3.11 Results from Comparative Fishing Power Studies Between *Albatross IV* and *Delaware II*

Fishing power studies (calibration experiments) are necessary if significant changes are made to elements of the trawl survey system over the time series. Such studies have been conducted in the past for the NEFSC bottom trawl surveys when elements such as survey ships and trawl doors have been changed (Sissenwine and Bowman, 1978; Byrne and Forrester, 1991; Forrester unpublished ms). These studies rely on side-by-side or repeat towing, with tows taken by one vessel serving as control, and the element of change (e.g., doors or ships) as the primary factor under investigation. Other variables such as the order of tows in repeat towing or the orientation of side-by-side towing (port vs. starboard) are usually randomized.

A one-time change in the trawl gear that affected the catching efficiency and, hence, the survey series was made in the 1980s as the doors were upgraded from a BMV wood and metal door to an all-metal oval polyvalent door (Byrne and Forrester 1991). To appropriately adjust the time series, conversion factors were estimated from replicated towing experiments to maintain the integrity of the time series, as the new doors generally improved the catch efficiency of the survey tows. Similarly, while the *Albatross IV* has been the primary survey vessel used in the bottom trawl time series, because of various scheduled and unscheduled maintenance and repair issues, the *Delaware II* has periodically been substituted as the survey ship. Therefore, a series of side-by-side comparison tows have been made since the early 1980s to estimate the relative efficiency of the two ships, by species, for use in calibration (Byrne and Forrester 1991). Following calibration, data from the two vessels are comparable. Since the *Albatross* will enter the shipyard for extensive repairs in late 2002, it was anticipated that the *Delaware II* would be used as the bottom trawl survey ship for the winter 2003 and spring 2003 surveys. Therefore, additional side-by-side tows were conducted in conjunction with the spring 2002 bottom trawl survey.

Unbeknownst to the NEFSC at the time, the spring 2002 side-by-side towing between *Albatross* and *Delaware* essentially compared one vessel with systematic and progressive trawl warps offset (*Albatross*) against a ship with small but non-biased warp measurement differences (*Delaware* warp offsets averaged 18", varying randomly between port and starboard sides). Since there are differences in fishing power by ship (Byrne and Forrester 1991), the side-by-side towing results in 2002 cannot be compared directly to measure effects of the warp offset on *Albatross*. However, the results of the hundreds of side-by-side tows made between 1982 and 1988 can be compared to 2002 results to see if the ratio of *Albatross* to *Delaware* catches (by species) have changed (catch rates cannot be compared directly between the two time periods since underlying abundances have changed). Thus, the *Delaware* effectively serves as control, because its operating procedure was constant before and after the warp offset on *Albatross*.

If the warp offsets on *Albatross* had a significant impact on trawl catch efficiency then this would be manifested as a difference in the ratio of *Albatross* to *Delaware* catches between time periods. Information on the mean ratio of catches (A/D) and their 95% confidence intervals are presented for the two time periods in Table 3.11 and Figure 3.11.1, for 10 species where there

were sufficient pairs of data to provide meaningful and reliable information for analysis. Sample sizes were 484 pairs of tows in the 1980s and 132 pairs in 2002. Over the 10 stocks considered, the mean ratio of *Albatross* to *Delaware* catch in the 1980s was 0.88, and in 2002 was 0.91. For the 10 species investigated, five had higher mean ratios in 2002 versus the 1980s, and 5 the opposite trend. Of the 10 species investigated, there were no statistically significant changes in the ratio of *Albatross* to *Delaware* catches in nine; the one significant difference was for yellowtail flounder, which indicated an apparent increase in fishing power of the *Albatross* relative to the *Delaware* in 2002. Because the experimental units are the trawl hauls, the results for the 10 species are not independent, and thus the most robust measure of change is based on the composite of species. The apparent increase in catching efficiency for yellowtail flounder could be spurious (one false positive out of ten is not unlikely; on average this occurs in one out of 20 times in tests at the 5% significance level).

