Estimating the harvest of Pacific walrus, *Odobenus rosmarus divergens*, in Alaska

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For thousands of years, walrus hunting has been an important component of the economy and culture of Native communities along the Bering and Chukchi Sea coasts (Ray, 1975). Today, the Pacific walrus (*Odobenus rosmarus divergens*) remains a valuable resource to coastal natives in Alaska (United States) and Chukotka (Russia) as a source of food and raw materials for traditional equipment and handicrafts.

Accurate information regarding the number of animals removed annually from the population is fundamental for the conservation and management of any species. As the agency responsible for managing Pacific walrus in U.S. waters, the U.S. Fish and Wildlife Service (FWS) gathers data on the size and composition of the subsistence walrus harvest in Alaska. The FWS presently administers two separate harvest monitoring programs: the Walrus Harvest Monitoring Project (WHMP) and the Marking Tagging and Reporting Program (MTRP).

The WHMP is an observer program carried out at select walrus hunting villages in Alaska. Each spring, as the pack ice recedes northward, hunters from coastal communities in the Bering Strait region have access to herds of walrus as they migrate to their summer range. Historical harvest information indicates that approximately 80% of the annual reported walrus harvest in Alaska occurs in this region (Fay and Bowlby[1]). WHMP monitors stationed at the primary walrus hunting villages in the Bering Strait region (Gambell, Savoonga, Little Diomede and Wales; Fig. 1) collect information on the size and composition of the walrus harvest. Harvest monitors meet boats as they return from walrus hunting trips in order to collect biological samples and harvest information at the boat landing site (Garlich-Miller[2]). The goal of the WHMP is to identify and record the gender and age class of every walrus retrieved by hunters from these villages during the monitoring period. Although there is no way of evaluating the degree to which this goal is achieved, WHMP monitors meet most of the returning boats, and the number of retrieved animals not recorded during the harvest monitoring period is believed to be small (Dickerson[3]).

The MTRP is a Federally mandated year-round, statewide program (Fig. 1). The marking and tagging rule requires that all hunters certify (tag) walrus ivory (tusks) and report all walruses that are taken. The objectives of the MTRP are to collect harvest information and to certify specified marine mammal parts to help control illegal harvests and trade. Hunters are required to bring walrus tusks to a MTRP tagger within 30 days of the kill. The tagger attaches individually numbered wire tags to the tusks and records the numbers on a tagging certificate. MTRP tags are not attached to calf walruses (or other walruses that may be missing tusks); however, hunters are required to report all animals taken. The age class, gender, kill date, and kill location of each walrus are recorded on the certificate (Stephensen et al.[4]).

These two programs independently provide information on the size and composition of the harvest. Except in the case of the village of Wales, WHMP and MTRP staff are different people. Each of the two monitoring programs has its strengths and weaknesses. The WHMP benefits from the presence of on-site staff to collect accurate biological information from every walrus retrieved in a community during the monitoring period. Unfortunately, the monitoring period is seasonal (restricted to the spring hunt) and operates only in four coastal villages. The MTRP is a statewide, year-round program; however hunter compliance with the MTRP rule is variable and animals lacking tusks (e.g. calves, yearlings, and animals with broken tusks) often go unreported (Burn, 1998).

1 Fay, F. H., and C. E. Bowlby. 1994. The harvest of Pacific walrus, 1931–1989. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. Technical report MMM 94-2,43 p.

2 Garlich-Miller, J. 1997. Age, sex, and reproductive status of Pacific walrus harvested in the Bering Strait region, 1994–1996. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. Technical Report MMM 97-1,25 p.

3 Dickerson, L. 1989. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. Personal commun.

4 Stephensen, W. D., D. Cramer, and D. Burn. 1994. Review of the Marine Mammal Marking Tagging and Reporting Program, 1982–1992. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. Technical Report MMM 94-1, 49 p.

