly high frequencies all the way from the coast of Japan east to 145°W where the sightings...
stop. Between 45°–50°N the same pattern persists with even higher frequencies of sightings all across the Pacific east to 140°W where the sightings stop.

In July, Omura et al.'s (1969) fig. 13.5 shows right whales in the southern Sea of Okhotsk south of 50°N just north and west of the Kuril Islands, along the southern edge of the Aleutian Islands mainly east of 180°W, in the southeastern Bering Sea and in the Gulf of Alaska east to about 55°N, 150°W (south of Kodiak Island). Townsend (1935) shows right whales persisting in the Sea of Japan, as well as being in the places reported in June. In the eastern North Pacific, Townsend shows whales throughout the Gulf of Alaska from the Queen Charlotte Islands to Unimak Pass and slightly west of there. In addition he shows a few whales (discussed above) between St. Lawrence Island and the Bering Straits and about 21 records from the southeastern Bering Sea and Bristol Bay.

Maury (1852 et seq.) continues to show a high frequency in the sighting of right whales in the Sea of Japan in July between 40–45°N (Table 3.7). He shows much whaling effort in the southern Sea of Okhotsk and the east coast of Kamchatka, and almost no whaling effort in the area east of the Kuril Islands that had been so productive the previous month. The right whales appear to have moved north of 50°N and west of 155°E in the Sea of Okhotsk.

In the eastern North Pacific, Maury's Chart 1 continues to show right whales as common throughout the Gulf of Alaska. There is an apparent increase in concentration of whales between 50–55°N, 165–175°N, near Unimak Pass, although there were only 25 days of searching effort in the area.

Omura et al. (1969) show no change in August and September in the species' distribution in the Sea of Okhotsk and around the Kuril Islands, but there are fewer records from the Gulf of Alaska and the Bering Sea. Townsend's chart shows a similar distribution in the Sea of Okhotsk and Bering Sea, but with more records off the east coast of Kamchatka, and in the Gulf of Alaska.

In August, the most striking feature of Maury's map is the extremely high frequency of sightings (0.92 with approximately 120 searching days) in the sector 50–55°N, 155–160°E which includes both the eastern and western shores of southern Kamchatka and the northern Kuril Islands (Table 3.8).

In September, as Table 3.9 shows, whaling effort decreased slightly in this sector (to about 110 days) and the frequency of sightings declined to 0.48. Worsening weather may have contributed to this. Sightings of right whales increased in the southern Kuril Islands and southern Sea of Okhotsk. Townsend shows many whales taken in the same areas, although he shows more whales caught in the southern Sea of Okhotsk in August and more off the coasts of Kamchatka in September, a reversal of the pattern in the Maury Chart.

The Maury Charts reveal relatively high indices of abundance between 50–60°N across the North Pacific, even in mid-ocean, as shown in Tables 3.6–3.9. This suggests that the absence of catches in the mid-Pacific in Townsend's data is at least in part a function of reduced whaling effort in the region, not the absence of whales.

If the right whales were present in the mid-Pacific, particularly along the Aleutian chain, in comparable densities to the more well-known whaling grounds, why was there not more whaling effort in the mid-Pacific? The answer is not clear. The Aleutians were a poorly explored region in the early 1840s. In addition, they have terrible weather, although how much worse than in the Gulf of Alaska or along the coast of Kamchatka is not clear. Finally, they were far from shelter and an established port.

Webb (pers. comm.) notes the bias in searching effort for right whales. He reports that the whalermen talked to each other, tended to sail to those coordinates where whales had previously been taken and tended to stay together. Given the remoteness of the whaling grounds and the dangers created by the severe weather, this clustering and conservativeness is understandable. Webb (1988) found that it was not until late in the 1840s, after the whaling grounds off Kamchatka became depleted, that the whalers started passing by the Aleutians on their way from the Kamchatka grounds to the Northwest grounds, making the relatively high abundances of right whales seen in this region all the more remarkable.

There is also a strange pattern of high indices of abundance from June through August in the sectors 35–45°N, 175–180°W and 40–45°N, 165–170°E. I have no suggestions as to the cause of these apparent concentrations. Neither Townsend (1935) nor Omura et al. (1969) appear to show any sightings in either of these sectors.

Recent observations of right whales also show their presence in the mid-Pacific. The locations described by Omura et al. (1969) are derived from observations by catcher boats during the period 1941–1968 when most whaling was occurring in the Bering Sea, just south of the Aleutians, and in the Gulf of Alaska. Thus, these data reflect a geographic bias in searching effort comparable to that found in Townsend's (1935) map. However, more recent sightings, from a time when scouting and catcher boats were operating in more southern latitudes, show right whales being found there also as shown in Tables 4 and 5.

Finally, there is at least one intriguing suggestion that right whale populations may have been geographically segregated by age or size. Bowles (1845) wrote:

'Within the deep bight formed by the peninsula of Alaska and near the Island of Kodiak, I have also seen large numbers of whales, but they were of a much smaller size than those we had found more to the Southward'.

Although Bowles does not describe what species of whale these smaller animals were, from the context of the article the strong inference is that they were right whales, rather than other whales found in these coastal waters such as humpbacks.

