Section 4 GARM Summary Comments on Evidence for Interventions in Trawl Survey Data Beginning in 2000

This section summarizes a variety of investigations on the potential effects of mismarked cables on the Northeast Fisheries Science Center trawl survey abundance indices for 2000 to 2002. There were eight affected surveys (winter 2000, 2001 and 2002; spring 2000, 2001 and 2002; and fall 2000 and 2001). Information collected from dockside warp measurements indicated that the warp mis-calibration was related to the initial biased marking of the 50 meter intervals on one warp and was not due to progressive wire stretch. Therefore, the degree of intervention was thought to be approximately equal in all surveys since winter 2000.

These indices serve as fishery-independent measures of relative population size and are integral components of mathematical models used to estimate absolute population size. The indices of average numbers and weight per tow are derived from a stratified random survey design and the precision of the estimates can be derived using well-known statistical methods. Every method of sampling has limitations that introduce bias into the estimates. If the various factors that introduce bias are constant over time, the ability to detect population trends is not compromised. However, if bias factors change over time, true changes in abundance are confounded with unestimated bias. The relative precision of the survey estimates has important implications for the ability to detect bias changes. In the case of potential bias induced by asymmetric trawl cables, the effect (or signal) must exceed the normal range of variability (or noise) in the survey estimates.

The potential effects of warp offset can be addressed with a combination of deductive and inductive approaches. The magnitude of the difference of marks between the port and starboard cables increases with the amount of cable deployed. Geometric principles suggest that the maximum difference in the area swept per tow at 250 m would be less than 5%; over 96% of the stations sampled in a typical survey occur at depths less than 250 m. If significantly greater reductions in catchability are postulated, they must be attributable to major changes in the performance of the doors such that a) the net does not open as wide, b) the net loses contact with the bottom, c) the headrope height decreases, or d) mechanical vibrations or changes in pressure waves enhance the avoidance behavior of fish. If a) is true, then all species should experience a common rate of decline. If b) is true, bottom tending fish, especially flounders should show greater reductions than round groundfish. Factor c) would reduce the volume of water filtered, and have a similar effect to reduction in area swept. Finally if d) is true, then abundance faster-swimming species and larger-sized individuals would have show greater reductions in abundance than their more sluggish counterparts. These deductions can be used in the interpretation of comparisons across species and can also guide the analysis of trawl mensuration data.

The GARM reviewed the results of a series of 10 different studies to evaluate evidence for an intervention in the NMFS trawl survey data associated with the use of mis-calibrated trawl warps (the wire ropes attaching the trawl doors to the vessel).

Information on the potential effects of the warp offset on trawl survey performance evaluated by the GARM included studies of rates of gear damage over time, calculations of trawl geometry as a function of the warp offsets, by depth, patterns in mean/variance relationships in trawl survey catch data by stock, and depth-at-capture information from pre- and post-warp misaligned cruises. Additionally, the GARM evaluated trends (directional changes from year-to-year) in abundance measures before and after the warp mis-marking. The results from side-by-side trawling experiments conducted by the *Albatross* and *Delaware* vessels to estimate their relative fishing power, conducted before and after the warp mis-marking on the *Albatross* were also considered. Standardized catch-rates from surveys conducted with mis-matched warps were compared to survey CPUEs from surveys with comparable spatial and temporal coverage, and unaffected by the problem (e.g., Canadian trawl surveys and USA sea scallop surveys). The GARM also examined evidence for differences in length distributions from survey catches pre- and post warp offset by evaluating the relative size composition in Canadian and USA spring surveys in overlapping survey areas (e.g. Eastern Georges Bank). Monkfish size composition data collected on industry-based surveys and the winter 2001 *Albatross* survey were also compared, as were length compositions obtained in side-by-side trawling between *Albatross* and *Delaware* in spring 2002.

The GARM examined information on wing-spread and headrope height measurements from experimental warp offsets as presented at the Trawl Warp Workshop conducted during October 2-3, 2002. Using data collected during the September 25-27 warp experiment. Additionally, The GARM examined video information collected in the same warp-offset experiments.

It was postulated by gear experts at the Trawl Warp Workshop that the warp offset would induce changes in gear efficiency resulting from the "long" trawl wing being more prone to damage (as it would be potentially more susceptible to hang-ups). The GARM found no significant change in the frequency of trawl tows experiencing minor or major damage associated with the warp offset as compared to previous surveys with correct warp markings.