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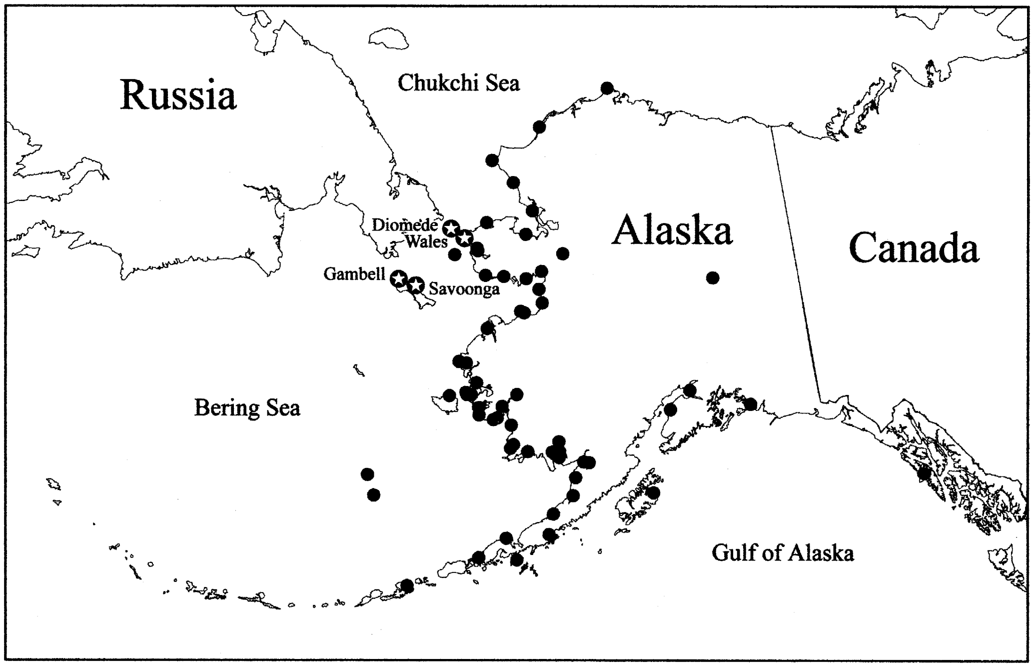

Figure 1

Location of Alaska villages where walrus harvest information is collected through the Walrus Harvest Monitor Project (✪) and the Marking Tagging and Reporting Program (●). Note that tusks may be tagged in selected locations outside the walrus' range.

Owing to funding and logistical constraints that prevent the year-round, statewide implementation of the WHMP and imperfect hunter compliance with the MTRP, not all harvested walruses are recorded. The FWS must therefore rely on analytical methods to estimate the size of the total annual harvest based on the best available information. Here we describe a new method for estimating the size of the annual walrus harvest in Alaska using a correction factor for noncompliance with the MTRP rule.

Materials and methods

Prior to the initiation of the MTRP, the statewide walrus harvest was approximated by using a prediction equation applied to WHMP data. The prediction equation was based upon the historic relationship of the size of the spring harvest at WHMP-monitored villages in relation to the remaining hunting villages in Alaska. This information was obtained from the Alaska Department of Fish and Game, which administered a statewide harvest monitoring program between the years of 1960 and 1978. To estimate the statewide harvest, the FWS used a least-squares regression to describe the relation between the Gambell, Savoonga, and Diomede harvests to the statewide totals. The resulting prediction equation (Equation 1, r^2=0.239) was subsequently used to estimate the total statewide harvest on the basis of data collected annually after 1978 through the WHMP at Gambell, Savoonga, and Diomede.

$$N = 459.7 + 1.26\ (WHMP_{Total}), \qquad (2)$$

where N = total statewide harvest estimate; and $WHMP_{Total}$ = total number of retrieved walruses recorded during monitored spring hunts at select villages (Diomede, Gambell, and Savoonga) for a given year.

The evolution of the MTRP as a year-round, statewide monitoring program provided the opportunity to improve the reliability of harvest estimates by using current data. Because there is spatial and temporal overlap between the two programs, the WHMP can serve as a baseline for evaluating compliance with the MTRP program. A correction factor for noncompliance can be estimated as a proportion by using the following equation:

$$R = \frac{WHMP_{Total}}{MTRP_{WHMP}}, \qquad (2)$$

Table 1

Walrus harvest data from the Walrus Harvest Monitor Project (WHMP) and Marking, Tagging, and Reporting Program (MTRP), 1992–1997.

Year	$WHMP_{Total}$	$MTRP_{WHMP}$	Correction factor (R)	Standard error SE(R)	$MTRP_{Total}$	Prediction Equation 1	Proportional Equation 3	95% CI of Equation 3
1992	820	976			1700	1491[1]		
1993	710	708	1.003	0.21	1189	1353	1192	703–1682
1994	971	799	1.215	0.17	1328	1681	1614	1171–2056
1995	1204	785	1.534	0.17	1096	1974	1681	1316–2046
1996	1220	773	1.578	0.33	1572	1994	2481	1464–3497
1997	856	574	1.491	0.09	1045	1537	1558	1373–1742

[1] The calculated estimate was less than the value of $MTRP_{Total}$. The $MTRP_{Total}$ was therefore used as a minimum estimate of the statewide walrus harvest.

where R = correction factor for noncompliance; and

$MTRP_{WHMP}$ = a subset of the number of walruses recorded through the MTRP with reported kill dates and locations that coincide with WHMP operations (presumed to have been recorded through both the MTRP and the WHMP).

The standard error of this ratio estimate is calculated according to Snedecor and Cochran (1967, p. 537) by treating each of the three villages as independent estimates of overall compliance. Data from the village of Wales were not used in the analysis because of small harvests and a lack of independence between the WHMP and MTRP programs in that village.