Distribution of right whales in summer in the Sea of Okhotsk was discussed previously in the section on distinguishing right whales from bowheads.

Winter distribution

Several areas have been suggested as possible wintering grounds for right whales in the western North Pacific and these are reviewed area by area. The mystery of the right whales' wintering grounds (if any) in the eastern North Pacific was reviewed in detail in Scarff (1986a), and will be addressed here only to the extent there is new information.

Both the Maury and Townsend Charts contain few winter records of right whales. Maury's (1851) Preliminary Sketch shows no records in winter. Maury's (1852 et seq.) Charts 1 and 2 record only 26 days on which right whales were seen in the entire North Pacific from November through February, although there were over 3,100 days of searching effort during this period (Tables 3.1–3.2, 3.11–3.12). During this season the whales moved south to the
Table 4

Right whale distribution from Japanese whaling data, 1955-1979. Key: Top number represents total number of individual right whales sighted by 10° longitude; lower number in parentheses represent the total number of years in which right whales were seen (5-20 years). Sectors were divided by 10° longitude as shown in Whal. (1981, Fig. 4b).

<table>
<thead>
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Note: Prior to 1976 sightings data reported by 10° longitude; from 1976 on by 5° of longitude. The post-1976 sighting data has been aggregated with the earlier data.

sperm whale grounds which appear to be south of the right whale’s wintering grounds (Bannister and Mitchell, 1980; Webb, 1988).

Western North Pacific and adjacent seas
In the western North Pacific and adjacent seas, Maury (1852 et seq.) shows no records of right whales in December (Table 3.12) or January (Table 3.1), only 6 records in February (Table 3.2) and almost no searching effort in any of these months. Townsend (1935) shows no records from October through January, 7 in February, and 26 in March.

The early American whalers reported in Maury’s sample did not venture often or far into the East China or Yellow Seas. Maury’s (1851) Preliminary Sketch shows no records of either right or sperm whales west of 130°E. Maury’s more detailed Chart 2 shows some effort, but few whales west of 125°E. The sectors west of 125°E on Maury’s (1852 et seq.) Chart 2 are not shown in Tables 3.1-3.12. These sectors include the southwest end of the Ryukyu chain as well as northern shore of Taiwan and the northern entrance to the Formosa Strait (25-30°N), the western East China Sea (25-35°N) and most of the Yellow Sea (35-45°N). Chart 2 shows no searching days in any month for the area 30-45°N, 120-125°E, and only four searching days and no right whale sightings in sector 25-30°N, 120-125°E.

Recent data are equally sparse. Omura (1958) records no sightings or catches between October and January, only 3 catches in February, and 1 in March. In discussing distribution of right whales between October and March, Omura et al. (1969) describe no additional recent sightings and rely entirely on Townsend’s (1935) historical data. Klumov (1962:Fig.9) shows two sightings in October just west of Paramushir Island at the NE end of the Kuril Islands (51°N, 154°W). (These same sightings are mislabeled as occurring during August in Klumov (1962:Fig.10); see Fig. 7).

One area mentioned as possible right whale wintering grounds is the Ryukyu Islands. These extend from the south coast of Kyushu, Japan at about 31°N, 131°E SSW to about 25°N, 125°E, forming the eastern boundary of the East China Sea. Based on historic coastal whaling records, Omura (1986) concluded that in late fall right whales migrating along the east and west coasts of Japan continued south to whaling grounds south of Kyushu, probably near the Ryukyu Islands.

Maury’s Chart 2 shows very little whaling effort in this region. However, in sector 30-35°N, 125-130°E, an area that encompasses the northern end of the Ryukyu chain as well as the west coast of Kyushu and the south coast of Korea, Chart 2 shows high indices of abundance in February (0.54), March (0.38), and April (0.80) (Tables 3.2-3.4).
Another area that has been mentioned as possible wintering grounds are the Bonin Islands. This group of small islands is approximately 1,300km SSE of Tokyo between 25–30°N, 140–145°E. Omura (1958) reported three right whales captured in February (between 1925–34) near the Bonin Islands. Webb (1988, p.54) states without elaboration that 'whalemen [in the 1840s] had seen right whales from the Bonin Islands northward along the Russian Kamchatka peninsula.' Townsend (1935) shows one record of a right whale in February just east of the Bonin Islands.

Right whales are not reported from this area in Maury's (1851) Preliminary Sketch, although sperm whales are marked as being abundant in summer. Maury's (1851 et seq.) Chart 2 shows a considerable amount of whaling effort in this area (25–30°N, 140–145°E) particularly in late winter and spring; (16 days in January, 34 in February, 38 in March, 26 in April). Despite this effort, the Chart shows no records of right whales. The vast majority of the whaling effort occurred in this area in May-July for sperm whales (Maury, 1852, et seq.).

Townsend (1935) shows four records of right whales in the Formosa Strait in February, and 2–3 in March. Based on Townsend's records, Omura (1958) concluded that the right whales' wintering grounds were probably about or a little north of 20°N in the western North Pacific. Maury's Chart 2 shows only four searching days in this area in February with no right whale sightings.

