SURVEY VESSELS AND GEAR MODIFICATIONS AND THEIR POSSIBLE EFFECTS ON ASSESSMENT ANALYSES

Presentations on this topic were made by C. Byrne, J. Forrester (SAW/12/Pl/5 and 6), and D. Hayes.

The first part of this presentation described fieldwork, data sets, and analyses employed to determine effects of changes in vessel and gear configurations within the NEFC bottom trawl survey time series. Vessel fishing power studies were necessary due to the use of the R/V DELAWARE II when the R/V ALBATROSS IV was unavailable, and exclusively since decommissioning of the ALBATROSS IV in 1989. The two vessels were also used jointly in some years to improve synopticity. ALBATROSS IV is scheduled to return to service in late autumn of 1991. Five paired-tow experiments were undertaken to evaluate vessel fishing power differences. In each case, DELAWARE II accompanied ALBATROSS IV during a standardized bottom trawl survey; standard survey procedures were used to collect and archive the resulting data. Mid-Atlantic, Southern New England, Georges Bank, and Gulf of Maine strata were covered in these experiments, resulting in a total of 510 paired tows for analysis.

A second series of experiments was conducted to evaluate the effects of changes in trawl doors on survey catch rates. In 1983, production of our standard (BMV) doors by the original Norwegian supplier was discontinued and no alternate supplier could be found. Based on size, weight and design characteristics, a polyvalent door manufactured in Portugal was selected as the replacement and was introduced to the survey in 1985. Experiments to compare and standardize the relative fishing power of BMV and polyvalent door trawls were initiated in 1984. Except where constrained by operational difficulties, these have employed an experimental grid design in which the two door types are alternated over a two day period between 4 six-hour time frames, 4 tows being taken in each time frame, e.g., BMV doors used from 6 am to noon on Day 1 and polyvalent doors from 6 am to noon on Day 2. All other factors were held constant. This arrangement permitted analysis by randomized block or paired tests. To date, 8 experiments have been completed, primarily in the southern New England and Georges Bank region, resulting in a total of 345 paired tows for analysis. Additional experiments are scheduled in autumn and winter of 1991-92 in the Middle Atlantic and the Gulf of Maine.

For species with 15 or more pairs of tows in which individuals were caught in each tow (termed "non-zero" pairs) data were transformed to natural logarithms. Paired t-tests were then employed to test for vessel and door effects. Where significant differences ($P<0.05$) were found, means were re-transformed back to the original scale to provide unbiased estimators of the vessel or door conversion coefficient and an approximate 95% confidence limit calculated using the "bootstrap" method.

For vessel effects, consistent differences ($P< 0.05$) were not observed for individual species either within or among cruises, although catches in terms of total number and weight were almost invariably higher for the DELAWARE II. To increase the power of the tests data were pooled over cruises (different doors were used in the vessel effects time series and different vessels in the door effects time series, but no evidence for cruise-door interactions was found in either case.) Of the 50 species tested, significant differences were found for numbers and/or weight for 27 in the pooled tests (Table PC1). For tests in which less than 30 pairs of tows were available results should be viewed with caution, since the paired t-test is less robust to normality in such situations. Overall conversion coefficients for DELAWARE II relative to ALBATROSS IV were 0.85 for numbers and 0.80 for weight. These differences may relate to differences in winching speed between the two vessels (ALBATROSS IV is able to set and retrieve gear more quickly). Also, an eleven foot long trawl door backstrap extension is required on DELAWARE II because of its stern configuration which may create a "herding" effect.

For door effects, 42 species were tested, of which significant differences were found for 15 in terms of numbers and/or weight as well as for all species combined Table PC2). Again, results should be viewed with caution in some cases due to low sample size. In almost all cases where significant differences were detected, catches were higher for the polyvalent doors. Field observations and measurements with SCANMAR trawl mensuration gear suggest that these doors tend bottom better and provide a wider wingspread and lower headrope height compared to the BMV doors.

