Revised 07/25/2011

HARBOR SEAL (*Phoca vitulina richardi*)

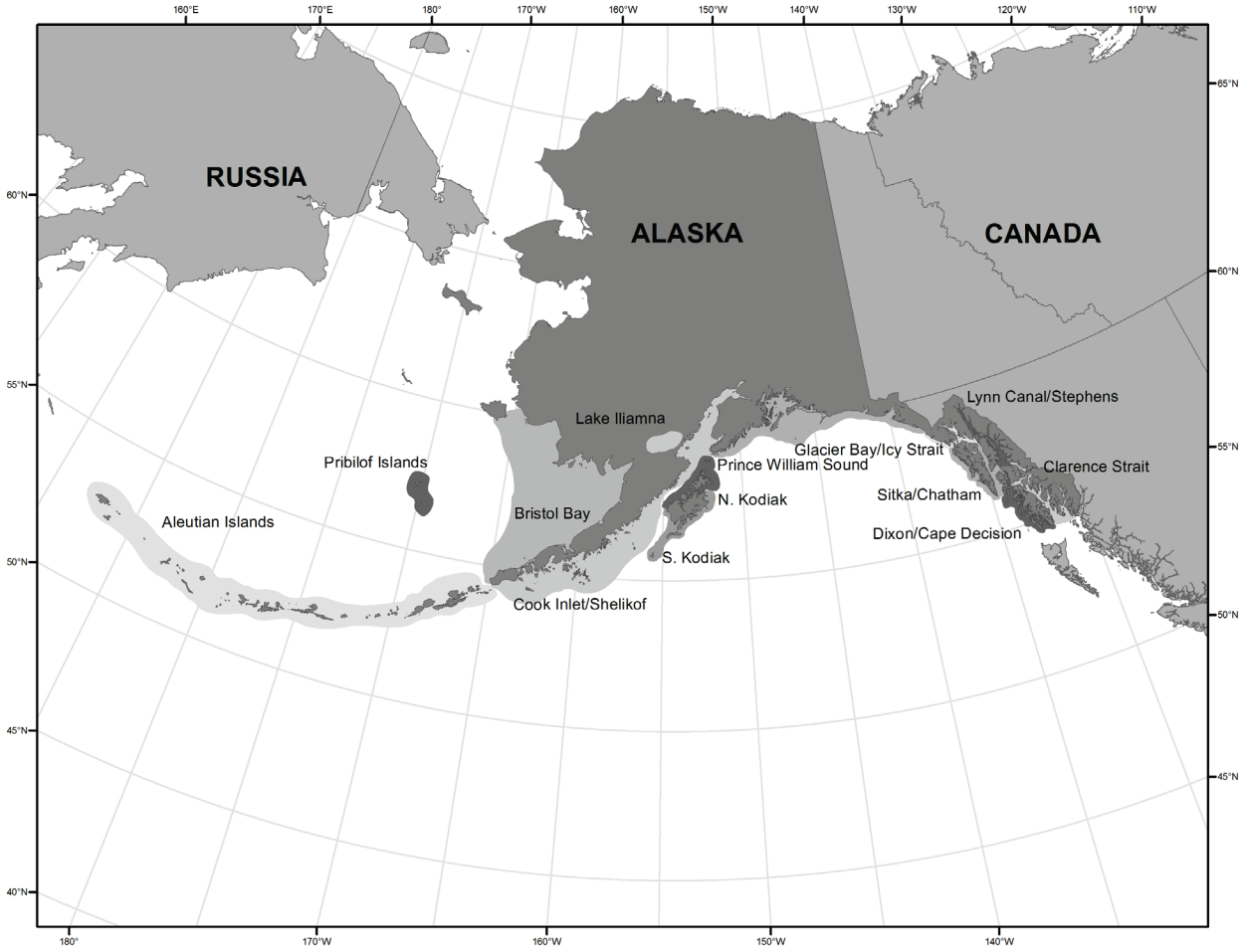

Figure 8. Approximate distribution of harbor seals in Alaska waters (shaded area).

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944, Fisher 1952, Bigg 1969, 1981, Hastings et al. 2004). The results of recent satellite tagging studies in Southeast Alaska, Prince William Sound, and Kodiak are also consistent with the conclusion that harbor seals are non-migratory (Swain et al. 1996, Lowry et al. 2001, Small et al. 2003). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2003). Strong fidelity of individuals for haul-out sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including in Alaska (Pitcher and McAllister 1981, Small et al. 2005). Harbor seals have declined dramatically in some parts of their Alaska range over the past few decades while in other parts their numbers have increased or remained stable over similar time periods, suggesting areas with independent population dynamics (O'Corry-Crowe et al. 2003).

Westlake and O'Corry-Crowe's (2002) analysis of genetic information revealed population subdivisions on a scale of 600-820 km. These results suggest that genetic differences within Alaska, and most likely over their entire North Pacific range, increase with increasing geographic distance. New information revealed substantial genetic differences indicating that female dispersal occurs at region specific spatial scales of 150-540 km. This research identified 12 demographically independent clusters within the range of Alaskan harbor seals; however significant geographic areas within the Alaskan harbor seal range remain un-sampled (O'Corry-Crowe et al. 2003).