In order to discern the ability of this test to detect differences in relative fishing power between ships and time periods, the 2002 data were subjected to a power analysis. Information presented is the percent difference in the ratio of *Albatross* to *Delaware* catches, by species, that can be detected at the 5% significance level in a two-sided test. For all species the average difference in catch ratios that could be detected was 21.4%, varying from 12.2% (haddock) to 34.6% (winter flounder; Table 3.11; Figure 3.11.2).

Estimates of fishing power coefficients (ratio of *Albatross* to *Delaware* catches) were thus 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 the 10 species examined (and this result could be spurious). These paired comparison tests (although not intended for the purpose when they were conducted) provide robust data to test the warp effects (and include any other systematic changes in the fishing system since 1988 such as the new method for lashing the net to the traveler wire). Based on information from 2002, the catch ratio test can detect differences of between 12% and 35%, with 95% probability, 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 as they should have been detected.

References

Byrne, C.J., and J.R.S. Forrester. 1991. Relative fishing power of NOAA R/Vs Albatross IV and Delaware II. National Marine Fisheries Service, Stock Assessment Workshop Working Paper SAW/12/P1. 8 pp (mimeo).

Forrester, J.R.S. (m.s.). A trawl survey conversion coefficient suitable for lognormal data. National Marine Fisheries Service, Woods Hole laboratory 17 pp (mimeo)

Sissenwine, M.P. and E.W. Bowman. 1978. An analysis of some factors affecting the catchability of fish by bottom trawls. ICNAF Research Bulletin 13: 81-87.

Table 3.11. Estimated relative fishing power coefficients (ratio of *Albatross* to *Delaware*) for side-by-side trawling studies done between 1982 and 1988 and in spring 2002. Data are given for 10 species for which sufficient numbers of catch pairs (Albatross and Delaware) are available to support the analysis. The percent of difference in fishing power that is detectable at the 0.05 level of significance (two-tailed test), based on 2002 data is also presented. Means over species and experiments are given.

Species	1982-1988 Ratio	1982-1988 SE	1982-1988 L-95% CI	1982-1988 U-95% CI	2002 Ratio	2002 SE	2002 L-95% CI	2002 U-95% CI	2002 % Detectable Difference
Yellowtail Flounder	0.7390	0.0512	0.6386	0.8394	1.1087	0.1118	0.8896	1.3278	19.8
Winter Skate	0.8450	0.1036	0.6419	1.0481	0.7750	0.0874	0.6037	0.9463	22.1
Winter Flounder	0.9745	0.0892	0.7997	1.1493	0.8781	0.1548	0.5747	1.1815	34.6
Four Spot Flounder	0.8396	0.0405	0.7602	0.9190	1.0530	0.1019	0.8533	1.2527	19.0
Cod	0.7190	0.1007	0.5216	0.9164	0.8780	0.1520	0.5801	1.1759	33.9
Haddock	1.1056	0.2069	0.7001	1.5111	0.8096	0.0506	0.7104	0.9088	12.2
Red Hake	0.8965	0.1073	0.6863	1.0167	0.8096	0.0507	0.7102	0.9090	12.3
Silver Hake	1.1040	0.2740	0.5670	1.6410	0.8620	0.0740	0.7170	1.0070	16.8
American Plaice	0.7802	0.0670	0.6489	0.9115	0.8975	0.0851	0.7307	1.0643	18.6
White Hake	0.7818	0.0949	0.5958	0.9678	1.0620	0.1320	0.8033	1.3207	24.4
Mean	0.8785	0.1135	0.6560	1.1010	0.9134	0.1000	0.7173	1.1094	21.4