Overall conversion coefficients for the BMV doors relative to the polyvalent doors are 1.28 for numbers and 1.41 for weight. Examination of the data for cod (for which the calculated coefficients were among the highest) for three length groups (<20 cm, 20-40 cm, and >40 cm) revealed a significant difference only for the latter group.

The latter part of this session involved a review of analyses conducted by Daniel Hayes (NEFC) on an example stock to illustrate the effects of the door conversion coefficient on VPA tuning with the Laurec-Shepherd method. Analyses included a base run (no door conversion coefficient), a series of runs in which the coefficient was incremented from 1.1 to 1.9 at intervals of 0.2 (Figure PC1), and runs in which commercial CPUE indices were incorporated along with the survey indices. Outputs included estimates of stock size at age 2 and 3, estimates of average F in the terminal year for ages 3-9 (Figure PC2), and catchability coefficients (spring and autumn surveys) for the survey indices relative to the VPA population size estimates (Figure PC3). The door conversion coefficients were applied to the pre-1985 data (collected using the BMV doors).

Increasing the door coefficient had the effect of reducing stock size estimates relative to the base run for the more recent years in the time series, e.g., for age 2 applying a door conversion coefficient of 1.5 depressed the 1989 stock size estimate from 28 million to 22 million fish, a reduction of over 20%. For ages 2 and 3 the effects of the coefficient appeared imperceptible prior to the third year (backward in the time series). At the same time un-weighted average F values (for ages 3-9) for the terminal year increased from approximately 0.3 to 0.4, an increase of about 25%.

Incorporating commercial indices had the effect of depressing stock size estimates still further, e.g., from 28 million to 14 million fish at age 2, while terminal year F increased substantially across the range of door conversion coefficient values tested. However, note that the influence of commercial CPUE data should not be taken as a general conclusion but specific to this example. It does illustrate how sensitive assessment results may be to the use of various data sources. The effect on F was proportionally less as the door conversion coefficient was increased, however. Some concern was expressed that since CPUE indices were not independent of catch at age a confounding effect might result from using them. Catchability was increased throughout the time series as the conversion coefficient increased for both the spring and autumn survey time series, with effects being minimal in the year in which the door change was made (1985).

Plenary Conclusion

The Plenary concluded that in cases where experiments have indicated an effect of vessel or door changes, the sensitivity of the assessment results to assumption about survey efficiency should be explored quantitatively. In practice this means presenting analyses which use corrected and uncorrected survey data until a clear judgement can be made as to which analysis is most appropriate.

It was noted that for any given situation effects would vary depending upon the time series and indices available. As a rule, however, the effect of using such coefficients would be to make assessment conclusions more conservative given the greater fishing power of the polyvalent doors in relation to the historical BMV time series. This effect will be particularly important for stock size projections due to their dependence on events in the terminal year. The importance of testing for differences in fishing power in relation to size class was also noted given the obvious potential impact of applying a conversion coefficient on recruitment estimates.

Table PC1.

Number non-zero pairs, p values ($Pr > |T|$ under Ho: no difference between vessels), conversion coefficients and approximate 95% confidence intervals for NEFC vessel fishing power study. Data are pooled across years; 510 total tows

