Revised 1/28/2010

# HUMPBACK WHALE (*Megaptera novaeangliae*): Central North Pacific Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The humpback whale is distributed worldwide in all ocean basins. In winter, most humpback whales occur in the subtropical and tropical waters of the Northern and Southern Hemispheres. Humpback whales in the high latitudes of the North Pacific are seasonal migrants that feed on euphausiids and small schooling fishes (Nemoto 1957, 1959; Clapham and Mead 1999). The humpback whale population was considerably reduced as a result of intensive commercial exploitation during the 20th century.

A large-scale study of humpback whales throughout the North Pacific was conducted in 2004-06 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). Initial results from this project (Calambokidis et al. 2008), including abundance estimates and movement information, are used in this report. Genetic results, which may provide a more comprehensive understanding of humpback whale population structure in the North Pacific, should be available in 2010 or 2011.

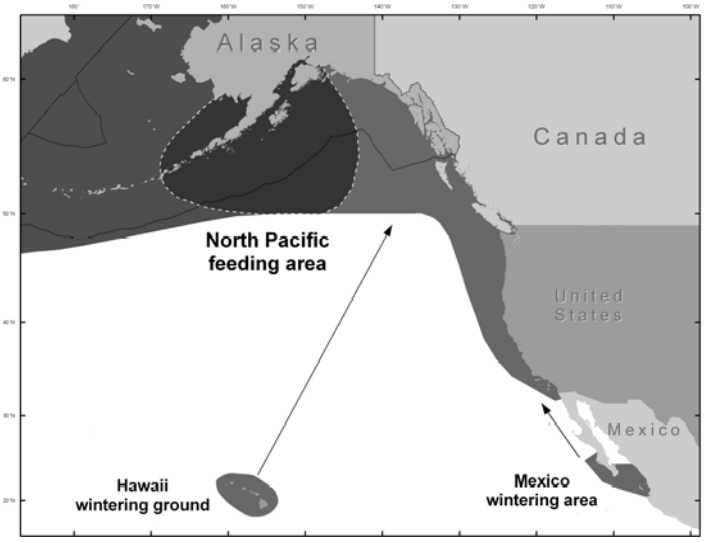


**Figure 39.** Approximate distribution of humpback whales in the western North Pacific (shaded area). Feeding and wintering grounds are presented above (see text). Area within the dotted line is known to be an area of overlap with the Central North Pacific stock. See Figure 39 for humpback whale distribution in the eastern North Pacific.

The historic summer feeding range of humpback whales in the North Pacific encompassed coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk and north of the Bering Strait (Zenkovich 1954, Nemoto 1957, Tomlin 1967, Johnson and Wolman 1984). Historically, the Asian wintering area extended from the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands (Rice 1998). Humpback whales are currently found throughout this historic range. Most of the current winter range of humpback whales in the North Pacific is relatively well known, with aggregations of whales in Japan, the Philippines, Hawaii, Mexico, and Central America. The winter range includes the main islands of the Hawaiian archipelago, with the greatest concentration along the west side of Maui. In Mexico, the winter range includes waters around the southern part of the Baja California peninsula, the central portions of the Pacific coast of mainland Mexico, and the Revillagigedos Islands off the mainland coast. The winter range also extends from southern Mexico into Central America, including Guatemala, El Salvador, Nicaragua, and Costa Rica (Calambokidis et al. 2008).

Photo-identification data, distribution information, and genetic analyses have indicated that in the North Pacific there are at least three breeding populations (Asia, Hawaii, and Mexico/Central America) that all migrate between their respective winter/spring calving and mating areas and their summer/fall feeding areas (Calambokidis et al. 1997, Baker et al. 1998). Calambokidis et al. (2001) further suggested that there may be as many as six subpopulations on the wintering grounds. From photo-identification and Discovery tag mark information there are known connections between Asia and Russia, between Hawaii and Alaska, and between Mexico/Central America and California (Calambokidis et al. 1997, Baker et al. 1998, Darling 1991; Darling and Cerchio 1993; S. Mizroch, AFSC-NMML, pers. comm., North Pacific Humpback Whale Working Group, unpublished data). This information led to the designation of three stocks of humpback whales in the North Pacific: 1) the California/Oregon/Washington and Mexico stock, consisting of winter/spring populations in coastal Central

America and coastal Mexico which migrate to the coast of California to southern British Columbia in summer/fall (Calambokidis et al. 1989, Steiger et al. 1991, Calambokidis et al. 1993); 2) the central North Pacific stock, consisting of winter/spring populations of the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997); and 3) the western North Pacific stock, consisting of winter/spring populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands.

New information from the SPLASH project mostly confirms this view of humpback whale distribution and movements in the North Pacific. For example, the SPLASH results confirm low rates of interchange between the three principal wintering regions (Asia, Hawaii, and Mexico). However, the full SPLASH results suggest the current view of population structure is incomplete. The overall pattern of movements is complex but indicates a high degree of population structure. Whales from wintering areas at the extremes of their range on both sides of the Pacific migrate to coastal feeding areas on the same side: whales from Asia in the west migrate to Russia and whales from mainland Mexico and Central America in the east migrate to California-Oregon. Whales from Hawaii and Mexico's offshore islands in the Revillagigedo Archipelago migrate to more central- and northern-latitude feeding areas, with considerable overlap (Calambokidis et al. 2008). Humpback whales from the Revillagigedos have been previously documented migrating to feeding areas off California, British Columbia, southeastern Alaska, Prince William Sound, and the Kodiak Island area (Gabriele et al. 1996, Calambokidis et al. 1997), and more recently Witteveen et al. (2004) reported matches between whales photographed at the Shumagin Islands in the western Gulf of Alaska between 1999 and 2002 and whales photographed in the Revillagigedos.