In 2010, the National Marine Fisheries Service and their co-management partners, the Alaska Native Harbor Seal Commission, decided on 12 separate stocks of harbor seals based largely on the genetic structure. Given the genetic samples were not obtained continuously throughout the range, a total evidence approach was used to consider additional factors such as population trends, observed harbor seal movements and traditional native use areas in the final designation of stock boundaries. This represents a significant increase in the number of harbor seal stocks from the three stocks (Bering Sea, Gulf of Alaska, Southeast Alaska) previously recognized.The twelve stocks of harbor seals identified in Alaska are 1) the Aleutian Islands stock, 2) the Pribilof Islands stock, 3) the Bristol Bay stock, 4) the North Kodiak stock, 5) the South Kodiak stock, 6) the Prince William Sound stock, 7) the Cook Inlet/Shelikof stock, 8) the Glacier Bay/Icy Strait stock, 9) the Lynn Canal/Stephens stock, 10) the Sitka/Chatham stock, 11) the Dixon/Cape Decision stock, and 12) the Clarence Strait stock (Fig. 8). Individual stock distributions can be seen in Fig. 9a-l.

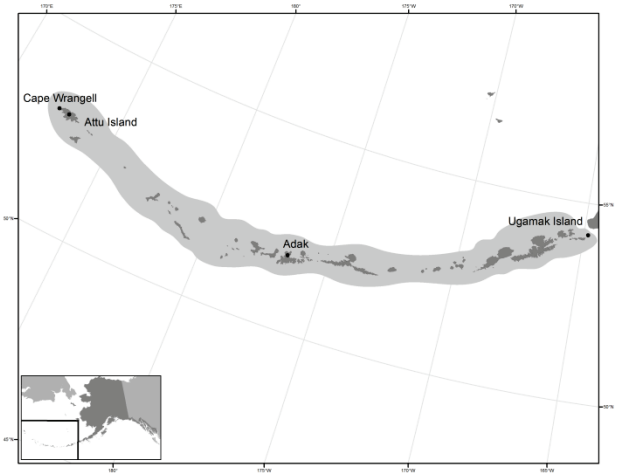

Figure 9a. Approximate distribution of Aleutian Islands harbor seal stock (shaded area).

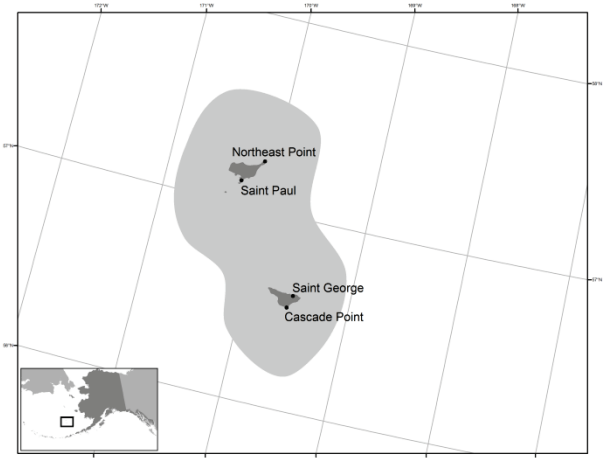

Figure 9b. Approximate distribution of Pribilof Islands harbor seal stock (shaded area).

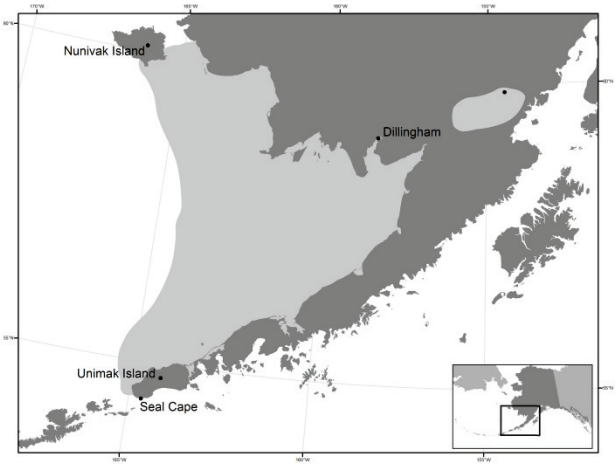

Figure 9c. Approximate distribution of Bristol Bay harbor seal stock (shaded area).

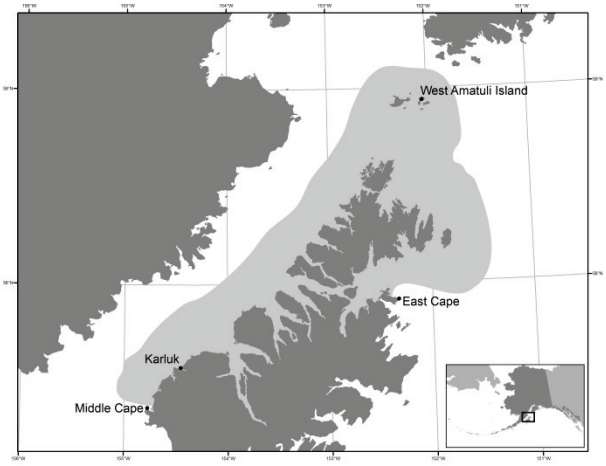

Figure 9d. Approximate distribution of North Kodiak harbor seal stock (shaded area).

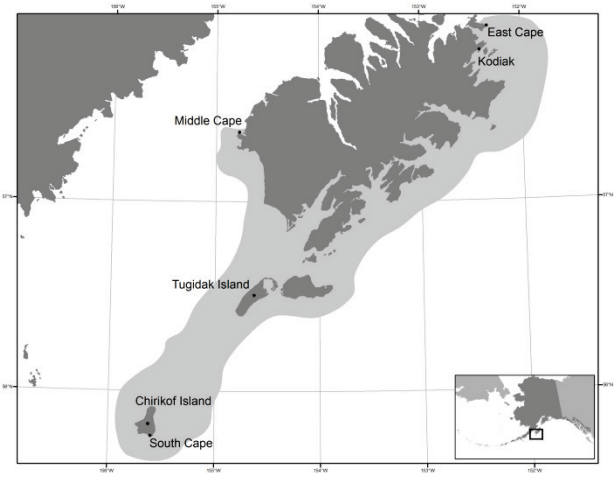

Figure 9e. Approximate distribution of South Kodiak harbor seal stock (shaded area).