Species	Number non-zero tows		p values		VCF_{number} [a]	Approx. 95% Confidence Interval	VCF_{weight}	Approx. 95% Confidence Interval
	number	weight	number	weight		number		weight
Alewife	25	24	0.273	0.034			0.58	0.39 - 0.99
American Plaice	79	78	0.017	0.001	0.82	0.70 - 0.94	0.69	0.56 - 0.85
Anchovy uncl.	21	17	0.401	0.086				
Atlantic Cod	121	121	0.003	0.001	0.79	0.69 - 0.94	0.67	0.53 - 0.87
Atlantic Herring	53	52	0.002	0.000	0.59	0.41 - 0.80	0.54	0.39 - 0.71
Atlantic Mackerel	15	15	0.586	0.854				
Black Sea Bass	22	14	0.350	0.888				
Bluefish	50	44	0.496	0.362				
Butterfish	252	212	0.067	0.057				
Cunner	15	15	0.009	0.013	0.56	0.42 - 0.85	0.51	0.32 - 0.81
Cusk	15	15	0.005	0.397	0.66	0.52 - 0.82		
Fawn Cusk - Eel	33	32	0.048	0.144	0.63	0.45 - 1.05		
Fourbeard Rockling	18	11	0.242	0.125				
Fourspot Flounder	166	161	0.010	0.005	0.85	0.76 - 0.96	0.84	0.75 - 0.95
Goosefish	60	60	0.034	0.102	0.83	0.68 - 1.00		
Gulfstream Flounder	57	29	0.001	0.003	0.70	0.56 - 0.84	0.60	0.47 - 0.80
Haddock	117	113	0.013	0.005	0.82	0.69 - 0.95	0.79	0.67 - 0.92
Little Skate	197	195	0.002	0.002	0.83	0.74 - 0.94	0.81	0.72 - 0.94
Longhorn Sculpin	153	150	0.005	0.000	0.82	0.72 - 0.95	0.77	0.68 - 0.87
Mailed Sculpin	28	15	0.842	0.038			1.67	0.94 - 2.67
Northern Searobin	61	56	0.836	0.715				
Ocean Pout	57	56	0.004	0.004	0.70	0.55 - 0.88	0.69	0.55 - 0.89
Pollock	32	32	0.917	0.658				
Red Hake	160	153	0.060	0.013			0.79	0.65 - 0.91
Redfish	42	40	0.200	0.056				
Round Herring	18	11	0.971	0.735				
Sand Lance	40	16	0.017	0.785	0.50	0.29 - 0.77		
Scup	83	71	0.436	0.233				
Sea Raven	101	95	0.757	0.483				
Silver Hake	327	293	0.470	0.616				
Smooth Dogfish	37	37	0.117	0.091				
Spiny Dogfish	192	192	0.000	0.003	0.79	0.69 - 0.90	0.81	0.70 - 0.92
Spotted Hake	70	70	0.527	0.475				
Summer Flounder	66	66	0.208	0.152				
Thorny Skate	64	59	0.347	0.770				
White Hake	98	98	0.130	0.428				
Windowpane	144	140	0.003	0.004	0.82	0.73 - 0.93	0.80	0.69 - 0.92
Winter Flounder	128	127	0.996	0.467				
Winter Skate	147	147	0.028	0.003	0.82	0.66 - 0.97	0.74	0.63 - 0.90
Witch Flounder	29	29	0.857	0.795				
Yellowtail Flounder	117	115	0.011	0.041	0.85	0.77 - 0.96	0.85	0.74 - 0.96
American Lobster	123	120	0.350	0.334				
Horseshoe Crab	16	15	0.011	0.029	1.66	1.25 - 2.42	1.91	1.14 - 3.55
Jonah Crab	20	19	0.003	0.003	0.34	0.19 - 0.56	0.31	0.18 - 0.61
Lady Crab	42	33	0.660	0.687				
Longfin Squid	261	251	0.039	0.033	0.83	0.71 - 1.03	0.85	0.74 - 0.99
Rock Crab	55	44	0.000	0.150	0.58	0.40 - 0.71		
Sea Scallop	86	70	0.052	0.395	1.22	0.99 - 1.45		
Shortfin Squid	230	207	0.000	0.000	0.64	0.54 - 0.77	0.71	0.59 - 0.87
Shrimp uncl.		36		0.469				
All Species Combined	510	510	0.000	0.000	0.85	0.78 - 0.94	0.80	0.75 - 0.86

[a] VCF-Vessel Conversion Coefficient (applied to DELAWARE catch)

Table PC2.