The SPLASH data now show the Revillagigedos whales are seen in all sampled feeding areas except California-Oregon and the south side of the Aleutians, and are primarily distributed in the Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia, but are also found in Russia and southern British Columbia/Washington. The migratory destinations of humpback whales from Hawaii were found to be quite similar, and a significant number of matches (14) were seen during SPLASH between Hawaii and the Revillagigedos (Calambokidis et al. 2008). This suggests a need for some modification to the current view of winter/breeding populations. A revision of population structure in the North Pacific, possibly similar to the structure based on summer feeding areas for the Atlantic population, will be considered when the full genetic results from the SPLASH project are available.

The winter distribution of the central North Pacific stock is primarily in the Hawaiian archipelago. In the SPLASH study sampling occurred on Kauai, Oahu, Penguin Bank (off the southwest tip of the island of Molokai), Maui and the island of Hawaii (the Big Island). Interchange within Hawaii was extensive. Although most of the Hawaii identifications came from the Maui sub-area, identifications from the Big Island and Kauai at the eastern and western end of the region showed a high rate of interchange with Maui.

A relevant finding from the SPLASH project is that whales from the Aleutian Islands have an unusually low re-sighting rate in winter areas compared to whales from other feeding areas. To a lesser extent this is also true of whales from the Gulf of Anadyr in Russia and the Bering Sea. One explanation for this result could be that some of these whales have a winter migratory destination that was not sampled during the SPLASH project. Given the location of these feeding areas, the most parsimonious explanation would be that some of these whales winter somewhere between Hawaii and Asia, which would include the possibility of the Marianas Islands (southwest of the Ogaswara Islands), the Marshall Islands (approximately half-way between the Marianas and Hawiian Islands), and the Northwestern Hawaiian Islands. Indeed, humpback whales have been found to occur in the Northwestern Hawaiian Islands, though apparently at relatively low density (Johnston et al. 2007). No areas with high densities of humpback whales are known between the Hawaiian main islands and Ogasawara, but this could be due to a lack of search effort. Which stock whales found in these locations would belong to is currently unknown.

In summer the majority of whales from the central North Pacific stock are found in the Aleutian Islands, Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia. High densities of humpback whales are found in the eastern Aleutian Islands, particularly along the north side of Unalaska Island, and along the Bering Sea shelf edge and break to the north towards the Pribilof Islands. Small numbers of humpback whales are known from a few locations not sampled during the SPLASH study, including northern Bristol Bay and the Chukchi and Beaufort Seas. In the Gulf of Alaska high densities of humpback whales are found in the Shumagin Islands, south and east of Kodiak Island, and from the Barren Islands through Prince William Sound. Although densities in any particular location are not high, humpback whales are also found in deep waters south of the continental shelf from the eastern Aleutians through the Gulf of Alaska. Relatively high densities of humpback whales occur throughout much of Southeast Alaska and northern British Columbia.

**POPULATION SIZE**

Prior to the SPLASH study, the most complete estimate of abundance for humpback whales in the North Pacific was from data collected in 1991-93, with a best mark-recapture estimate of 6,010 (CV = 0.08) for the entire North Pacific, using a winter-to-winter comparison (Calambokidis et al. 1997). Estimates for Hawaii and Mexico were higher using marks from summer feeding areas with recaptures on the winter grounds, and totaled almost 10,000 summed across all winter areas. In the SPLASH study fluke photographs were collected by over 400 researchers in all known feeding areas from Russia to California and in all known wintering areas from Okinawa and the Philippines to the coast of Central America and Mexico during 2004-2006. Over 18,000 fluke identification photographs were collected, and these have been used to estimate the abundance of humpback whales in the entire North Pacific Basin. Based on a comparison of all winter identifications to all summer identifications, the Chapman-Petersen estimate of abundance is 21,808 (CV=0.04) (Barlow et al. submitted). A simulation study identifies significant biases in this estimate from violations of the closed population assumption (+5.3%), exclusion of calves (-10.3%), failure to achieve random geographic sampling (+1.5%), and missed matches (+9.8%) (Barlow et al. submitted). Sex-biased sampling favoring males in wintering areas does not add significant bias if both sexes are proportionately sampled in the feeding areas. The bias-corrected estimate is 20,800 after accounting for a net positive bias of 4.8%. This estimate is likely to be lower than the true abundance due to two additional sources of bias: individual heterogeneity in the probability of being sampled (un-quantified) and the likely existence of an unknown and un-sampled wintering area (-7.2%).

The central North Pacific stock of humpback whales winters in Hawaiian waters (Baker et al. 1986). Baker and Herman (1987) used capture-recapture methods in Hawaii to estimate the population at 1,407 (95% CI: 1,113-1,701), which they considered an estimate for the entire stock for 1980-83. Mobley et al. (2001) conducted aerial surveys throughout the main Hawaiian Islands during 1993, 1995, 1998, and 2000. Abundance during these line-transect surveys was estimated as 2,754 (95% CI: 2,044-3,468), 3,776 (95% CI: 2,925-4627), 4,358 (95% CI: 3,261-5,454), and 4,491 (95% CI: 3,146-5,836). Before the SPLASH study, the best estimate of abundance for Hawaii from photo-identification data was 4,005 (CV = 0.10) for the years 1991-93 (Calambokidis et al. 1997). Initial mark-recapture abundance estimates have been calculated from the SPLASH data. Point estimates of abundance for Hawaii ranged from 7,469 to 10,103; the estimate from the best model (as chosen by AICc) was 10,103. Confidence limits or CVs have not yet been calculated for the SPLASH abundance estimates.