Maury's Chart 2 shows right whales being seen in the east China Sea west of Kyushu, Japan (30–35°N, 125–130°E) on approximately 6 days out of 11 searching days in February and on approximately 3 days out of 8 searching days in March. Townsend (1935) shows two records of right whales in the northern East China Sea (apparently west of Maury's records) in February, and 17 records in the western side of the East China Sea between 30–31°N in March.

Maury's Chart 2 shows right whales seen on 11 out of 22 searching days in March in a quadrant (35–40°N, 125–130°E) which straddles both the Sea of Japan and Yellow Sea coasts of Korea. Townsend (1935) shows no records in the Yellow Sea.

More recently, Tomilin (1957) states that right whales winter in the Yellow Sea, but provides no details. Wang (1978) reports that two right whales, a 18m female and a 13.8m male, were caught near Hai Yang Island (39°N, 123°E). These may be the same two right whales that Wang (1984) reports were caught by Japanese whalers in 1944 in the Yellow Sea. Wang (1984) also reports that in January 1973, two right whales were sighted in the Hai Yang Dao, and a single right whale was seen in the southeastern waters of the Hai Yang Dao in December 1977.

Maury's Chart 2 shows no searching effort in the Sea of Japan from October through February. However, it does show five records of right whales during eight days searching in March along the north coast of Honshu, Japan. Townsend (1935) shows one right whale record in the southern Sea of Japan in February, and 4–5 in the south central Sea of Japan in March.

**Eastern North Pacific**

In contrast to the records in the western North Pacific, the lack of winter records of right whales in the eastern North Pacific is particularly striking. The very few records in the Maury Chart 1 are from far offshore locations. Townsend (1935) shows only one record of a right whale taken in winter (December) east of 180°W at about 43°N, 145°W.

Townsend's chart shows no records in this area during the months of November, January, February and March. Although searching effort in the eastern North Pacific was particularly light in winter as Tables 3.11–3.2 show, there was enough searching that the extreme scarcity of records appears inconsistent with the widely suggested theory that the west coast of North America was a significant wintering ground.

Braham and Rice (1984) and Scarff (1986a) both questioned the idea that many right whales historically wintered off the west coast of North America. Articles which hypothesized that this was an important wintering ground were critically reviewed in Scarff (1986a), who found few records to support them. Despite this, the hypothesis that the west coast of North America was an important wintering ground has recently been repeated uncritically by Hay (1985) and Gaskin (1987).

In searching for historic wintering grounds on the west coast, Scarff (1986a) reviewed archaeological and anthropological evidence of aboriginal whaling, 19th and 20th century coastal and pelagic whaling, all published records of right whales south of 50°N in the eastern North Pacific, and historic and recent searching effort in the eastern North Pacific. Based on the extent of the historic record prior to depletion of the right whale population, he concluded that the very few winter records of right whales was a valid indication that right whales had not wintered in significant numbers in the near-shore waters of the west coast of North America prior to 1880. A recent, more comprehensive review of aboriginal whaling in the eastern and central North Pacific (Mitchell and Reeves, 1990) revealed extremely few records of right whales along the coast of North America south of the Queen Charlotte Islands.

There have been three sightings of right whales along the west coast of North America not reported in Scarff (1986a). Reeves and Leatherwood (1985) report an unconfirmed, but apparently reliable sighting, by Professor R.T. Paine of 1–2 right whales (40–50ft, 12.1–15.2m) on 28 August 1983 off the coast of southwest British Columbia at the mouth of Juan de Fuca Strait (48°N, 125°W). A single right whale was seen by many observers (but not photographed) off the dock of the Scripps Oceanographic Institute in La Jolla, California (33°N, 117°W) on 5 February 1988 (W. Perrin, pers. comm.). Another single right whale estimated to be 16.7–17.6m long was seen, photographed, and videotaped on 9 May 1990 eight miles north of Santa Catalina Island (33°N, 118°W) in southern California (Rae-Dupree and Kriksinan, 1990).

Reeves and Leatherwood (1985) also describe one previously unreported historic record of two right whales seen by the whalship William L[afrenze] in 1856 near Guadalupe Island off the coast of Baja California (28°30′N, 117°W). This corroborates Scammon's (1874:66–7) statement that 'some' right whales 'have been taken (from February to April) as far south as the Bay of San Sebastian Viscaino, and about Cedros or Cortes Island, both places being near the parallel of 29° north latitude.'

It is also consistent with Rice and Fiscus's (1968) record of two right whales at 26°39′N, 113°40′W.

These additional records do not cause me to change my opinion that the near-shore waters of the west coast of North America were not a major wintering grounds for right whales. Although Scammon states that right whales were taken in Baja, he qualifies this observation by stating that the right whales seen off California 'are supposed to have
been merely stragglers,' and states that 'nothing is definitely known of their winter resort' (1874, pp.66–7).

Bowles (1845) also noted that attempts at bay whaling in winter had been made even at that early date, but that no right whales had been seen.