Number non-zero pairs, p values ($Pr > |T|$ under Ho: no difference between doors), conversion coefficients and approximate 95% confidence intervals for NEFC door fishing power study. Data are pooled across years; 345 total tows

Species	Number non-zero tows		p values		DCF_{number} [a]	Approx. 95% Confidence Interval number	DCF_{weight}	Approx. 95% Confidence Interval weight
	number	weight	number	weight				
Alewife	44	39	0.402	0.666				
Alligatorfish	16		0.902					
American Plaice	110	106	0.427	0.714				
American Shad	15		0.511					
Atlantic Cod	107	107	0.000	0.000	1.56	1.33 - 1.88	1.62	1.37 - 1.94
Atlantic Herring	49	47	0.265	0.203				
Black Sea Bass	25	22	0.579	0.603				
Blueback Herring	29	26	0.537	0.822				
Butterfish	69	67	0.871	0.866				
Fourbeard Rockling	55	50	0.903	0.708				
Fourspot Flounder	119	118	0.095	0.200				
Goosefish	30	30	0.587	0.835				
Gulfstream Flounder	28	15	0.039	0.446	0.66	0.46 - 0.94		
Haddock	109	109	0.000	0.000	1.49	1.18 - 1.82	1.51	1.22 - 1.85
Little Skate	132	131	0.016	0.012	1.20	1.04 - 1.42	1.22	1.06 - 1.43
Longhorn Sculpin	132	130	0.000	0.000	1.44	1.20 - 1.67	1.39	1.11 - 1.67
Mailed Sculpin	30		0.019		1.67	1.09 - 2.37		
Northern Searobin	55	53	0.100	0.122				
Ocean Pout	77	74	0.916	0.809				
Pollock	19	19	0.027	0.009	2.21	1.11 - 4.30	2.90	1.38 - 5.54
Red Hake	136	134	0.001	0.005	1.31	1.11 - 1.54	1.26	1.06 - 1.45
Redfish	46	45	0.683	0.469				
Sea Raven	67	66	0.648	0.163				
Silver Hake	182	163	0.612	0.971				
Smooth Skate	31	29	0.003	0.024	1.65	1.23 - 2.14	1.70	1.07 - 2.66
Spiny Dogfish	120	120	0.579	0.679				
Spotted Hake	17	16	0.465	0.676				
Summer Flounder	50	50	0.537	0.369				
Thorny Skate	114	110	0.296	0.121				
White Hake	71	71	0.205	0.296				
Windowpane	25	22	0.001	0.001	1.54	1.28 - 1.94	1.67	1.34 - 2.18
Winter Flounder	60	60	0.000	0.004	1.46	1.21 - 1.85	1.39	1.15 - 1.72
Winter Skate	92	92	0.062	0.011			1.36	1.05 - 1.70
Witch Flounder	31	31	0.079	0.248				
Yellowtail Flounder	81	79	0.016	0.006	1.22	1.02 - 1.39	1.28	1.07 - 1.46
American Lobster	97	97	0.174	0.821				
Jonah Crab	25	19	0.222	0.074				
Longfin Squid	115	114	0.085	0.016			1.24	1.07 - 1.47
Octopus uncl.	18		0.577					
Sea Scallop	83	73	0.008	0.176	1.39	1.15 - 1.79		
Shortfin Squid	69	58	0.469	0.195				
Shrimp uncl.		52		0.057				
ALL SPECIES COMBINED	345	345	0.000	0.000	1.27	1.17 - 1.38	1.40	1.26 - 1.52

[a] DCF-Door Conversion Coefficient (applied to BMV catch)