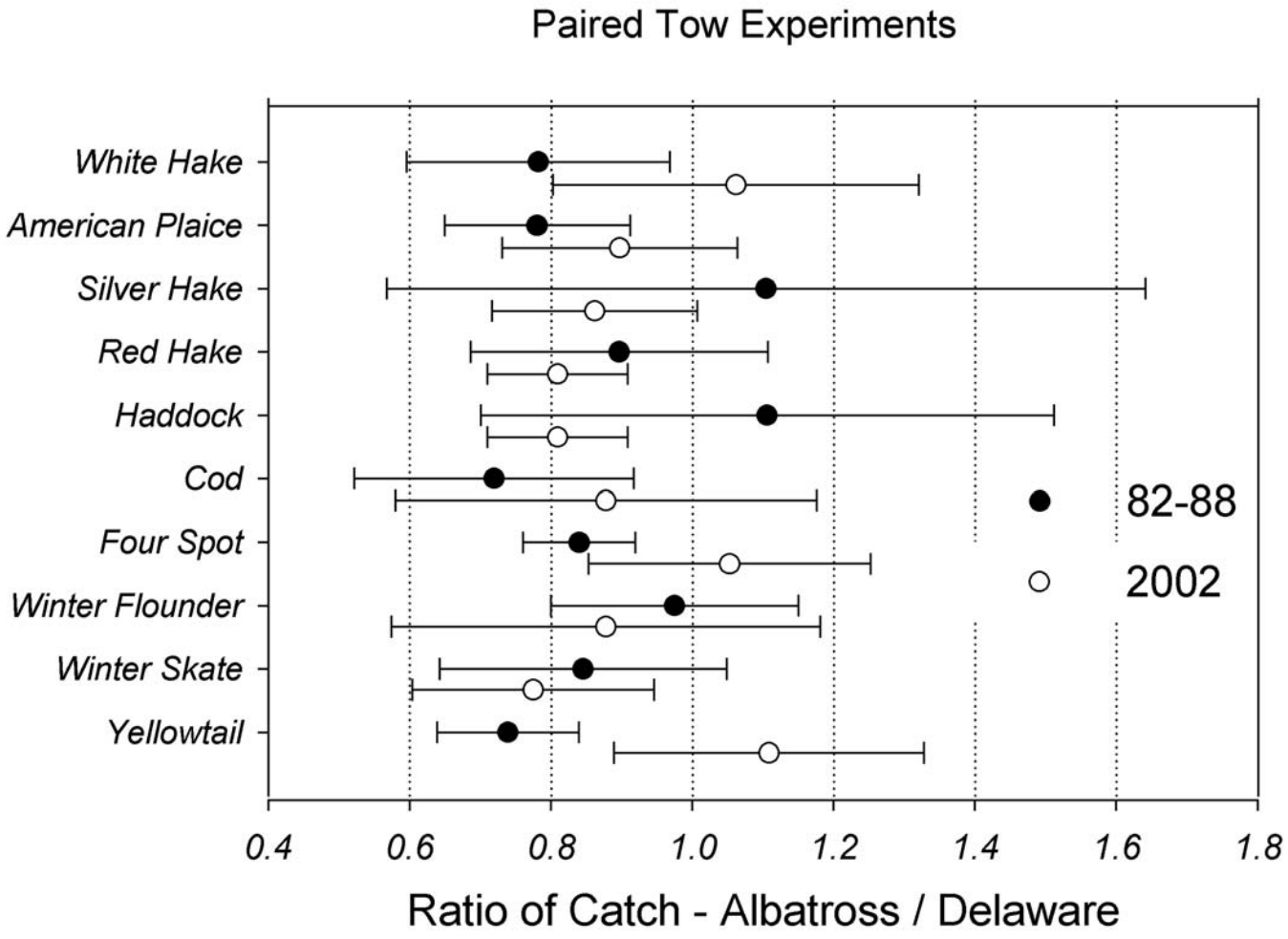

Figure 3.11.1. Results of fishing power calibration studies for NOAA R/Vs *Albatross IV* and *Delaware II* during two time periods. Data are the mean ratio of catch by species (A/D) and the 95% confidence intervals