In summer feeding areas of the central North Pacific stock, photo-identification studies have been conducted in a number of locations in Alaska, but abundance estimates have been relatively modest. These include a catalogue of 315 individual humpback whales in Prince William Sound from 1977 to 2001 (von Ziegesar 1992, Waite et al. 1999, von Ziegesar et al. 2004), and mark-recapture estimates of 651 (95% CI: 356-1,523) for the Kodiak region (Waite et al. 1999) and 410 (95% CI: 241-683) for the Shumagin Islands from 1999-2002 (Witteveen et al. 2004).

From line-transect surveys Moore et al. (2000) estimated abundance of humpback whales in the central Bering Sea as 1,175 humpback whales (95% CI: 197-7,009) in 1999, though Moore et al. (2002) suggested these sightings were too clumped in the central-eastern Bering Sea to be used to provide a reliable estimate for the area. Moore et al. (2002) estimated abundance as 102 (95% CI: 40-262) for humpback whales in the eastern Bering Sea in 2000. Zerbini et al. (2006) estimated abundance of humpback whales from line-transect surveys in 2001-03 as 2,644 (95% CI 1,899–3680) for coastal/shelf waters from the central Gulf of Alaska through the eastern Aleutian Islands. Although there is a small amount over overlap between this survey and the Bering Sea surveys (in the eastern Aleutian Islands), considering both surveys this suggests a combined total of about 4,000 whales. In the SPLASH study the number of unique identifications in different regions included 63 in the Aleutian Islands (defined as everything on the south side of the Islands), 491 in the Bering Sea, 301 in the western Gulf of Alaska (including the Shumagin Islands), and 1,038 in the northern Gulf of Alaska (including Kodiak and Prince William Sound), with a few whales seen in more than one area (Calambokidis et al. 2008). The SPLASH abundance estimates ranged from 6,000 to 19,000 combined for the Aleutian Islands, Bering Sea, and Gulf of Alaska, a considerable increase from previous estimates that were available. However, the SPLASH surveys were more extensive in scope, including areas not covered in those surveys, such as parts of Russian waters (Gulf of Anadyr and Commander Islands), the western and central Aleutian Islands, offshore waters in the Gulf of Alaska and Aleutian Island, and Prince William Sound. Additionally, mark-recapture estimates can be higher than line-transect estimates because they estimate the total number of whales that have used the study area during the study period, whereas line-transect surveys provide a snapshot of average abundance in the survey area at the time of the survey. For the Aleutian Islands and Bering Sea,

the SPLASH estimates ranged from 2,889 to 13,594. For the Gulf of Alaska, the SPLASH estimates ranged from 2,845 to 5,122. Given known overlap in the distribution of the western and central North Pacific humpback whale stocks, estimates for these feeding areas may include whales from the western North Pacific stock.

The SPLASH study showed a relatively high rate of interchange between Southeast Alaska and northern British Columbia, so they are considered together. Humpback whale studies have been conducted since the late 1960s in Southeast Alaska. Baker et al. (1992) estimated an abundance of 547 (95% CI: 504-590) using data collected from 1979 to 1986. Straley (1994) recalculated the estimate using a different analytical approach (Jolly-Seber open model for capture-recapture data) and obtained a mean population estimate of 393 animals (95% CI: 331-455) using the same 1979 to 1986 data set. Using data from 1986 to 1992 and the Jolly-Seber approach, Straley et al. (1995) estimated that the annual abundance of humpback whales in Southeast Alaska was 404 animals (95% CI: 350-458). Straley et al. (2009) examined data for the northern portion of southeast Alaska from 1994 to 2000 and provided an updated abundance estimate of 961 (CV=0.12). In the northern British Columbia region (primarily near Langara Island), 275 humpback whales were photo-identified from 1992 to 1998 (G. Ellis, Pacific Biological Station, pers. comm.). As of 2003, approximately 850-1,000 humpback whales had been identified in British Columbia (J. Ford, Department of Fisheries and Oceans, Canada, pers. comm.). During the SPLASH study 1,115 unique identifications were made in Southeast Alaska and 583 in northern British Columbia, for a total of 1,669 individual whales, after subtracting whales seen in both areas (1,115+583-13-16=1,669) (Calambokidis et al. 2008). From the SPLASH study estimates of abundance for Southeast Alaska/northern British Columbia ranged from 2,883 to 6,414. The estimates from SPLASH are considerably larger than the estimate from Straley et al. (2009). This is because the SPLASH estimates included areas not part of the Straley et al. (2009) estimate, including southern Southeast Alaska, northern British Columbia, and offshore waters of both British Columbia and Southeast Alaska.

**Minimum Population Estimate**

A total of 2,367 unique individuals were seen in the Hawaiian wintering areas during the 2-year period (3 winter field seasons) of the SPLASH study. As discussed above, point estimates of abundance for Hawaii from SPLASH ranged from 7,469 to 10,103; the estimate from the best model was 10,103, but no associated CV has yet been calculated. The 1991-93 abundance estimate for Hawaii using similar (but less) data had a CV of 0.095. Therefore, it is unlikely the CV of the SPLASH estimate, once calculated, would be greater than 0.300. The minimum population estimate ($N_{MIN}$) for this stock is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. As a worst case, using the lowest population estimate (N) of 7,469 and an assumed conservative CV(N) of 0.30 results in an $N_{MIN}$ for the central North Pacific humpback whale stock of 5,833.