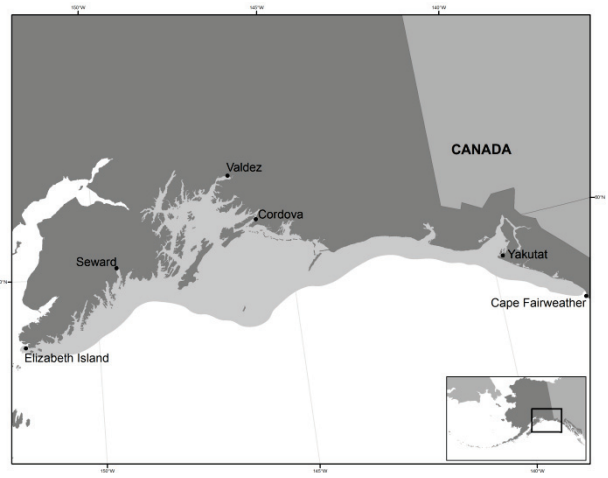

Figure 9f. Approximate distribution of Prince William Sound harbor seal stock (shaded area).

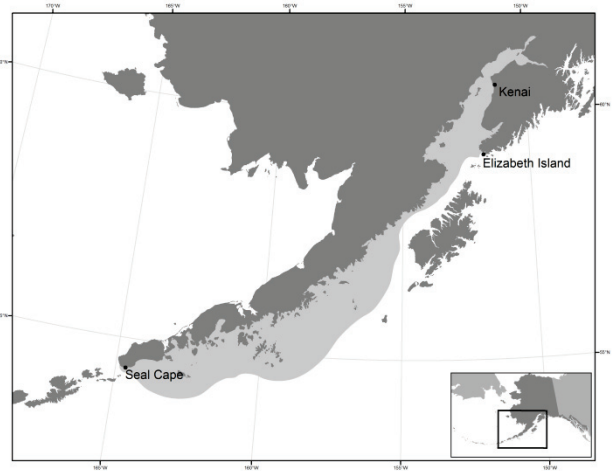

Figure 9g. Approximate distribution of Cook Inlet/Shelikof harbor seal stock (shaded area).

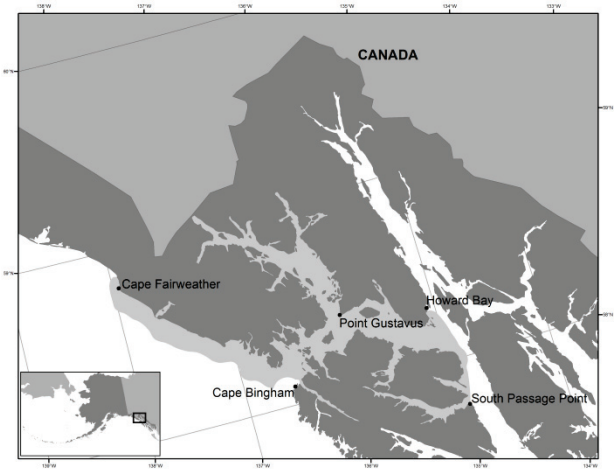

Figure 9h. Approximate distribution of Glacier Bay/Icy Strait harbor seal stock (shaded area).

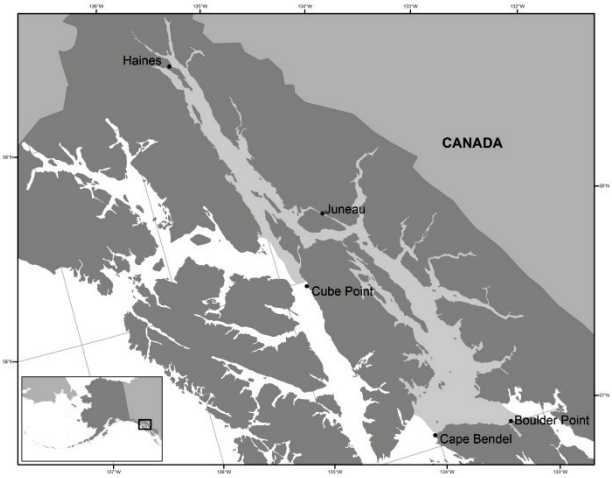

Figure 9i. Approximate distribution of Lynn Canal/Stephens harbor seal stock (shaded area).

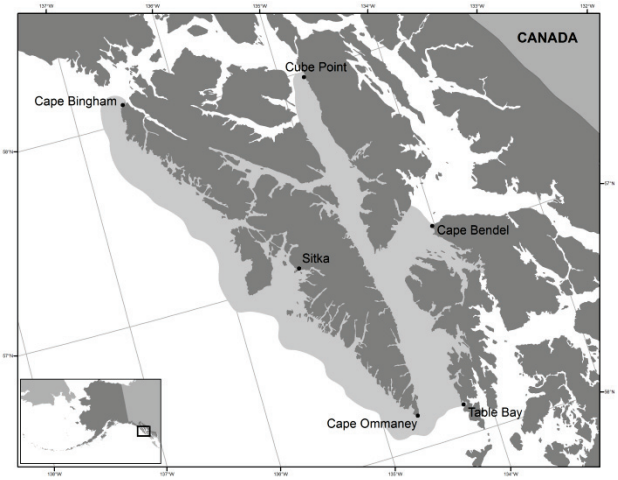

Figure 9j. Approximate distribution of Sitka/Chatham harbor seal stock (shaded area).