Preliminary research by R. Webb (pers. comm.) and D. Henderson (pers. comm.) into the few surviving logbooks of the first pelagic whalers along the west coast of Baja and California between 1793–1847 have not revealed any concentrations of right whales along the coasts of California or Baja California. In addition to these whalers, there was considerable settlement along these coasts, plus traffic of commercial sealers and sea otter hunters. Had there been concentrations of right whales in bays similar to that in Argentina, South Africa and Australia, it seems likely that they would have been reported.

**Spring and fall distributions and migratory patterns**

**North Pacific**

The Maury Charts' records for spring and fall offer intriguing clues to the right whale's winter grounds. In October, Maury shows a cluster of about 29 right whale sightings between 35–45°N, 170–180°W, truly in the middle of the Pacific. There are almost no records again until March, when Maury shows sightings of approximately 22 right whales between 30–40°N, 160°E-165°W. The total number of sightings in mid-ocean were fairly small, but so was the amount of whaling effort. The small number of sightings does increase the probability that these are simply errors in the transcription of the locations or in the identification of the species – 35°N was the approximate northern edge of sperm whaling in these regions. During March, Townsend (1935) shows two records of right whales in mid-ocean at approximately 170°W, 31°N.

The extent to which right whales in the eastern North Pacific engage in north-south migrations is not known. It has generally been assumed that right whales migrate long distances south from their summering grounds in the Gulf of Alaska and near the Aleutian Islands.

Omura (1958), Omura et al. (1969) and Berzin and Doroshenko (1982) amongst others have described apparent right whale migrations in the North Pacific from seasonal differences in sighting data. However, given the very small number of sightings of right whales in recent years, it is difficult to determine the extent to which seasonal differences in searching effort bias the sighting data. Kraus et al. (1986) have been able to document the migration of individually identified right whales in the western North Atlantic. This work suggests that at least some of the right whales in this region, including some mothers and calves, migrate up to 1,800 miles twice each year between summer feeding grounds in more northern waters and calving grounds in more southern waters. However, the low numbers of whales seen off Florida and Georgia and winter records of right whales from more northern waters (Reeves and Mitchell, 1986b; Schevill et al., 1986) suggest that the migratory pattern may be very dispersed.

Omura et al. (1969) describe and map the patterns of sightings of right whales in the North Pacific by Japanese and Russian whale catchers between April and September. In April, whales were reported being seen almost entirely between 40–45°N east of Hokkaido (145–155°E). For the same month, in the western part of their range, Townsend (1935) shows about 20 right whales caught in the southern Sea of Japan and about caught east of Hokkaido. He also shows two records from the mid-Pacific (30°N, 170°E), another in mid-ocean far south of Kodiak Island (45°N, 152°W), and one record southwest of the Queen Charlotte Islands (42°N, 135°W).

In striking contrast, Maury's Charts 1 and 2 show a distribution of right whales in April that extends much further north and includes surprisingly high indices of abundance from broad mid-ocean regions (Table 3.4). There are records of nine days with right whales in the southeastern Bering Sea, and 35 days with right whales north of 55°N in the Gulf of Alaska. A high index of abundance (0.71) was also reported from the Kamchatka peninsula north of 50°N, far north of Omura et al.'s (1969) records for this month, although this is based on only five days with right whales. Maury also shows right whales as being in the Sea of Japan, but he does not report much searching effort in the region in April.

In May, Omura et al. (1969) show the right whales as having moved slightly further north with a concentration of sightings east of Hokkaido and south of the Kuril Islands. The furthest sightings east of Japan are at about 45°N, 165°E. They also show three sightings east of Kodiak Island in the Gulf of Alaska.

Townsend (1935) continues to show a large number of catches in the Sea of Japan in May. He also shows catches south and east of the Kuril Islands and Kamchatka, north all the way to 60°N. In the eastern North Pacific, he shows large numbers of right whales being caught throughout the Gulf of Alaska and south of the eastern Aleutian Islands. It is worth noting that he shows seven records at about 40°N between 150–160°W in mid-ocean.

The data from the Maury Charts for May (Table 3.5) show right whales being common at even higher latitudes than the Townsend Chart. Table 3.5 shows right whales at high indices of abundance on their summer feeding grounds in the eastern Bering Sea and northern Gulf of Alaska in May. Yet during the same month right whales appear to have been common further south in the Pacific east of the Kuril Islands and even as far south as Hokkaido. The broad north-south distribution of right whales during spring raises the possibility that different segments of population may have migrated at different times, or that some of the right whales may have wintered further north than previously thought.

Although whaling effort was much less in the mid-Pacific, the indices of abundance in Table 3.5 are higher than the traditional notion of a bicoastal distribution would suggest. The absence of sightings from the west coast of North America is also noteworthy, although searching effort was very low.

There is even less information regarding the fall migration of right whales southwards. Traditional Japanese coastal whaling for right whales apparently occurred during the fall and spring migrations. Omura (1986) has reviewed the historic whaling records and reports that the whaling season in the Kochi prefecture extended from the end of September until December during the southern migration and from February to April during the northern migration. The catch included humpback and gray whales as well as right whales, so it is not clear what part of the whaling seasons reflected the peak of the right whale migration.