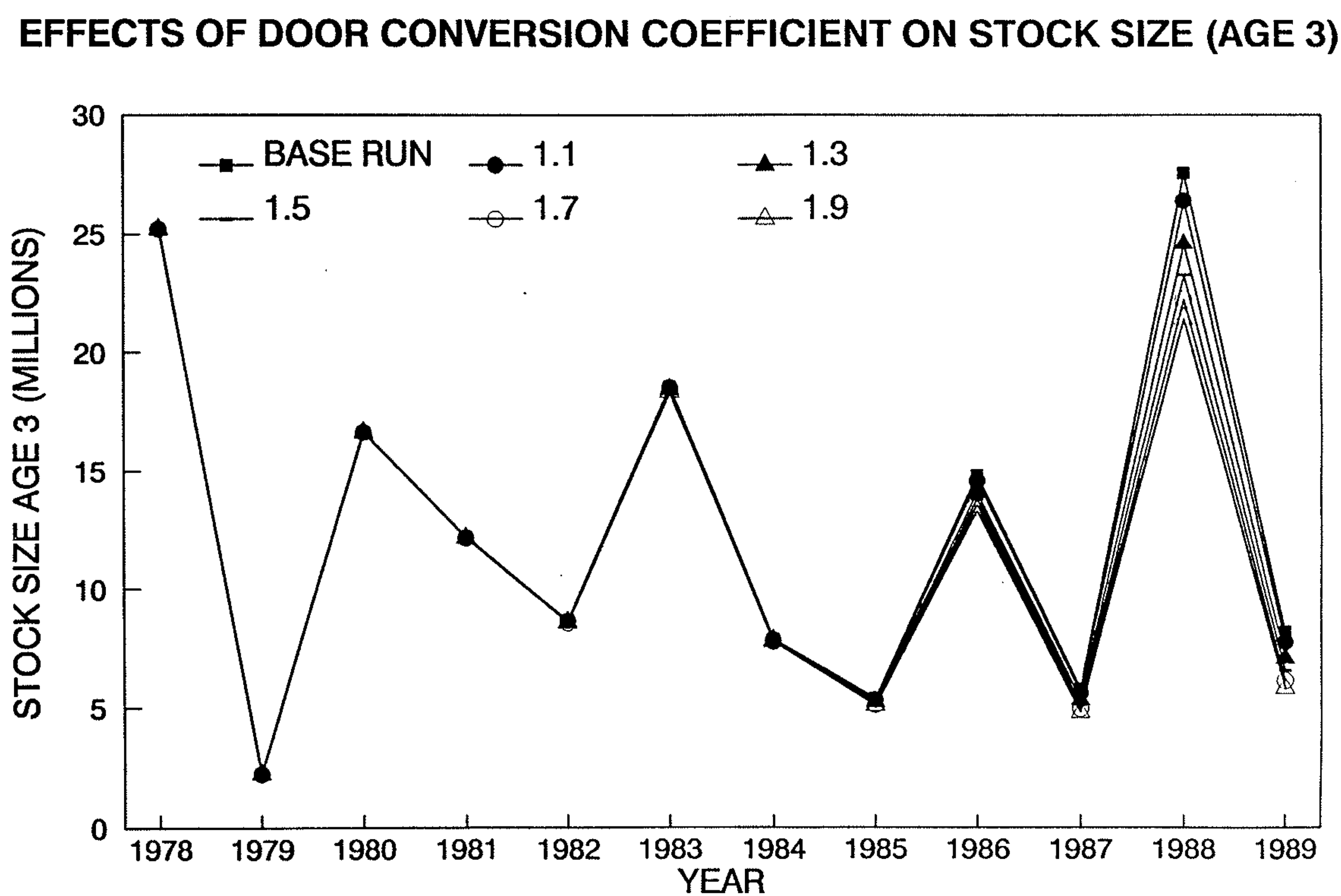
EFFECTS OF DOOR CONVERSION COEFFICIENT ON STOCK SIZE (AGE 3)
BASE RUN
1.1
1.3
1.5
1.7
1.9
STOCK SIZE AGE 3 (MILLIONS)
30
25
20
15
10
5
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
YEAR

Figure PC1.