Although the Southeast Alaska/northern British Columbia feeding aggregation is not formally considered a stock, the calculation of a PBR for this area is useful for management purposes. The total number of unique individuals seen during the SPLASH study was 1,669 (1,115 in southeast Alaska). The abundance estimate of Straley et al. (2009) had a CV of 0.12, and the SPLASH abundance estimates are unlikely to have a much higher CV. Using the lowest population estimate (N) of 2,883 and an assumed worst case CV(N) of 0.30, $N_{MIN}$ for this aggregation is 2,251. Similarly, for the Aleutian Islands and Bering Sea, using the lowest SPLASH estimate of 2,889 with an assumed worst-case CV of 0.30 results in an $N_{MIN}$ of 2,256. For the Gulf of Alaska, using the lowest SPLASH estimate of 2,845 with an assumed worst-case CV of 0.30 results in an $N_{MIN}$ of 2,222. Estimates for these feeding areas may include whales from the western North Pacific stock.

**Current Population Trend**

Comparison of the estimate for the entire stock provided by Calambokidis et al. (1997) with the 1981 estimate of 1,407 (95% CI: 1,113-1,701) from Baker and Herman (1987) suggests that abundance increased in Hawaii between the early 1980s and early 1990s. Mobley et al. (2001) estimated a trend of 7% per year for 1993-2000 using data from aerial surveys that were conducted in a consistent manner for several years across all of the Hawaiian Islands and were developed specifically to estimate a trend for the central North Pacific stock. Mizroch et al. (2004) estimated survival rates for North Pacific humpback whales using mark-recapture methods, and a model fit to data from Hawaii for the years 1980-1996 resulted in an estimated rate of increase of 10% per year (95% C.I. of 3-16%). For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2006) estimated an annual rate of increase for humpback whales from 1987-2003 of 6.6% per year (95% CI: 5.2-8.6%). The SPLASH abundance estimate for the total North Pacific represents an annual increase of 4.9% over the most complete estimate for the North Pacific from 1991-93. Comparisons of SPLASH abundance estimates for Hawaii to estimates from 1991-93 gave estimates

of annual increase that ranged from 5.5 to 6.0% (Calambokidis et al. 2008). No confidence limits were calculated for these rates of increase from SPLASH data. It is also clear that the abundance has increased in Southeast Alaska, though a trend for the Southeast Alaska portion of this stock cannot be estimated from the data because of differences in methods and areas covered.

**CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

Using a birth-interval model, Barlow and Clapham (1997) have estimated a population growth rate of 6.5% (SE = 1.2%) for the well-studied humpback whale population in the Gulf of Maine, although there are indications that this rate has slowed over the last decade (Clapham et al. 2003). Estimated rates of increase for the Central North Pacific stock include values for Hawaii of 7.0% (from aerial surveys), 5.5-6.0% (from mark-recapture abundance estimates), and 10% (95% CI 3-16%) (from a model fit to mark-recapture data), and for the northern Gulf of Alaska a value of 6.6% (95% CI 5.2-8.6%) (from ship surveys) (Calambokidis et al. 2008). Although there is no estimate of the maximum net productivity rate for the Central North Pacific stock, it is reasonable to assume that $R_{MAX}$ for this stock would be at least 7%. Hence, until additional data become available from the Central North Pacific humpback whale stock, it is recommended that 7% be employed as the maximum net productivity rate ($R_{MAX}$) for this stock.

**POTENTIAL BIOLOGICAL REMOVAL**

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the recommended value for cetacean stocks listed as endangered under the Endangered Species Act (Wade and Angliss 1997). The default value of 0.04 for the maximum net productivity rate is replaced by 0.07, which is the best estimate of the current rate of increase and is considered a conservative estimate of the maximum net productivity rate. For the Central North Pacific stock of humpback whale, using the smallest SPLASH study abundance estimate for 2004-06 for Hawaii of 7,469 with an assumed CV of 0.300 and its associated $N_{MIN}$ of 5,833, PBR is calculated to be 61.2 animals (5,833 x 0.035 x 0.3). A recovery factor of 0.3 is used in calculating the PBR based on the suggested guidelines of Taylor et al. (2003).

At this time, stock structure of humpback whales is under consideration and revisions may be proposed within the next few years. One possibility would be to revise stock structure to be consistent with summer feeding aggregations, as has been done for the North Atlantic population of humpback whales. If this were to occur, possible groupings could be: Southeast Alaska/northern British Columbia, Gulf of Alaska, and Aleutian Islands/Bering Sea. For Southeast Alaska and northern British Columbia, the smallest abundance estimates from the SPLASH study were used with an assumed worst-case CV of 0.3 to calculate PBRs for feeding areas. Using the suggested guidelines presented in Taylor et al. (2003), it would be appropriate to use a recovery factor of 0.3 only for the Southeast Alaska/ northern British Columbia feeding aggregation since this aggregation has an Nmin greater than 1,500 and less than 5,000 and an increasing population trend. A recovery factor of 0.1 is appropriate for the Aleutian Islands and Bering Sea feeding aggregation and the Gulf of Alaska feeding aggregation because the Nmin is greater than 1,500 and less than 5,000 and based on an unknown population trend. For the Southeast Alaska/northern British Columbia feeding aggregation PBR is calculated to be 23.6 (2,251 x 0.035 x 0.3). For the Aleutian Islands and Bering Sea, PBR is calculated to be 7.9 (2,256 x 0.035 x 0.1). For the Gulf of Alaska, PBR is calculated to be 7.8 (2,222 x 0.035 x 0.1).

**ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

**Fisheries Information**

Until 2004, there were four different federally-regulated commercial fisheries in Alaska that occurred within the range of the central North Pacific humpback whale stock that were monitored for incidental mortality by fishery observers. As of 2004, changes in fishery definitions in the List of Fisheries have resulted in separating these four fisheries into 17 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. Between 2002 and 2006, there were incidental serious injuries and mortalities of central North Pacific humpback whales in the Bering Sea/Aleutian Islands sablefish pot fishery and in the Hawaii shallow set longline fishery (Table 36). Estimates of marine mammal

serious injury/mortality in observed fisheries are provided in Perez (2006), Perez (unpubl. ms.), and Forney (unpubl. ms.).

**Table 36.** Summary of observer reported incidental mortalities and serious injuries of humpback whales (Central North Pacific stock) due to commercial fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary data. Details of how percent observer coverage is measured is included in Appendix 6.

| Fishery name | Years | Data type | Observer coverage | Observed mortality/ serious injury (in given yrs.) | Estimated mortality/ serious injury (in given yrs.) | Mean annual mortality/ serious injury |
|---|---|---|---|---|---|---|
| Bering Sea sablefish pot | 2002 | obs data | 40.6 | 0 | 1[1] | 0.20[2] |
| | 2003 | | 21.7 | 0 | 0 | (N/A) |
| | 2004 | | 49.1 | 0 | 0 | |
| | 2005 | | 39.2 | 0 | 0 | |
| | 2006 | | 35.3 | 0 | 0 | |
| | 2007 | | - | 0 | 0 | |
| | 2008 | | - | 0 | 0 | |
| HI shallow set longline | 2003 | obs data | 100 | 0 | 0 | 0.20 |
| | 2004 | | 100 | 0 | 00 | |
| | 2005 | | 100 | 0 | 1 | |
| | 2006 | | 100 | 1 | 0 | |
| | 2007 | | 100 | 0 | | |
| Minimum total annual mortality | | | | North: 0.2<br>SE: 0.0<br>HI: 0.2<br>Total: 0.4 | | |

[1] Mortality was seen by an observer but not during an "observed set"; thus quantification of effort cannot be accomplished and the single record cannot be extrapolated to provide a total estimated mortality level.
[2] These mortalities occurred in an area of known overlap with the Western North Pacific stock of humpback whales. Since the stock identification is unknown, the mortalities are reflected in both stock assessments.

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached occur in both Alaskan and Hawaiian waters. All reports of mortalities or injuries of humpback whales from the central North Pacific stock from 2003 to 2007 are provided in Appendix 8 and a summary of the information is provided in Table 37. Overall, there were 86 reports of human-related mortalities or injuries during this 5-year period. Of these, there were 54 incidents which involved commercial fishing gear, and 23 of those incidents involved serious injuries or mortalities. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or cause of death determined.

**Table 37.** Summary of central North Pacific humpback whale mortalities and serious injuries caused by commercial and recreational fishery entanglement and ship strikes from stranding reports, 2003-2007. A summary of information used to determine whether an injury was serious or non-serious is included in Appendix 8. Fisheries with zero average annual mortality indicate historical marine mammal interactions.

| Area | Human activity/fishery | Year | Mortality | Serious | Not determinable | Average annual serious injury/mortality rate (2003-2007) |
|---|---|---|---|---|---|---|
| North | Ship strike | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 1 | 0 | 1 | |
| | | 2006 | 0 | 0 | 0 | |

| Area | Human activity/fishery | Year | Mortality | Serious | Not determinable | Average annual serious injury/mortality rate (2003-2007) |
|---|---|---|---|---|---|---|
| | | 2007 | 0 | 0 | 1 | |
| | Unspecified gear | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 1 | |
| | | 2006 | 0 | 1 | 0 | |
| | | 2007 | 0 | 0 | 1 | |
| | Salmon set gillnet | 2003 | 0 | 0 | 0 | 0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified set gillnet | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 1 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Purse seine | 2003 | 0 | 0 | 0 | 0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified pot gear | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 1 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Crab pot gear | 2003 | 0 | 0 | 0 | 0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Yakutat salmon set gillnet | 2003 | 0 | 0 | 0 | 0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Cook Inlet salmon set gillnet | 2003 | N/A | N/A | N/A | 0.2 |
| | | 2004 | N/A | N/A | N/A | |
| | | 2005 | 0 | 1 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Kodiak salmon purse seine | 2003 | N/A | N/A | N/A | 0.2 |
| | | 2004 | N/A | N/A | N/A | |
| | | 2005 | 1 | 0 | 0 | |

| Area | Human activity/fishery | Year | Mortality | Serious | Not determinable | Average annual serious injury/mortality rate (2003-2007) |
|---|---|---|---|---|---|---|
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Lower Cook Inlet salmon purse seine | 2003 | N/A | N/A | N/A | 0.2 |
| | | 2004 | N/A | N/A | N/A | |
| | | 2005 | 1 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Average annual serious injury/mortality rate commercial fisheries only | | | | | 1.2 |
| | Average annual serious injury/mortality rate total | | | | | 1.4 |
| SE | Ship strike | 2003 | 1 | 0 | 0 | 1.4 |
| | | 2004 | 2 | 1 | 0 | |
| | | 2005 | 1 | 1 | 0 | |
| | | 2006 | 0 | 0 | 1 | |
| | | 2007 | 1 | 0 | 1 | |
| | Unspecified gear | 2003 | 0 | 0 | 0 | 0.6 |
| | | 2004 | 0 | 2 | 0 | |
| | | 2005 | 0 | 0 | 1 | |
| | | 2006 | 1 | 0 | 4 | |
| | | 2007 | 0 | 0 | 2 | |
| | Salmon set gillnet | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified gillnet | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 1 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 1 | |
| | Unspecified drift gillnet | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 1 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified net gear | 2003 | 1 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Purse seine | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |

| Area | Human activity/fishery | Year | Mortality | Serious | Not determinable | Average annual serious injury/mortality rate (2003-2007) |
|---|---|---|---|---|---|---|
| | Unspecified pot gear | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 1 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Crab pot gear | 2003 | 0 | 1 | 0 | 0.6 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 2 | 2 | |
| | | 2006 | 0 | 0 | 1 | |
| | | 2007 | 0 | 0 | 0 | |
| | Recreational crab pot gear | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 1 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified longline gear | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 1 | |
| | | 2007 | 0 | 0 | 0 | |
| | Unspecified shrimp gear | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 1 | |
| | Halibut longline | 2003 | 0 | 0 | 0 | 0.2 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 1 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | SE salmon drift gillnet | 2003 | N/A | N/A | N/A | 0.2 |
| | | 2004 | N/A | N/A | N/A | |
| | | 2005 | 1 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Average annual serious injury/mortality rate fishery only | | | | | 2.2 |
| | Average annual serious injury/mortality rate total | | | | | 3.8 |
| Hawaii | Unspecified gear | 2003 | 0 | 0 | 0 | 0.0 |
| | | 2004 | 0 | 0 | 0 | |
| | | 2005 | 0 | 0 | 0 | |
| | | 2006 | 0 | 0 | 0 | |
| | | 2007 | 0 | 0 | 0 | |
| | Average annual serious injury/mortality rate fishery only | | | | | 0.0 |
| | Average annual serious injury/mortality rate total | | | | | 0.0 |

Summary of central North Pacific humpback whale mortalities and serious injuries caused by entanglement and ship strikes based on stranding reports, 2003-2007.

| | Vessel collisions | Commercial fishery related | Recreational fishery related | Total SI/M |
|---|---|---|---|---|
| Northern AK | 0.2 | 1.2 | 0 | 1.4 |
| Southeast AK | 1.4 | 2.2 | 0.2 | 3.8 |
| TOTAL | 1.6 | 3.4 | 0.2 | Average annual SI/M (2003-2007): 5.2 |

The overall U. S. commercial fishery-related minimum mortality and serious injury rate for the entire stock is 3.8 humpback whales per year, based on observer data from Alaska (0.2), observer data from Hawaii (0.2), stranding records from Alaska (3.4), and stranding records from Hawaii (0). The estimated fishery-related minimum mortality and serious injury rate incidental to commercial fisheries for the northern portion of the stock is 1.6 humpback whales per year, based on observer data from Alaska (0.2), stranding records from Alaska (1.2), observer data from Hawaii (0.2), and stranding data from Hawaii (0) (Table 37). The estimated minimum mortality and serious injury rate incidental to the commercial fisheries in southeast Alaska is 2.4 humpback whales per year, based on observer data from Hawaii (0.2), stranding records from Alaska (2.2), and stranding data from Hawaii (0) (Table 37). The single serious injury record from Hawaii was included in the minimum mortality and serious injury estimates for both the northern portion and southeast Alaska portion of this stock.

As mentioned previously, these estimates of serious injury/mortality levels should be considered a minimum. No observers have been assigned to several fisheries that are known to interact with this stock, making the estimated mortality rate unreliable. Further, due to limited Canadian observer program data, mortality incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Though interactions are thought to be minimal, data regarding the level of humpback whale mortality related to commercial fisheries in northern British Columbia are not available, again indicating that the estimated mortality incidental to commercial fisheries is underestimated for this stock.

**Subsistence/Native Harvest Information**

Subsistence hunters in Alaska are not authorized to take from this stock of humpback whales, and no takes have been reported.

**Other Mortality**

Ship strikes and other interactions with vessels unrelated to fisheries have also occurred to humpback whales. Those cases are included in Appendix 8 and summarized in Table 37. Of those, eight ship strikes constitute "other sources" of mortality or serious injury; seven of these ship strikes occurred in Southeast Alaska and one occurred in the northern portion of this stock's range. It is not known whether the difference in ship strike rates between Southeast Alaska and the northern portion of this stock is due to differences in reporting, amount of vessel traffic, densities of animals, or other factors. Averaged over the year period from 2003 to 2007, these account for an additional 1.6 humpback whale mortalities per year for the entire stock (0.2 ship strikes/year for the northern portion of the stock, and 1.4 strikes/year for the Southeast portion).

**HISTORICAL WHALING**

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century. Humpback whales in the North Pacific were theoretically protected in 1965, but illegal catches by the U.S.S.R. continued until 1972 (Ivashchenko et al. 2007). From 1961 to 1971, 6,793 humpback whales were killed illegally by the USSR. Many animals during this period were taken from the Gulf of Alaska and Bering Sea (Doroshenko 2000); however, additional illegal catches were made across the North Pacific, from the Kuril Islands to the Queen Charlotte Islands, and other takes in earlier years may have gone unrecorded.

On the feeding grounds of the central North Pacific stock after World War II the highest density of catches occurred around the western Aleutian Islands, in the eastern Aleutian Islands (and adjacent Bering Sea to the north

and Pacific Ocean to the south), and British Columbia (Springer et al. 2006). Lower but still relatively high density of catches occurred south of the Commander Islands, along the south side of the Alaska Peninsula and around Kodiak Island. Lower densities of catches also occurred in the Gulf of Anadyr, in the central Aleutian Islands, in much of the offshore Gulf of Alaska, and in Southeast Alaska.

No catches were reported in the winter grounds of the central North Pacific stock in Hawaii, nor in Mexican winter areas.