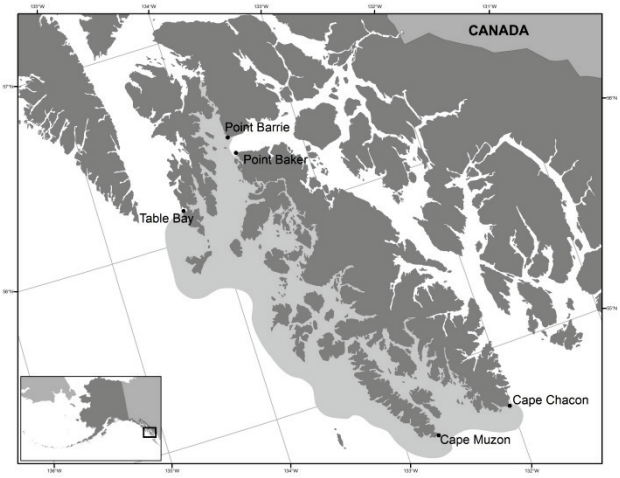

Figure 9k. Approximate distribution of Dixon/Cape Decision harbor seal stock (shaded

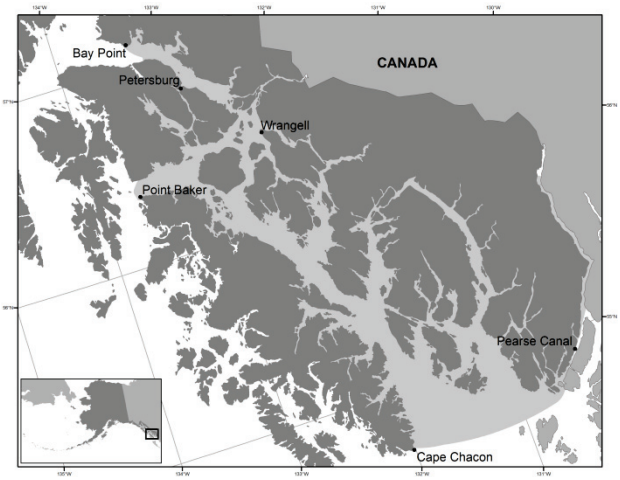

Figure 9l. Approximate distribution of Clarence Strait harbor seal stock (shaded area).

POPULATION SIZE

The National Marine Mammal Laboratory (Alaska Fisheries Science Center) routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Prior to 2008, Alaska was divided into five survey regions, with one region surveyed per year. In 2010, the survey sites were prioritized based on the newly defined harbor seal stock divisions and annual aerial surveys attempt to cover the full geographic range of harbor seals in Alaska. We focused on surveying sites that make up a significant portion of each stock's population every year. Those sites with fewer seals are flown every 3 to 5 years, eventually providing the data necessary to estimate harbor seal population and trends on an annual basis. To derive an accurate estimate of population size from these surveys, a method was developed to address the influence of external conditions on the number of seals hauled out on shore, and counted, during the surveys. Many factors influence the propensity of seals to haul out, including tides, time of day, and date in the seals' annual life history cycle. A statistical model defining the relationship between these factors and the number of seals hauled out was developed. Based on those models, the survey counts for each year were adjusted to the number of seals that would have been ashore during a hypothetical survey conducted under ideal conditions for hauling out (Boveng et al. 2003). In a separate analysis of radio-tagged seals, a similar statistical model was used to estimate the proportion of seals that were hauled out under those ideal conditions (Simpkins et al. 2003). The results from these two analyses were combined for each region to estimate the population size of each stock in Alaska. An additional analysis of abundance and trend for each stock is currently in progress and will be reported in the 2012 stock assessment reports.

Abundance Estimates and Minimum Population Estimates

The current statewide abundance estimate for Alaskan harbor seals is 152,602 (SE: 7,703) (NMFS, unpublished data), based on aerial survey data collected during 1998-2007. See table 1 for abundance estimates of the twelve stocks of harbor seals identified in Alaska. The minimum population estimate (N_{MIN}) for each of the twelve stocks of harbor seals identified in Alaska is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$.

Table 9b. Abundance and minimum population size estimates of harbor seals in Alaska by stock

Stock	Abundance Estimate	SE	Nmin
Aleutian Islands	3579	329	3313
Pribilof Islands	232		232
Bristol Bay	18577	1080	17690
N. Kodiak	4509	290	4272
S. Kodiak	11117	573	10645
Prince William Sound	31503	5599	27157
Cook Inlet/Shelikof	22900	1221	21896
Glacier Bay/Icy Strait	5042	377	4735
Lynn Canal/Stephens	8870	473	8481
Sitka/Chatham	8586	443	8222
Dixon/Cape Decision	14388	860	13682
Clarence Strait	23289	989	22471

Current Population Trend

Aerial surveys of harbor seal haulout sites throughout Alaska are conducted annually and provide information on trends in abundance. The following summarizes available information on the population trend for each of the 12 new stocks.

Aleutian Islands: A partial estimate of harbor seal abundance in the Aleutian Islands was conducted from a skiff survey of 106 islands from 1977-1982 (8,601 seals). Small et al. (2008) compared counts from the same islands during a 1999 aerial survey (2,859 seals). Counts decreased at a majority of the islands. Islands with greater than 100 seals decreased by 70%. The overall estimates showed a 67% decline during the approximate 20-year period (Small et al. 2008). The current population trend in the Aleutian Islands is unknown.