**Sea of Japan and Sea of Okhotsk**

Omura (1986) does not describe the whaling season along the west coast of Japan, but presumably it was similar to the season along the east coast.
Maury (1855, pp. 270–6) reprints a letter from American whaling captain Crocker of the Minerva Smith. Crocker describes hunting for right whales during the seasons 1846 and 1847. After having wintered in the western North Pacific, Crocker headed north in the spring of 1847 through the Yellow Sea and the straits of Korea with no sightings of right whales until his ship arrived in the Sea of Japan in April. Crocker was confident that he was the first whaler to enter the Sea of Japan in search of right whales. He first encountered right whales ‘about sixty miles’ northeast of the straits of Korea, although they were not ‘regular’. He continued sailing to an undisclosed latitude near the coast of Japan where he found the right whales at home, and I commenced taking them rapidly.’ He continued hunting right whales in that area until 10 June, when he sailed to the coast of China where he remained until 15 July ‘when it became evident that the whales were all moving quickly towards the northeast.’

Crocker followed the right whales through the La Perouse strait between Hokkaido and Sakhalin Island into the Sea of Okhotsk. Crocker tells of seeing ‘many whales’ in the straits all heading east. Less than a full day’s sail east of the straits, Crocker reported finding a ‘fleet’ of whalers ‘most of whom were boiling.’ He describes ‘plenty of whales in sight, all of which were at home.’ He also reports from the other whalers that the ‘bulk’ of the whales had been set on about a week prior to his arrival. During August, Crocker filled up his ship and left the sea.

**Calving grounds**

Since there is almost no evidence of calving grounds in the North Pacific, it is useful to review briefly the seasonal and geographic pattern of right whale calving reported for other areas. In the western North Atlantic, calving has been estimated to occur over a broad period ranging from September through April, with most of the calves being born between December and March. This conclusion is supported by observations off the coast of Florida and Georgia of newborn calves (Kraus et al., 1986; 1988), strandings of calves from the same area (Mead, 1986), sightings of newborn calves near Cape Cod (Schevill et al., 1986) and extrapolation from calves of known size in Bay of Fundy (Kraus et al., 1982). Calves observed by Kraus et al. (1986) off Florida and Georgia in January and February ranged from 4.7 to 5.8 m, while four of the five stranded calves between December and February reported by Mead (1986) ranged from 4 to 4.6 m. In addition to the long calving period, the latitudinal range of calving grounds, from Florida (28°N) to Cape Cod (42°N) is also striking.

Data on the timing and length of the calving season and the length of calves at birth in the North Pacific are almost nonexistent. Klumov’s (1962) conclusion that right whales calve in November–December is widely cited as authority, but is based on minimal data and unlikely assumptions regarding fetal and calf growth rates. There are published records of only six fetuses and no records of calves less than 9 m (Klumov, 1962; Omura et al., 1969; Reeves et al., 1985; Brueggeman et al., 1986).

Neither Maury nor Townsend distinguish calves from adults in their charts, and the Japanese historical records apparently do not contain this level of detail either since calves are not mentioned by Omura (1986).

Scammon (1869, p. 39) wrote:

> The southern Right Whales resort to the bays in that region to bring forth their young, and formerly were sought for in those inland waters, where many a ship has quickly completed her cargo by bay-whaling in high southern latitudes. But no bay has yet been discovered north of the equator in the Pacific where the North-West Right Whales go to calve.

Not much more has been learned in the past century about the calving grounds of right whales in the North Pacific.

All known right whale calving grounds in other oceans have been close to shore. This is true for Argentina (Whitehead and Payne, 1981; Payne, 1986), South Africa (Best, 1981), Australia (Bannister, 1986) and the western North Atlantic (Kraus et al., 1986; Schevill et al., 1986; Winn et al., 1986). However, right whales may also have off-shore calving grounds, even in these oceans. Kraus et al. (1986) note that the calves seen off Florida and Georgia are only a subset of the calves seen later the same year on the summer feeding grounds. Payne (1986) notes that the females seen in Peninsula Valdes with calves are usually absent from the area in the two years preceding birth, suggesting that they may also give birth elsewhere during the other years.

In the North Pacific, no near-shore calving grounds have ever been described. Scarff (1986a) reported no records of sightings, catches, or strandings of newborn or very young calves in the eastern North Pacific in the 150 years since pelagic and coastal whales came to this area or in the aboriginal and archaeological record. This absence of records is striking in the context of the numerous stranding records from Argentina (IWC, 1986, Appendix 9; Payne, 1990) and the western North Atlantic (Mead, 1986), particularly in recent years (five newborn calves during the last 10 years in Argentina [Neuhausser et al., 1990]).

Scarff (1986a) concluded that the lack of sighting or stranding records of calves in the eastern North Pacific reflected a true absence of coastal calving grounds along the west coast of North America at least within historic times. He speculated that the right whales that had historically summered in the Gulf of Alaska may have calved in the western North Pacific along the coast of Kamchatka or further south perhaps far offshore along the Emperor Seamount.

