Appendix 3

BOWHEAD POPULATION ESTIMATE AND VARIANCE

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As indicated in SC/39/PS7, likely upward bias in the 1986 population size estimates in Table 7 of that paper preclude their use in assessing the size of the stock. Sub-committee discussions have pointed to the estimates 8,778 and 5,641 as the most acceptable estimates among those presented for 1985. Clear sources of bias (for example, the failure to account for unmonitored hours) suggest that the other 1985 estimates in Table 7 should be eliminated.

It would be desirable to have independent evidence that the tracking parameters used produce unbiased counts of whales. Separate studies of bowhead migration behaviour indicate a reasonable range of speed and direction parameters but provide only limited help in setting these parameters for a particular part of a particular season.

We therefore depend on the visual census to guide our choices. The tracking parameters which result in the

estimate 8,778 also produce counts of visual tracks which match the observers' counts of new whales plus half the conditional whales. The tracking parameters which produce the estimate of 5,641 result in a somewhat better match between speed and direction distributions computed from tracks and from duplicate sightings made by the visual census.

Thus we cannot be sure which of these estimates is most unbiased. We therefore propose their average (7,200) as our current best estimate of the size of this stock. A jack-knife variance estimate was suggested by Chapman. Such an estimate, conditioned on the assumption that the tracking algorithm counts duplicates correctly, was computed from the data which produced the estimate 5,641. We were not able to compute a variance for the larger estimate because we did not have all the necessary data at this meeting.

The jack-knife variance estimate we use is given by (18) and (19) of Zeh *et al.* (1986, *Rep. int. Whal. Commn* 36: 317–23). We have 35 time periods of varying length with acoustic and/or visual watch in the 1985 season*. We can therefore obtain 35 different population estimates by omitting each period in turn from our calculations. The appropriate average of these provides a variance estimate which reflects the effect of omission of each period on the mark-recapture estimates of whale numbers and detection probabilities, the estimates P_3, and interpolation for unmonitored hours. The estimated standard error obtained by this method is 1,900. We believe this provides a reasonable measure of the variability of the estimate 5,641.

The standard error reported above indicates a coefficient of variation of 34% which we assume is applicable to the mean estimate of 7,200. We therefore propose 7,200 ± 2,400 (where 2,400 is 1SE) as the current best population size estimate.

* Our 35 time periods take the role of the watched days in equations (18) and (19).