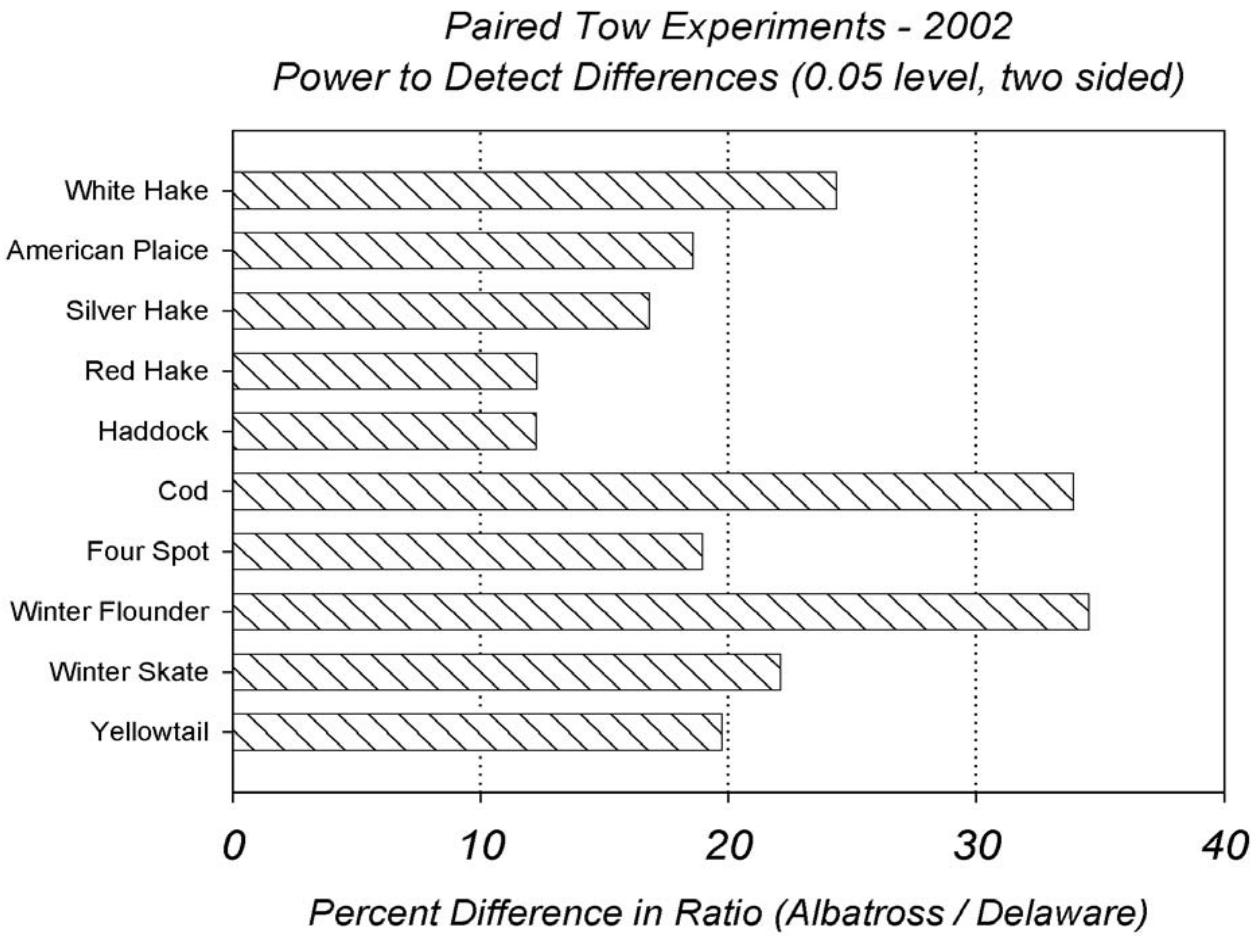

Figure 3.11.2. Calculated ratios of *Albatross* to *Delaware* surveys that can be detected at the 0.05 level of significance, using a two-tailed test. Analyses are based on 2002 side-by-side trawling experiments