The report of the 1983 IWC Workshop stated:

> Although no evidence of coastal calving grounds could be identified, workshop participants were reluctant to speculate that right whales calve in pelagic rather than coastal waters of the North Pacific. Such behavior would be contrary to what appears to be true in all other oceans, although it cannot be certain that all calving in the Southern Hemisphere and North Atlantic takes place near shore. The possibility that inshore waters of the Pacific Northwest [of North America] may have served as calving grounds cannot be dismissed. (IWC, 1986, p. 3 and Appendix 11).

The Workshop reviewed the preliminary analyses of the Maury charts contained in Scarff (1986a) and Maury’s (1851) Preliminary Sketch. Both suggested that the population was not significantly more dense close to shore, and indicate no nearshore migration along the west coast of North America. Indeed, the data suggest that at least some of the right whales may have migrated south far offshore near the meridian.

The Workshop urged more detailed examination of the pelagic whaling record. The mid-ocean records of right whales in winter in Maury Map No. 1 (1852 et seq.) and the late fall records in Townsend (1935) suggest that right whales may have wintered and calved far offshore in the North Pacific.

Support for the idea that right whales did not use inshore waters of western North America as calving grounds comes indirectly from the almost total absence of right whale catches or strandings in the records of aboriginal
whaling cultures in this region (Mitchell and Reeves, 1990).

In the western North Pacific, there is also no record of coastal bays in which right whales would give birth or protect their newborn calves. The sighting data from Townsend for February and March were summarized above. Maury’s charts provide no indication of near-shore calving grounds.

**Stock identity**

Participants at the 1983 IWC Right Whale Workshop (IWC, 1986, p.3) recommended that it would be convenient for statistical purposes to consider the right whale populations on the east and west sides of the North Pacific as separate stock units. However, in the absence of direct evidence, no conclusion can be reached concerning the identity of different biological populations.

This treatment of right whales in the North Pacific as being from two stocks (eastern North Pacific and western North Pacific) is consistent with the speculations of most previous studies, although some believe there is a third stock in the Sea of Okhotsk. These previous studies all seem to assume implicitly that the right whale’s breeding season is in winter, and that right whales from different wintering grounds do not intermingle on summer feeding grounds. Having apparently identified discrete summer feeding grounds, the studies conclude these represent different stocks.

The assumption that the breeding season of right whales in the North Pacific is in winter has been largely unquestioned. Until recently it was widely thought that right whales had a gestation period of 11–12 months (Klumov, 1962; Reeves and Brownell, 1982). Thus, if whales in the Northern Hemisphere were born between December and March as claimed, conception was assumed also to occur also between December and March.

However, recent observations suggest that the gestation period may be several months longer, moving the time of conception earlier in the year. Right whales have been observed in sexual activity in the western North Atlantic in March, April and July (Kraus et al., 1982), and in July through October (Reeves et al., 1983). Furthermore, studies of the closely related bowhead whale in the western Arctic suggest a gestation period for that species of 13 months with a period of peak mating in March (Nerini et al., 1984).

Autumn breeding, if it occurs in the North Pacific, may explain Scammon’s (1869, p.39; 1874, p.68) comment that right whales were often met with singly, or in pairs or triplets, but ‘toward the last of the season they are seen in large numbers, crowded together,’ called ‘gangs’ by the whalers. These may have been mating groups similar to those described by Kraus (1989). Data regarding the length of the right whale’s gestation period in the North Pacific and elsewhere are being critically reviewed in a separate study (S. Kraus, New England Aquarium, pers. comm.).

Regarding the intermingling of winter populations on summer feeding grounds, there is no direct evidence from the North Pacific. There are no Discovery tag recaptures, no multiple photo-identifications of known individuals and no DNA analysis of right whales in the North Pacific. Accordingly, all previous discussions have based their speculations on historic whaling records shown in Townsend’s (1935) chart. From study of this chart, combined with the few modern spring and summer records, they have concluded that there was an eastern stock which summered in the Gulf of Alaska and migrated southeast toward the west coast of North America, and a western North Pacific stock that wintered in the western North Pacific or China Sea, and perhaps a separate summer stock in the Sea of Okhotsk which also wintered in the western North Pacific (Gilmore, 1956; 1978; Omura, 1958; Klumov, 1962; Berzin and Rovnin, 1982). Omura (1958, p.7) states without further explanation that ‘it is well known’ that the whales which summer in the Gulf of Alaska are a different stock than the whales which winter off Japan. Klumov (1962, p.297) states that the Asiatic and American populations ‘are independent and do not mingle.’

However, there are at least two problems with this stock separation hypothesis. First, no present or historic wintering grounds for right whales has been found along the west coast of North America or elsewhere in the eastern North Pacific (Scarff, 1986a). Second, the clear geographic separation in summering populations apparent in Townsend’s (1935) chart, is shown by examination of the Maury charts to be in large part an artifact of the geographic segregation of the whaling effort. In addition, the two stock hypothesis has difficulty explaining the recurrent sightings of right whales in the mid-Pacific thousands of miles from any coast.