Surveying harbor seals in the Aleutian Islands is notoriously difficult. The Aleutian Islands are often blanketed with fog or high winds that limit aerial surveys to narrow windows of time. The logistics of surveying the entire length of the Aleutian Chain are also quite difficult with limited airports and limited access to fuel. Additionally, the haul-out patterns of harbor seals in the Aleutian Islands have not been studied, and there is no stock specific estimate of a survey correction factor. NMFS is committed to conducting surveys on an annual basis within the Aleutian Islands stock and improving our understanding of these behaviors; however, the logistical challenges likely mean longer time periods before adequate assessment of population trends and parameters can be completed.

Pribilof Islands: Counts of harbor seals in the Pribilof Islands ranged from 250 to 1,224 in the 1970s. Counts in the 1980s and 1990s ranged between 119 and 232 harbor seals. Prior to July 2010, the most recent count was in 1995 and reported a total count of 202. In July 2010, approximately 185 adult and 27 pups were observed on Otter Island plus approximately 20 on all the other islands combined for a total of 232 harbor seals. Maximum seal counts (all ages) are nearly identical to the 1995 counts (212 vs. 202), but pup numbers are slightly less (27 vs. 42). The current population trend in the Pribilof Islands is unknown.

Bristol Bay: At Nanvak Bay (the largest haul-out in northern Bristol Bay), harbor seals declined in abundance between 1975-1990 and increased from 1990-2000 (Jemison et al. 2006). Land-based harbor seal counts at Nanvak Bay from 1990-2000 increased at 9.2%/year during the pupping period and 2.1%/year during the molting period (Jemison et al. 2006). Data from the NMFS aerial surveys also show an increasing trend for this stock (NMFS unpublished data).

North Kodiak: Population trend information for the North Kodiak harbor seal stock is not available at this time.

South Kodiak: A significant portion of the harbor seal population within the South Kodiak stock is located at and around Tugidak Island off the southwest of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher 1990). While the number of seals on Tugidak has stabilized and show some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al. 2006). The current population trend for this stock is unknown.

Prince William Sound: The Prince William Sound stock includes harbor seals both within and adjacent to Prince William Sound. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost et al. 1999). More recent analysis of population abundance (ADFG, unpublished) and trend within Prince William Sound proper indicates the population stabilized around 2002 and has likely been increasing since then. Trend information and analysis for the entire Prince William Sound stock is not available at this time.

Cook Inlet/Shelikof: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and data from this study indicates a stable population of harbor seals during the August molting period (Montgomery et al. 2007). Aerial surveys along the Alaska Peninsula present greater logistical challenges and have therefore been conducted less frequently. The current population trend for the entire stock is unknown.

Glacier Bay/Icy Strait: The Glacier Bay/Icy Strait stock shows a negative population trend estimate for harbor seals from 1992-2008 in June and August for glacial (-7.7%/yr; -8.2%/yr) and terrestrial sites (-12.4%/yr, August only) (Womble et al. 2010). Trend estimates by Mathews and Pendleton (2006) were similar for both glacial and terrestrial sites. Long-term monitoring of harbor seals on glacial ice has occurred in Glacier Bay since the 1970's (Hoover 1983, Hoover-Miller 1994, Mathews and Pendleton 2006), and has shown this area to support one of the largest breeding aggregations in Alaska (Steveler 1979, Calambokidis et al. 1987). After a dramatic retreat of Muir Glacier, in the East Arm of Glacier Bay, between 1973 and 1986 (more than 7 km) and the subsequent grounding and cessation of calving in 1993, floating glacial ice was greatly reduced as a haul-out substrate for harbor seals and ultimately resulted in the abandonment of upper Muir Inlet by harbor seals (Calambokidis et al. 1987, Hall et al. 1995, Mathews 1995), Prior to 1993 seal counts were up to 1,347 in the East Arm of Glacier Bay; 2008 counts were fewer than 200 (Streveler 1979, Molnia 2007). The most recent data through 2008 show a decline of harbor seals in Glacier Bay (Womble et al. 2010) with adjusted mean counts from 2004-2008 less than those for 1992-2002 (Mathews and Pendleton 2006).

Lynn Canal/Stepehns: Population trend information for the Lynn Canal/Stephens harbor seal stock is unknown.

Sitka/Chatham: The population trend for the Sitka/Chatham harbor seal stock is unknown.

Dixon/Cape Decision: Population trend information for the Dixon/Cape Decision harbor seal stock is either increasing or stable.

Clarence Strait: The population trend for the Clarence Strait harbor seal stock is either stable or increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated for the twelve stocks of harbor seals identified in Alaska. Population growth rates were estimated at 6% and 8% between 1991 and 1992 in Oregon and Washington, respectively (Huber et al. 1994). Harbor seals have been protected in British Columbia since 1970, and the population has responded with an annual rate of increase of approximately 12.5% since 1973 (Olesiuk et al. 1990). However, until additional data become available from which more reliable estimates of population growth can be determined, it is recommended that the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Aleutian Islands: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Aleutian Islands stock harbor seal stock, PBR = 99 animals (3,313 x 0.06 x 0.5).

Pribilof Isands: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Pribilof Islands harbor seal stock, PBR = 7 animals ($232 \times 0.06 \times 0.5$).

Bristol Bay: 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: $PBR = N_{MIN} \times 1.0R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for pinniped stocks with an increasing or stable population trend (Wade and Angliss 1997). Thus, for the Bristol Bay harbor seal stock, PBR = 1,061 animals ($17,690 \times 0.06 \times 1.0$).