**STATUS OF STOCK**

As the estimated annual mortality and serious injury rate for the entire stock (5.6; 3.8 of which were commercial fishery-related; Table 38) is considered a minimum, it is unlikely that the level of human-caused mortality and serious injury exceeds the PBR level (61.2) for the entire stock. The estimated annual mortality and serious injury rate in Southeast Alaska (3.4.0, of which 2.4 were commercial fishery-related) is less than the PBR level if calculated only for the Southeast Alaska portion of the population (23.3), or for the Southeast Alaska/northern British Columbia feeding aggregation (23.6). The estimated annual mortality and serious injury rate in the Northern area (Gulf of Alaska, Aleutian Islands, Bering Sea) is 1.8, which does not exceed the combined PBR for these feeding areas (15.7). The minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock is less that 10% of the calculated PBR for the entire stock (6.1) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The humpback whale is listed as "endangered" under the Endangered Species Act, and therefore designated as "depleted" under the MMPA. As a result, the central North Pacific stock of humpback whale is classified as a strategic stock. However, the status of the entire stock relative to its Optimum Sustainable Population size is unknown.

**Table 38.** Summary of average annual serious injury (SI) and mortality (M) levels for the central North Pacific (CNP) stock of humpback whales (2003-2007).

| Area | Data types for fishery-related information | | | | | | Ship strikes | Total | "PBR" |
|---|---|---|---|---|---|---|---|---|---|
| | AK Observer data | AK Strand. | HI Observer data | HI Strand. | Total Commercial fish. | Total Rec. fish. | | | |
| Northern | 0.2 | 1.2 | 0.2[3] | 0 | 1.6 | 0 | 0.2 | 1.8 | 15.7 |
| Southeast | N/A | 2.2 | 0.2[3] | 0 | 2.4 | 0.2 | 1.4 | 4.0 | 23.3 |
| Southeast Alaska/northern British Columbia | | | | | | | | | 23.6 |
| TOTAL | 0.2 | 3.4 | 0.2[3] | 0[1] | 3.8[2,3] | 0.2 | 1.6 | 5.6[3] | 61.2 |

[1] The average annual SI/M in HI is 0.
[2] This is the sum of the observed SI/M (0.4), the AK strandings (3.4), and the average HI stranding rate (0).
3 Total HI observed fisheries SI/M is 0.2. This value is included in the sum for both the northern and southeast portions of the stock; however, it is only counted once in the total SI/M for the entire stock.

**Habitat Concerns**

This stock is the focus of a large whale watching industry in its wintering grounds (Hawaii) and a growing whale watching industry in its summering grounds (Alaska). Regulations concerning minimum distance to keep from whales and how to operate vessels when in the vicinity of whales have been developed for Hawaii waters in an attempt to minimize the impact of whale watching. Additional concerns have been raised about the impact of jet skis and similar fast waterborne tourist-related traffic, notably in nearshore areas inhabited by mothers and calves. In 2001, NMFS issued regulations to prohibit most approaches to humpback whales in Alaska within 100 yards (91.4 m; 66 FR 29502; 31 May 2001). The growth of the whale watching industry, however, is a concern as preferred habitats may be abandoned if disturbance levels are too high.

Elevated levels of sound from the Acoustic Thermometry of Ocean Climate (ATOC) program, the U.S. Navy's Low Frequency Active (LFA) sonar program, and other anthropogenic sources (i.e., shipping and whale watching) in Hawaii waters is of potential concern for this stock. Results from experiments in 1996 off Hawaii indicated only subtle responses of humpback whales to ATOC-like transmissions (Frankel and Clark 1998). Frankel and Clark (2002) indicated that there were also slight shifts in humpback whale distribution in response to ATOC.

Efforts are underway to evaluate the relative contribution of sound (e.g., experiments with LFA sound sources) to Hawaii's marine environment, although reports summarizing the results of recent research are not available.

**CITATIONS**

Baker, C. S., A. Perry, and L. M. Herman. 1987. Reproductive histories of female humpback whales (*Megaptera novaeangliae*) in the North Pacific. Mar. Ecol. Prog. Ser. 41:103-114.

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis, and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344:238-240.

Baker, C. S., J. M. Straley, and A. Perry. 1992. Population characteristics of individually identified humpback whales in southeastern Alaska: summer and fall 1986. Fish. Bull., U.S. 90:429-437.

Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Mol. Ecol. 7(695-707).

Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley, A. A. Wolman, G. D. Kaufman, H. E. Winn, J. D. Hall, J. M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. Mar. Ecol. Prog. Ser. 31:105-119.

Barlow, Calambokidis, Falcone, Baker, Burdin, Clapham, Ford, Gabriele, LeDuc, Mattila, Quinn, Rojas-Bracha, Straley, Taylor, Urban, Wade, Weller, Witteveen, Yamaguchi. Submitted. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Marine Mammal Science.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecol. 78(2):535-546.

Calambokidis, J. E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final report for Contract AB133F-03-RP-00078. 58 p.
(Available at http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf)

Calambokidis, J., G. H. Steiger, J. C. Cubbage, K. C. Balcomb III, and P. Bloedel. 1989. Biology of humpback whales in the Gulf of the Farallones. Report to Gulf of the Farallones National Marine Sanctuary, San Francisco, CA by Cascadia Research Collective, 218½ West Fourth Avenue, Olympia, WA. 93 pp.

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, La Jolla, CA 92038. 67 pp.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urban R., J. K. Jacobsen, O. von Ziegesar, K.C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara P., M. Yamaguchi, F. Sato, S. A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow and T. J. Quinn, II. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mamm. Sci. 17(4): 769-794.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. R. Urban, J. Jacobson, O. Von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara, S. A. Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 72 pp.