**Sea of Okhotsk**

Klumov (1962) argues that there are two separate stocks of right whales in the western North Pacific. His ‘Okhotsk herd’, is represented (Fig. 3) as summering in the central, northern and western Sea of Okhotsk, and wintering in the Sea of Japan, the East China Sea and in the Formosa Straits. However, as noted above, Klumov (1962) did not believe that bowhead whales summer in the Sea of Okhotsk and the summer distribution he describes for this Okhotsk herd is that of bowheads rather than right whales.

Within the southern and central Sea of Okhotsk and the Kuril Islands there is no obvious boundary between two stocks of right whales. Henderson (1983) stated that two such stocks ‘seems improbable’ from the more or less continuous distribution of right whales from the Kuril Islands to Sakhalin Island revealed in his review of Yankee whaling in the Sea of Okhotsk.

Omura (1986) states that two separate populations of right whales migrate past Japan. He suggests that the population which migrates along the west coast summers in the Sea of Okhotsk. The population which migrates along the Pacific coast continues up to the Kuril Islands and may go into the Bering Sea or perhaps even to the Gulf of Alaska.

**Factors possibly limiting population recovery**

Since Scarff (1986a) reviewed the possible factors limiting population recovery of right whales in the eastern North Pacific, a little more information has become available as a result of this and other studies regarding predation by killer whales, competition for food with sei whales and mortality from entanglement in fishing nets.

Scarff (1986a) mentioned predation by killer whales (Orcinus orca) as a possible limiting factor, citing the old
records from various oceans described in Mitchell and Reeves (1982). Payne (1990) mentions records of over 35 attacks by killer whales on right whales off the coast of Argentina. Of these, it could be concluded that a right whale was probably killed on only one occasion. Gaskin (1982, p.32) states that 'there is at least one confirmed record of an [killer whale] attack on a right whale off the coast of British Columbia', but provides no further details.

Possible competition with sei whales (Balaenoptera borealis) for food as a factor causing slowed or non-recovery of right whale populations has been suggested for the western North Atlantic (Mitchell, 1975), for the Southern Hemisphere (Kawamura, 1978) and for the eastern North Pacific (Scarff, 1986a). Scarff (1986a) reviewed the literature on right and sei whale feeding habits in the North Pacific, which shows that throughout much of their range both right whales and sei whales feed primarily on various copepod species (Calanus plumchrus, C. cristatus, Metrida lucens), and that other species also prey heavily on copepods and must be considered in evaluating competition for food and right whales.

The hypothesis that increasing sei whale populations may have affected the rate of recovery of right whale populations was considered by the 1983 IWC Workshop who concluded that

'more data are needed, especially on the feeding strategy of the sei whale, before the question of interspecific competition can be properly addressed' (IWC, 1986, pp.10-11).

Based on the distribution of right whales shown in Tables 3.1-3.12, they appear to be generally sympatric with sei whales in the North Pacific at a broad geographic level (Masaki, 1977). A similar gross sympatry has been reported in the Southern Hemisphere (Ohsumi and Kasamatsu, 1986).

The extent of the species' sympatry has been examined in more detail in the western North Atlantic, and the studies suggest the situation is complex with close sympathy of the two species on the feeding grounds observed on the Scotian shelf off Nova Scotia in the western North Atlantic (Mitchell et al., 1986), but not in other areas. Neuhauser et al. (1990) conclude that the observations made during the Cetacean and Turtle Assessment Program (CeTAP, 1982) 'indicated little overlap in the ranges' of the two species along the east coast of North America.

Scarff (1986a) reported finding no records of right whales being killed by entanglement in fishing nets. Neuhauser et al. (1990) describe 12 right whale encounters with fishing gear in the western North Atlantic since 1975, including at least three fatalities. In the North Pacific, there is one tentative sighting of a right whale from a salmon gillnet vessel during a net retrieval in the vicinity 51°29.5′N, 173°38.5′E on 21 June 1983. The whale was not entangled in the net (NMFS Platforms of Opportunity Program, L.L. Jones, NMML, Seattle). There is also a record of a right whale stranded on the Pacific side of Cape Lopatka (Mys Lopatka) at the southern end of the Kamchatka peninsula on 16 October 1989. It was dragging a 20m 6x6cm salmon net from its caudal peduncle (Kornev, 1990).

Recommendations

(1) Establish local networks to report right whale sightings as they are occurring

Local authorities which monitor marine radio communications should be designated as formal contact persons for right whale sightings and trained to notify the appropriate researchers immediately. For example, in the United States, the Coast Guard continuously monitors marine radio channels and is a known contact for virtually all boaters. In other regions other agencies or persons may provide similar services. These persons would be trained to (a) immediately notify appropriate researchers and (b) inform the observer of the importance of the observation, the desirability of photographs of the animal if possible, and any reward that may exist if the observer remains with the animal until scientists are able to establish contact (see below).

(2) Establish a reward system to compensate opportunistic observers of right whales if they remain with the whale until wildlife officials or researchers can establish visual or acoustic contact with the animal

Given the rarity of right whales in the North Pacific and adjacent seas, traditional scientific surveys have not generally proved effective at detecting right whales. Several of the recent sightings, particularly along the west coast of North America have been made opportunistically by persons engaged in other commercial activities. The observers have had to break off contact with the whale before wildlife officials or scientists could establish contact, and these scientists were unable to establish such contact independently once it had been lost by the initial observers.