N. Kodiak: 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: $PBR = N_{MIN} \times 1.0R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for pinniped stocks with an increasing or stable population(Wade and Angliss 1997) . Thus, for the North Kodiak harbor seal stock, PBR = 256 animals ($4,272 \times 0.06 \times 1.0$).

South Kodiak: 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 1.0, the value for pinniped stocks with an increasing or stable population (Wade and Angliss 1997). Thus, for the South Kodiak harbor seal stock, PBR = 639 animals ($10,645 \times 0.06 \times 1.0$).

Prince William Sound: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Prince William Sound harbor seal stock, PBR = 815 animals ($27,157 \times 0.06 \times 0.5$).

Cook Inlet/Shelikof: 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: $PBR = N_{MIN} \times 1.0R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for pinniped stocks with stable or increasing trends (Wade and Angliss 1997). Thus, for the Cook Inlet/Shelikof harbor seal stock, PBR = 1,314 animals ($21,896 \times 0.06 \times 1.0$).

Glacier Bay/Icy Strait: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Glacier Bay/Icy Strait harbor seal stock, PBR = 142 animals ($4,735\times 0.06 \times 0.5$).

Lynn Canal/Stephens: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Lynn Canal/Stephens harbor seal stock, PBR = 254 animals ($8,481 \times 0.06 \times 0.5$).

Sitka/Chatham: 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Sitka/Chatham harbor seal stock, PBR = 247 animals (8,222 × 0.06 × 0.5).

Dixon/Cape Decision: 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 1.0, the value for pinniped stocks with an increasing or stable population (Wade and Angliss 1997). Thus, for the Dixon/Cape Decision harbor seal stock, PBR = 821 animals (13,682 × 0.06 × 1.0).

Clarence Strait: 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 1.0, the value for pinniped stocks with an increasing or stable population (Wade and Angliss 1997). Thus, for the Clarence Strait harbor seal stock, PBR = 1,348 animals (22,471 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Previous stock assessment for harbor seals indicated three observed commercial fisheries operated within the range of the Bering Sea stocks of harbor seals, three within the range of stocks in Southeast Alaska, and five within the range of harbor seal stocks in the Gulf of Alaska. As of 2003, changes in how fisheries are defined in the List of Fisheries have resulted in separating these fisheries in the Bering Sea into 14 fisheries, those in Southeast Alaska into 9 fisheries, and 22 fisheries in the Gulf of Alaska based on both gear type and target species (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.

Observer programs in several fisheries have documented mortalities or serious injuries of harbor seals in the Bering Sea/Aleutian Islands flatfish trawl, the Bering Sea/ Aleutian Islands pollock trawl, and the Bering Sea/Aleutian Islands Pacific cod trawl, as well as in salmon set gillnet (Cook Inlet and Kodiak Island) and salmon drift gillnet (Prince William Sound, Alaska Peninsula/ Aleutian Islands, and Cook Inlet) fisheries. Between 2007-2009, there was one observed mortality of a harbor seal in the Bering Sea/ Aleutian Islands pollock trawl fishery, which is the only observed serious injury or mortality observed in any Alaska groundfish fishery for this 3-year period (NMFS unpubl. data; Table 10).

The estimated minimum annual mortality rate of harbor seals incidental to commercial groundfish fisheries for the period 2007-2009 is 0.40. However, a reliable estimate of the overall mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with several of these stocks. Additionally, allocating any reported fishery mortalities to any one particular stock is problematic and the methodology for stock assignment is still under development. Therefore, for the purposes of stock assessment, a rate of 0.40 commercial fisheries mortalities is used for each stock.

Table 10. Summary of incidental mortality of harbor seals due to commercial fisheries from 2007 through 2009 and calculation of the mean annual mortality rate.

Fishery name	Years	Data type	Range of observer coverage (%)	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/	2007	obs	85	0	0	0.40
Aleutian Islands	2008	data	85	1	1.2	(CV = 0.40)
pollock trawl	2009		86	0	0	
Minimum total annual mortality						0.40 (CV = 0.40)

The Prince William Sound salmon drift gillnet fishery is known to interact with harbor seals, although the most recent observer data available for this fishery is from 1990 and 1991. The estimated minimum annual mortality rate incidental to salmon set and drift gillnet commercial fisheries is 24.0 (Table 11). This estimated annual mortality rate in the Prince William Sound salmon drift gillnet fishery (24.0) is added to the overall annual commercial fishery mortality (0.4) in the overall commercial fisheries mortality estimate (24.4) for the Prince William Sound stock of harbor seals.

Table 11. Summary of incidental mortality of harbor seals due to commercial salmon drift and set gillnet fisheries from 1990 through 2002 and calculation of the mean annual mortality rate based on the most recent observer program data available.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Prince William Sound salmon drift gillnet	90-91	obs data	4-5%	2, 1	36, 12	24 (CV = 0.50)
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90	obs data	4%	0	0	0
Cook Inlet salmon drift gillnet	1999 2000	obs data	1.8% 3.7%	0 0	0 0	0
Cook Inlet salmon set gillnet	1999 2000	obs data	7.3% 8.3%	0 0	0 0	0
Kodiak Island salmon set gillnet	2002	obs data	6.0%	0	0	0
Observer program total						24.0 (CV = 0.50)
Minimum total annual mortality						24.0 (CV = 0.50)

Subsistence/Native Harvest Information

The Alaska Native subsistence harvest of harbor seals has been estimated by the Alaska Native Harbor Seal Commission (ANHSC) and the Alaska Department of Fish and Game (ADFG). Recent information from the ADFG indicates the average harvest levels for the 12 stocks of harbor seals identified in Alaska from 2002-2008, including struck and lost, as follows (see table 12; average annual take column). As of 2009, data on community subsistence harvests are no longer being collected by ADFG. Therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating annual mortality estimates for all areas.