Clapham, P.J., Barlow, J., Bessinger, M., Cole, T., Mattila, D., Pace, R., Palka, D.. Robbins, J. & Seton, R. 2003. Abundance and demographic parameters of humpback whales from the Gulf of Maine, and stock definition relative to the Scotian Shelf. J. Cet. Res. Manage. 5:13-22.

Clapham, P. J., and J. G. Mead. 1999. *Megaptera novaeangliae*. Mamm. Species 604:1-9.

Darling, J. D. 1991. Humpback whales in Japanese waters. Ogasawara and Okinawa. Fluke identification catalog 1987-1990. Final Contract Report, World Wide Fund for Nature, Japan. 22 pp.

Darling, J. D., and S. Cerchio. 1993. Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawaii. Mar. Mammal Sci. 1:84-89.

Doroshenko, N. V. 2000. Soviet catches of humpback whales (*Megaptera novaeangliae*) in the North Pacific. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet whaling data (1949-1979), Center for Russian Environmental Policy, Marine Mammal Council, Moscow, 96-103.

Forney, K. A. unpubl. ms. Serious injury determinations for cetaceans caught in Hawaii longline fisheries during 1994-2008. Document presented to Pacific Scientific Review Group. 19 October 2009.

Frankel, A. S., and C. W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae*, in Hawai'i. Can. J. Zool. 76:521-535.

Frankel, A.S., and C. W. Clark. 2002. ATOC and other factors affecting the distribution and abundance of humpback whales (*Megaptera novaeangliae*) off the North Shore of Hawaii. Mar. Mamm. Sci. 18(3):644-662.

Gabriele, C. M., J. M. Straley, L. M. Herman, and R. J. Coleman. 1996. Fastest documented migration of a North Pacific humpback whale. Mar. Mamm. Sci. 12:457-464.

Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell Jr. (eds.). 2007. Scientific reports of Soviet whaling expeditions, 1955-1978. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-175. 36 pp. [Translation: Y. V. Ivashchenko] + Appendix.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46:30-37.

Johnston, D.W., M. E. Chapla, L. E. Williams and D. K. Mattila. 2007. Identification of humpback whale wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling, Endang. Species Res. 3:249-257 .

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 pp.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. L. Hobbs. 2000. Mysticete whale abundance observations of prey associations on the Central Bering Sea Shelf. J. Cetacean Res. Manage. 2(3): 227-234.

Moore, S. E., J. M. Waite, N. A. Friday and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Progr. Oceanogr. 55(1-2):249-262.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

Nemoto T. 1959. Food of baleen whales with reference to whale movements. Scientific Reports of the Whales Research Institute, 14**:**149-290.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available by request – D. Allen, NMML-AFSC, 7600 Sand Point Way NE, Seattle, WA 98115.

Perry, A., C. S. Baker, and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Comm. (Special Issue 12):307-317.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation and numbers. Appendix 4. Pp. 29-44 *In* K. S. Norris and R.R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. U.S. Dep. Commer., Nat. Tech. Info. Serv. PB-280 794. Springfield, VA.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc. Mar. Mammal. Spec. Publ. No. 4.

Springer, A., G.B. van Vliet, J.F. Piatt, and E. M. Danner. 2006. Pages 245-261 In: "Whales, Whaling and Ocean Ecosystems", J.A. Estes, R.L. Brownell, Jr., D.P DeMaster, D.F. Doak, and T.M. Williams (eds), University of California Press. 418 pp.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Straley, J. M. 1994. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Master's thesis, University of Alaska - Fairbanks, Fairbanks, Alaska, 99775. 121 pp.

Straley, J. M., C. M. Gabriele, and C. S. Baker. 1995. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Pp. 229-237 *In* D. R. Engstrom, ed. Proceedings of the Third Glacier Bay Science Symposium, 1993. National Park Service, Anchorage, AK.

Straley, J M., C. M. Gabriele and T. J. Quinn II. 2009. Assessment of mark recapture models to estimate the abundance of a humpback whale feeding aggregation in Southeast Alaska. J. Biogeogr. 36:427-438.

Taylor, B. L., M. Scott, J. Heyning and J. Barlow. 2003. Suggested guidelines for recovery factors for endangered marine mammals. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-354, 6 pp.

Tomlin, A. G. 1967. Mammals of the USSR and adjacent countries. vol. 9, Cetacea. Israel Program Sci. Transl. No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 pp. (Translation of Russian text published in 1957).

von Ziegesar, O. 1992. A catalogue of Prince William Sound humpback whales identified by fluke photographs between the years 1977 and 1991. North Gulf Oceanic Society, P. O. Box 15244, Homer, AK. 29 pp.

von Ziegesar, O., B. Goodwin, and R. Devito. 2004. A catalog of humpback whales in Prince William Sound Alaska, 1977-2001. Eye of the Whale Research, Fritz Creek, Alaska.

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waite, J. M., M. E. Dahlheim, R. C. Hobbs, S. A. Mizroch, O. von Ziegesar-Matkin, J. M. Straley, L. M. Herman, and J. Jacobsen. 1999. Evidence of a feeding aggregation of humpback whales (*Megaptera novaeangliae*) around Kodiak Island, Alaska. Mar. Mammal Sci. 15:210-220.

Witteveen, B. H., J. M. Straley, O. Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Can. J. Zool. 82:1352-1359.

Zenkovich B. A. 1954. Vokrug sveta za kitami, Vol. Gosudarstvennoe Izdatel'stvo Geograficheskoi Literatury, Moscow.

Zerbini, A. N., J. M. Waite, J. L. Laake and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. Part I:1772-1790.