It was postulated at the Trawl Warp Workshop that one effect of misaligned warps might be the differential loss of large fish in survey catches. Based on examinations of size distributions of cod and haddock, not only was there little difference in the proportions of large fish but there was little apparent difference in the entire size frequency, by survey series, of these stocks pre- and post warp offset time period in both USA and Canadian series in areas of overlap (northeast Georges Bank). The small relative differences in USA mean length distributions of cod and haddock for the three years before and three years after the warp offset were similar to the differences in the Canadian series in pre- and post warp periods. Differences in the size composition of large monkfish between industry and *Albatross* winter surveys were minimal. Size compositions from *Albatross-Delaware* paired towing experiments in spring 2002 also indicated no loss of large fish due to the *Albatross* warp mis-marking.

Trawl mensuration data indicate that wing spread and head rope height did not vary appreciably with offsets that occurred in depths where groundfish typically occur (e.g. warp offset up to about 9 feet), and the net remained open with warp offsets up to 18 feet. Consistent trawl performance within this range of warp offsets is supported by the absence of detectible effects as indicated by the other information reported herein. The GARM noted that catching efficiency might be related to other factors such as bottom contact by the foot rope and vibrations associated with the offset gear. Video information on the former was equivocal (as concluded at the Trawl Warp Workshop where some participants thought the foot rope contact changed with offsets while others did not). Measurements on vibrations and pressure waves in relation to warp offsets were not made.

Calculations based on geometry of the trawl in the offset condition (a worst-case scenario) and the postulated increase in the potential problem in relation to species catches-at-depth indicate that reductions on the order of 50% or larger in trawl survey catches are implausible.

It was postulated by the GARM that if there was a trawl warp effect, more variable catches might result from a misaligned net, influencing the relationship between the variance and the mean. Empirical plots of catch data indicated no apparent differences in the variance compared to mean relationships for the species examined, and plots of the coefficient of variation (standard deviation divided by the mean) of catches in numbers by survey stratum over time showed no obvious differences pre- and post warp offsets.

Since the warp offset increased proportionally with depth, it was postulated that if the catch efficiency of the trawl decreased accordingly, a shallower apparent depth of capture for the deeper-dwelling species in the post-offset period as compared with the pre-offset surveys would be observed. There were no detectable differences in the catch-weighted depth of capture of any species examined relative to the warp offset.

There was no evidence for a trend in the direction of abundance index changes associated with the warp offset, when comparing pairs of adjacent years. For each pair of years (e.g., 1998 versus 1999, 1999 versus 2000, etc.), the direction of the abundance index change was evaluated. While the evaluation of the changes in abundance indices are potentially confounded by underlying changes in resource abundance, the number of stock/index combinations showing positive increases in abundance was virtually identical between 1998-1999 and 1999-2000 (when the intervention was made). The abundance indices for the deepest dwelling stocks did not show differential reductions between years pre and post-warp offsets.

Albatross trawl survey data were compared to independent surveys conducted by other vessels (e.g. Canadian trawl survey and sea scallop dredge surveys aboard *Albatross* but using a single warp*)*. The frequency of species showing positive relative changes in abundance in *Albatross* surveys was nearly the same in the three years before (50%) and the three years after (54%) the warp change. For all species, the relative fishing power of

Albatross post warp change was slightly but not statistically greater than the comparison vessels.

In examining the various stock assessments, there was no obvious improvement in VPA residual patterns (e.g., reduced serial correlation) or tightness of the fit when trawl survey catches were arbitrarily increased by 10%, 25% and 100%. In fact, VPA model fits showed, on average, a 4% decrease in model fit when survey indices in 2000-2002 were arbitrarily increased by 100%. Similarly, retrospective patterns that occur in some VPA models persisted even with the arbitrarily increased survey catches. The stock assessment models integrate catch-at-age information and the full time series from the surveys, thereby damping the influence of variation in recent survey indices.

Fishing power studies were conducted between *Albatross IV* and *Delaware II* in 2002 (after the warp change on the *Albatross*) and in 1982, 1983, and 1988. Estimates of fishing power coefficients (ratio of *Albatross* to *Delaware* catches) were similar between vessels in experiments before and after the warp change on *Albatross IV*. There was only one statistically significant change in this ratio after the warp change in 10 species examined. In this one case, the ratio of *Albatross* to *Delaware* catch of yellowtail flounder increased between the 1980s and 2002. These paired comparison tests (although not intended for that purpose at the time) provide robust data to test the warp effects (and include any other systematic changes in the fishing system since 1988). Specifically, because these paired trawl studies were conducted simultaneously before and after the warp offset they are not confounded by underlying changes in the abundance of the groundfish stocks. Based on information from 2002, the catch ratio test can detect differences of between 12 and 35%, depending on species. Therefore large (greater than 40-50%) reductions in catchability of the *Albatross* survey during the period of the warp offset are highly unlikely. For all species combined, the ratio of *Albatross-Delaware* catches was 0.88 before the warp offset and 0.91 after, suggesting negligible change.

Based on the evidence cited above, there is no indication of a systematic reduction in trawl survey fish catch efficiency due to the trawl warp offsets.