Table 12. Summary of the subsistence harvest data for all 12 harbor seal stocks in Alaska, 2003-2008. Data are from (Wolfe et al. 2004, Wolfe et al. 2006, Wolfe et al. 2008, Wolfe et al. 2009a, Wolfe et al. 2009b).

Stock	Minimum Annual Harvest	Maximum Annual Harvest	Average Annual Harvest
Aleutian Islands	50	146	90
Pribilof Islands	0	0	0
Bristol Bay	82	188	141
N. Kodiak	66	260	131
S. Kodiak	46	126	78
Prince William Sound	325	600	439
Cook Inlet/Shelikof	177	288	233
Glacier Bay/Icy Strait	22	108	52
Lynn Canal/Stephens	17	60	30
Sitka/Chatham	97	314	222
Dixon/Cape Decision	100	203	157
Clarence Strait	71	208	164

Other Mortality

The Alaska Region stranding records from 2005 to 2009 document stranded harbor seals with signs of human interaction. During this 5-year period, 5 strandings occurred due to unknown fishery interaction (1 in 2006, 1 in 2007, 2 in 2008, and 1 in 2009) and 2 from vessel collision (1 in 2008 and 1 in 2009. The average annual serious injury and mortality estimate based on stranding data is 1.4 over the 5 year period from 2005-2009. Stock assignment for these mortalities have not been made; therefore, the conservative approach of applying the 1.4 average annual mortality will be attributed to all stocks will be used. Mortalities may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003-2007, there were no mortalities resulting from research on the Bering Sea stock of harbor seals (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 10% of PBR can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. The status of all twelve stocks of harbor harbor seals identified in Alaska relative to their Optimum Sustainable Population size is unknown.

Aleutian Islands: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 9.9 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 90 + 1.4 = 91.8) is not known to exceed the PBR (99). Therefore, the Aleutian Islands stock of harbor seals is not classified as a strategic stock

Pribilof Islands:. Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 0.7 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 0 + 1.4 = 1.8) is not known to exceed the PBR (7). Therefore, the Pribilof Islands stock of harbor seals is not classified as a strategic stock.

Bristol Bay: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 106.1 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 141 + 1.4 = 142.8) is not known to exceed the PBR (1061). Therefore, the Bristol Bay stock of harbor seals is not classified as a strategic stock.

North Kodiak: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 25.6 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 131 + 1.4 = 132.8) is

not known to exceed the PBR (256). Therefore, the North Kodiak stock of harbor seals is not classified as a strategic stock.

South Kodiak: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 63.9 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 78 + 1.4 = 79.8) is not known to exceed the PBR (639). Therefore, the South Kodiak stock of harbor seals is not classified as a strategic stock.

Prince William Sound: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 81.5 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (24.4 + 439 + 1.4 = 464.8) is not known to exceed the PBR (815). Therefore, the Prince William Sound stock of harbor seals is not classified as a strategic stock.

Cook Inlet/Shelikof: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 131.4 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 233 + 1.4 = 234.8) is not known to exceed the PBR (1314). Therefore, the Bristol Bay stock of harbor seals is not classified as a strategic stock.

Glacier Bay/Icy Strait: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 14.2 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 52 + 1.4 = 97.8) is not known to exceed the PBR (142). Therefore, the Glacier Bay/Icy Strait stock of harbor seals is not classified as a strategic stock.

Lynn Canal/Stephens: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 25.4 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 30 + 1.4 = 31.8) is not known to exceed the PBR (254). Therefore, the Lynn Canal/Stephens stock of harbor seals is not classified as a strategic stock.

Sitka/Chatham: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 24.7 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury

(0.4 + 222 + 1.4 = 223.8) is not known to exceed the PBR (247). Therefore, the Sitka/Chatham stock of harbor seals is not classified as a strategic stock.

Dixon/Cape Decision: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 82.1 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 157 + 1.4 = 158.8) is not known to exceed the PBR (821). Therefore, the Dixon/Cape Decision stock of harbor seals is not classified as a strategic stock.

Clarence Strait: Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 134.8 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 164 + 1.4 = 165.8) is not known to exceed the PBR (1,348). Therefore, the Clarence Strait stock of harbor seals is not classified as a strategic stock.

CITATIONS

Bigg, M. A. 1969. The harbor seal in British Columbia. Bulletin Fisheries Research Board of Canada 172:1-33.

Bigg, M. A. 1981. Harbour seal: *Phoca vitulina* Linnaeus, 1758, and *Phoca largha* Pallas, 1811. Pages 1-27 *in* S. H. Ridgway and R. J. Harrison, editors. Handbook of Marine Mammals. Volume 2: Seals. Academic Press, London, UK.

Boveng, P. L., J. L. Bengtson, D. E. Withrow, J. C. Cesarone, M. A. Simpkins, K. J. Frost, and J. J. Burns. 2003. The abundance of harbor seals in the Gulf of Alaska. Mar. Mammal Sci. 19:111-127.

Calambokidis, J., B. L. Taylor, S. D. Carter, G. H. Steiger, P. K. Dawson, and L. D. Antrim. 1987. Distribution and haul-out behavior of harbor seals in Glacier Bay, Alaska. Canadian Journal of Zoology 65:1391-1396.

Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Bull. Fish. Res. Bo. Can. 93:1-58.

Frost, K. J., L. F. Lowry, and J. M. Ver Hoef. 1999. Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the Exxon Valdez oil spill. Mar. Mammal Sci. 15:494-506.

Hall, D. K., C. S. Benson, and W. O. Field. 1995. Changes of glaciers in Glacier Bay, Alaska using ground and satellite measurements. Physical Geography 16:27-41.

Härkönen, T., and K. C. Harding. 2001. Spatial structure of harbour seal populations and the implications thereof. Can. J. Zool. 79:2115-2127.

Hastings, K. K., K. J. Frost, M. A. Simpkins, G. W. Pendleton, U. G. Swain, and R. J. Small. 2004. Regional differences in diving behavior of harbor seals in the Gulf of Alaska. Can. J. Zool. 82:1755-1773.

Hoover, A. A. 1983. Behavior and ecology of harbor seals, *Phoca vitulina richardsi*, inhabiting glacial ice in Aialik Bay, Alaska. M.S. Thesis. University of Alaska, Fairbanks, Fairbanks, AK. 133 p.

Hoover-Miller, A. 1994. The harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission. 1-67 p.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal, *Phoca vitulina richardsi*, stock assessment in Washington and Oregon, 1993. U.S. Department of Commerce, 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources.

Jemison, L. A., G. W. Pendleton, C. A. Wilson, and R. J. Sniall. 2006. Long-term trends in harbor seal numbers at Tugidak Island and Nanvak Bay, Alaska. Mar. Mammal Sci. 22:339-360.

Lowry, L. F., K. J. Frost, J. M. Ver Hoef, and R. A. DeLong. 2001. Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. Mar. Mammal Sci. 17:835-861.

Mathews, E. A. 1995. Longterm trends in the abundance of harbor seals, *Phoca vitulina richardsi*) and the development of monitoring methods in Glacier Bay National Park, Southeast AlaskaD. R. Engstrom, editor. Proceedings of the Third Glacier Bay Science Symposium, Gustavus, AK. U.S. National Park Service, Glacier Bay National Park and Preserve.

Mathews, E. A., and G. W. Pendleton. 2006. Declines in harbor seal (*Phoca vitulina*) numbers in Glacier Bay National Park, Alaska, 1992-2002. Mar. Mammal Sci. 22:167-189.

Molnia, B. F. 2007. Late nineteenth to early twenty-first century behavior of Alaskan glaciers as indicators of changing regional climate. Global and Planetary Change 56:23-56.

Montgomery, R. A., J. M. Ver Hoef, and P. L. Boveng. 2007. Spatial modeling of haul-out site use by harbor seals in Cook Inlet, Alaska. Marine Ecology Progress Series 341:257-264.

O'Corry-Crowe, G. M., K. K. Martien, and B. L. Taylor. 2003. The analysis of population genetic structure in Alaskan harbor seals, *Phoca vitulina*, as a framework for the identification of management stocks. Southwest Fisheries Science Center Administrative Report LJ-03-08. 1-54 p.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Recent trends in the abundance of harbor seals, *Phoca vitulina*, in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 47:992-1003.

Pitcher, K. W. 1990. Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Mar. Mammal Sci. 6:121-134.

Pitcher, K. W., and D. C. McAllister. 1981. Movements and haulout behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field-Nat. 95:292-297.

Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington State. Am. Midland Nat. 32:373-416.

Simpkins, M. A., D. E. Withrow, J. C. Cesarone, and P. L. Boveng. 2003. Stability in the proportion of harbor seals hauled out under locally ideal conditions. Mar. Mammal Sci. 19:791-805.

Small, R. J., P. L. Boveng, V. G. Byrd, and D. E. Withrow. 2008. Harbor seal population decline in the Aleutian archipelago. Mar. Mammal Sci. 24:845-863.

Small, R. J., L. F. Lowry, J. M. Ver Hoef, K. J. Frost, R. A. DeLong, and M. J. Rehberg. 2005. Differential movements by harbor seal pups in contrasting Alaska environments. Mar. Mammal Sci. 21:671-694.

Small, R. J., G. W. Pendleton, and K. W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. Mar. Mammal Sci. 19:344-362.

Streveler, G. P. 1979. Distribution, population ecology and impact susceptibility of the harbor seal in Glacier Bay, Alaska U. S. National Park Service Final Report 49 p.

Swain, U., J. Lewis, G. Pendleton, and K. Pitcher. 1996. Movements, haul-out, and diving behaviour of harbor seals in southeast Alaska and Kodiak Island. Pages 59-144 *in* Annual Report: Harbor Seal Investigations in Alaska, NOAA Grant NA57FX0367. Division of Wildflife Conservation, Alaska Department of Fish and Game, Douglas, AK.

Wade, P. R., and R. P. 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 p.

Westlake, R. L., and G. M. O'Corry-Crowe. 2002. Macrogeographic structure and patterns of genetic diversity in harbor seals (*Phoca vitulina*) from Alaska to Japan. Journal of Mammalogy 83:1111-1126.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2008. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2006. Alaska Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 339. 91 p.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2009a. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2007. Alaska Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 345. 95 p.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2009b. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2008. Alaska Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 347. 93 p.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2004. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2003. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 291.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2006. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2005. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 319.

Womble, J. N., G. W. Pendleton, E. A. Mathews, G. M. Blundell, N. M. Bool, and S. M. Gende. 2010. Harbor seal (*Phoca vitulina richardii*) decline continues in the rapidly changing landscape of Glacier Bay National Park, Alaska 1992–2008. Marine Mammal Science 26:686-697.