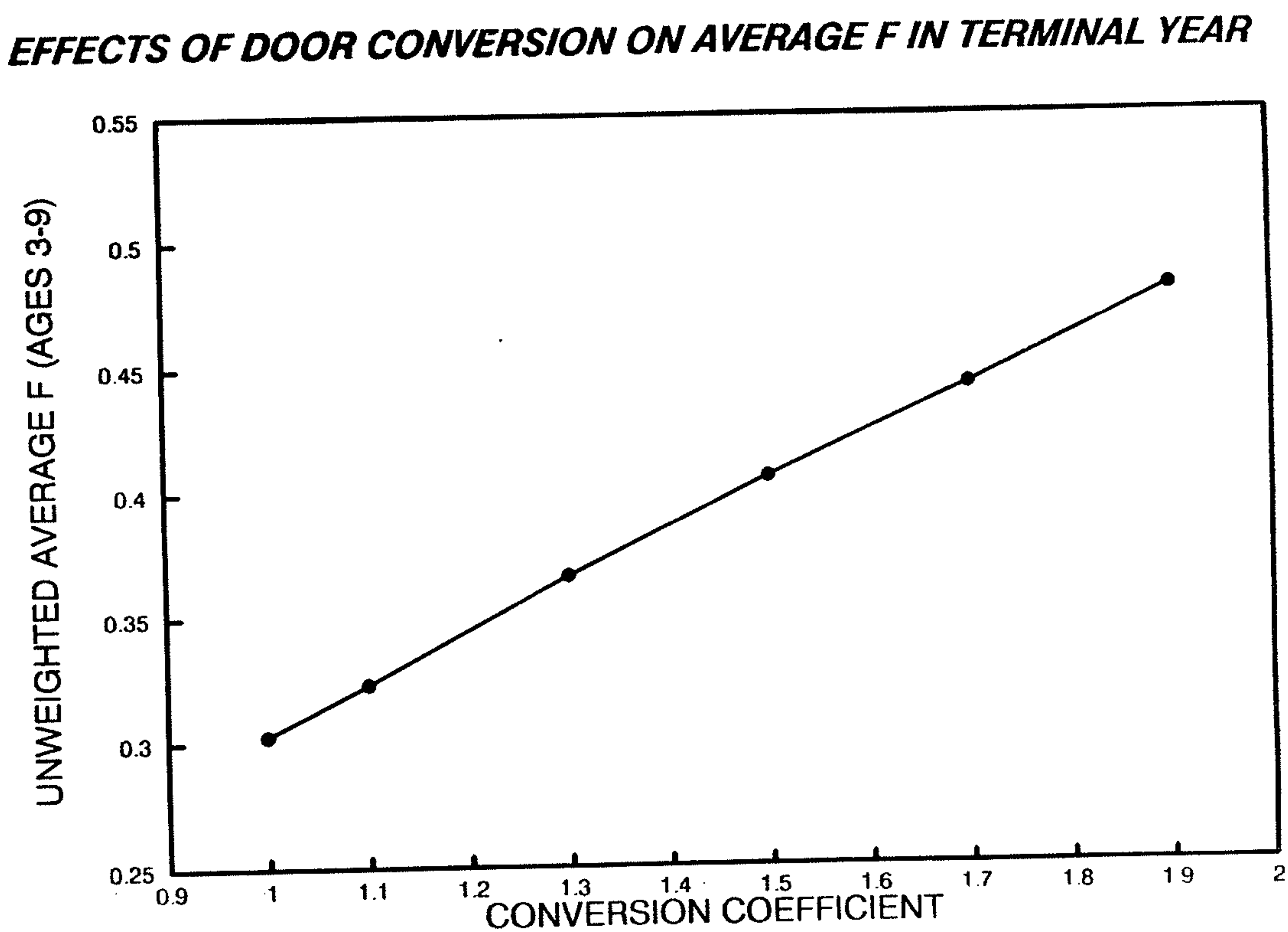
EFFECTS OF DOOR CONVERSION ON AVERAGE F IN TERMINAL YEAR
UNWEIGHTED AVERAGE F (AGES 3-9)
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
CONVERSION COEFFICIENT

Figure PC2.