For example, recent sightings along the coast of California have been made during commercial whale watching cruises for gray whales in 1981 (Woodhouse and Strickley, 1982) and again in 1982 (Johnson, 1982; Scarff, 1986b). Once contact with the whale was broken, the whale was not resighted, even though in the case of the 1982 sighting local whale researchers were notified immediately and attempted a search by airplane for the whale within hours (T. Dohl, Univ. of Santa Cruz, pers. comm.). In these two cases and the 1990 sighting (Rae-Dupree and Kikorian, 1990) contact with the whale by the initial observers had to be broken because continuing it would have cost the operators of the observing boat money in foregone income. A reward, payable only if a research team is able to establish contact before the sighting boat leaves the immediate area, is necessary to provide sufficient incentive for non-researchers to stay with the whale until scientists can arrive on the scene.

(3) Conduct surveys for right whales in the Kuril Islands, southern Sea of Okhotsk, along the Pacific coast of Kamchatka, and in the western Gulf of Alaska south and southwest of Kodiak Island

The Maury Whale Charts show that in the 1840s right whales were particularly abundant in summer along the Kuril Islands, in the southern Sea of Okhotsk, and along the southeastern coast of Kamchatka. Klumov (1962) found that they could still be found there in the 1950s. Russian catcher and sighting boats made 323 sightings of right whales in these areas in 7 years. In addition, Russian catcher boats were able to catch 10 right whales along the Kuril Islands between 17 May and 28 August 1955. It seems unlikely that so many right whales could have been found in the eastern North Pacific in the 1950s with comparable searching effort.

Klumov (1962) wrote that there were places where right whales nearly always could be found. He relies on a whaling captain for the information that right whales could be reliably found of the Pacific side of Friza and Bussol Channels (Proliv Friza and Proliv Bussol) at the southwest and northeast ends of Iturup Island in the southwest Kuril Islands. Other areas where right whales were reported as
relatively common include the coast of Paramushir Island at the northeast end of the Kuril Island chain.

Another area where the Maury Charts show right whales as being historically common is in the western Gulf of Alaska south and southwest of Kodiak Island. Right whales continued to be killed or sighted south and southeast of Kodiak through the 1930s (Reeves et al., 1985).

(4) *Authorize scientists to radio-tag right whales in the North Pacific as the whales are found opportunistically without having to specify in their permit applications* the exact location or timing of the radio-tagging

Opportunities for radio-tagging a right whale in the North Pacific are so rare and fleeting that special administrative procedures seem justified.

(5) *Examine as large a sample of logbooks from the North Pacific in the 1840s as feasible to extract more data regarding the portions of struck animals that were lost in order to better estimate the historic catch*

I understand this work is being done by R. Webb (Maine Maritime Museum) as time is available, and should be encouraged.

(6) *Establish a centralized catalog(s) of photographs of right whales for possible photo-identification of individuals*

This would parallel the effort in the western North Atlantic (Kraus et al., 1986), although with far fewer photographs. Given the lack of information regarding migratory routes of this species, at least to begin with photographs from throughout the Pacific and Sea of Okhotsk should be maintained at one location.

(7) *Russian and Japanese sighting data from the North Pacific should be made available to researchers in their original form*

The 1983 IWC Workshop stated that in the alternative data regarding searching effort should be made available on a monthly basis for 5° squares, and the latitude, longitude, and date be made available for each sighting, including sightings by catcher boats since 1969 (IWC, 1986, pp.3-4).

(8) *Observers on North Pacific salmon drift net boats should be trained to recognize right whales and obtain photographs of any sightings*

The distribution of right whales across a much greater area of the North Pacific reported by Maury suggests much greater overlap of this fishery with right whales than may have been previously thought. The 1983 sighting of a right whale from a salmon gillnet boat (NMFS Platforms of Opportunity Program cited in Neuhauser et al. [1990, p. 48]) supports the idea that such training might increase sightings. Scientific observers placed by US officials on salmon gillnet vessels already receive this training (L.L. Jones, Natl. Marine Mammal Center, NMFS, pers. comm.).

(9) *Retain the Protected Status of Right Whales*

The very few recent records of this species in the North Pacific and adjacent seas demonstrate that populations in this area remain extremely depleted. Clearly no killing of right whales should be permitted from this stock even under scientific permit, because even a small kill could adversely affect the stock (IWC, 1986, p.13).

It seems only fitting to close with a few words from Maury (1855, p.iv):

"The facts they [the Wind and Current Charts] contain I believe to be true and faithful results of what the logbooks contain, and so believing I will not yield them for any others, unless these others be derived from a greater number of observations, from more faithfully kept abstract logs, or from some more thorough system of investigation. But as for theory, if I have anywhere carried theory where the scaffolding of abstract logs and pertinent facts is not sufficient to support me, I am, as I have been and hope to be, most happy to see sound opinion take its place."

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