Assuming the estimated compliance with the MTRP is uniform throughout the full range of walrus hunting villages, the total MTRP harvest can be adjusted as follows:

$$N = MTRP_{Total} \times R, \qquad (3)$$

where $MTRP_{Total}$ = the total number of walrus recorded through the MTRP.

Results

Data from the MTRP and WHMP are currently available for the years 1992–97 (Table 1). Estimated compliance with the MTRP (the reciprocal of R) ranged from 63% to 99%. Harvest estimates based on the prediction equation and the proportional equation differed depending on the proportion of animals recorded through each of the two monitoring programs. The difference between the two methods was not statistically significant for any year. Comparisons of the 1992 MTRP and WHMP harvest data suggests that the WHMP monitors were unable to account for all the retrieved walruses landed during the monitoring period. In this instance, the $MTRP_{Total}$ was considered the minimum estimate of the statewide harvest.

Discussion

Prior to 1997, the FWS used WHMP data collected annually at Gambell, Savoonga, and Diomede as an index for estimating the total statewide harvest of walrus. One drawback of this method has been that the equation assumes that the relation between the hunting success of WHMP and non-WHMP villages is constant over time (Fay et al., 1997). In fact, recent harvest data have shown that the relative hunting success of each village is highly variable. The annual harvest at each village is subject to large interannual variation, presumably as a result of weather and ice patterns affecting the availability of walruses to hunters at a given geographical location (Garlich-Miller[2]).

One advantage of the proportional equation (Eq. 3) over the prediction equation (Eq. 1) is that it can account for variability in the relative success of hunting villages. For example, on the basis of comparable numbers of walrus recorded through the WHMP in Gambell, Savoonga, and Diomede in 1995 and 1996, the prediction equation produced remarkably similar harvest estimates for the two years (1974 and 1994 walrus, respectively). Although MTRP compliance rates were also comparable for these years, the proportional equation, in which statewide MTRP data were used, produced harvest estimates that were markedly different (1681 and 2481 walrus, respectively). We believe that this difference, which reflects interannual variability in the hunting success of non-WHMP villages, more accurately reflects statewide harvest levels for these two years. For the reasons stated above, the FWS has adopted the use of the proportional equation to estimate the size of the walrus harvest.

In 1992, the assumption that all retrieved walrus were recorded during WHMP operations was not met. In this instance we considered the uncorrected MTRP data as a minimum harvest estimate for that year. The WHMP was re-initiated in 1992 after a two-year hiatus; the lack of experienced personnel likely contributed to the poor monitoring results that season. Since that time, program managers have attempted to improve the program by hiring experienced monitors and additional village assistants to meet all returning boats and by emphasizing the importance of recording all retrieved animals (Dickerson[3]).

Another assumption of the proportional equation is that compliance in the villages of Gambell, Savoonga, and Diomede is representative of non-WHMP villages. Compliance was variable between villages and years, suggesting that there was little correlation between the two programs. Since conducting analyses of MTRP compliance, information and education efforts in these villages appear to have been effective at increasing compliance. The accuracy of this method could be improved by increasing the number of villages in the WHMP.

In both the prediction and proportional equations, estimates are based on the number of walrus that are retrieved by hunters. Fay et al. (1994) estimated that 42% of walrus struck by hunters are not retrieved and subsequently die at sea. In order to estimate total human-caused removals from the Pacific walrus population, harvest estimates are adjusted to account for animals struck and lost.

Accurate harvest data are vital to the management of the Pacific walrus population. Harvest data are incorporated into stock assessment reports that chart the status and trend of the population. The stock assessment process compares estimates of human-caused mortality with a calculated potential biological removal (PBR) level to determine the status of a stock. One of the reasons a stock may be designated as “strategic” depends upon whether or not its level of human-caused mortality exceeds the calculated PBR level (Wade, 1998). Since 1992, most human caused mortality affecting the Pacific walrus population has been associated with walrus hunting activities in Alaska and Chukotka. Between 1992 and 1996 the combined annual take of walrus in the U.S. and Russia averaged 4869 walrus per year (Gorbics et al.[5]). Russian harvest data are currently unavailable for 1997. Because annual estimates of human caused mortality have been lower than the calculated PBR of 7533 the population has been classified as non-strategic (Gorbics et al.[5]). It is essential that harvest monitoring in both nations be maintained in order to accurately assess the impact of the harvest to this stock.

In summary, this new method of harvest estimation uses data from both harvest monitoring programs to account for interannual and intervillage variability in hunting success and applies a correction factor to adjust total harvest estimate to account for noncompliance with the MTRP. The accuracy of harvest estimates is therefore dependent upon the degree of hunter compliance with the MTRP rule. It is hoped that through ongoing information and education efforts that explain the importance of accurate harvest data, the understanding of and compliance with monitoring programs will improve.

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