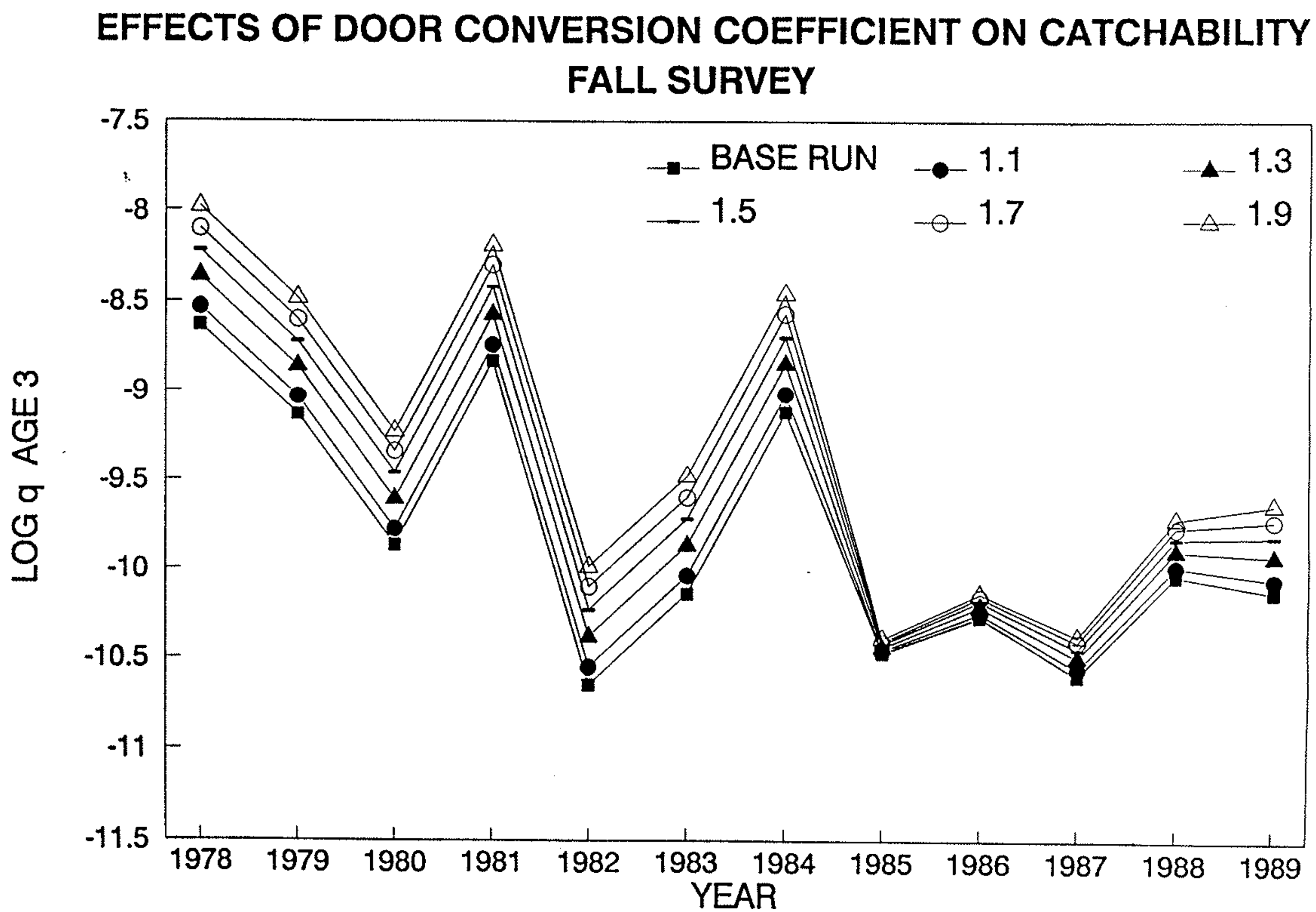
EFFECTS OF DOOR CONVERSION COEFFICIENT ON CATCHABILITY
FALL SURVEY
BASE RUN
1.1
1.3
1.5
1.7
1.9
-7.5
-8
-8.5
-9
-9.5
-10
-10.5
-11
-11.5
LOG q AGE 3
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
YEAR

Figure PC3.