Section 6 Comments and Recommendations

This section summarizes various generic discussion items at the GARM meeting, and provides additional recommendations.

6.1 Projections

Medium-term projections for assessments were conducted for years 2002-2009, with the exception of Georges Bank cod which had a 2002-2019 time horizon. The index assessments were projected assuming a 10% growth rate in stock size each year to determine the expected catch under this condition. The ASPIC assessment of Georges Bank winter flounder was projected assuming the r and K estimates from each bootstrap of the tuning indices. This projection used the F needed to achieve Bmsy in 2009 with 50% probability over all the bootstraps. The two sources of uncertainty included in the age-based projections were initial stock abundance at age in 2001 and future recruitment. Other potential sources of variability, such as implementation uncertainty and changes in weight-at-age, maturity-at-age, selectivity-at-age, or natural mortality, were not included. Therefore, the confidence intervals presented in the assessment projections are minimal estimates of future uncertainty.

More importantly, the lack of inclusion of other sources of uncertainty in the projections could bias the estimated probability of achieving a biomass target. If unmodeled uncertainties were symmetrically distributed about the median, then the probability of achieving a biomass target would remain unchanged. However, if unmodeled uncertainties were not symmetrically distributed about the median, the probability of achieving a biomass target would either decrease or increase. For example, although many of the age-based assessments exhibited retrospective patterns, no corrections were made to the 2001 population abundances. Since many of the retrospective patterns showed an overestimation of SSB in the terminal year, the projections may be biased upwards in terms of the initial stock abundance and produce overly optimistic rebuilding trajectories. A recent examination of stock assessment projections using a wide range stocks found that unmodeled uncertainties were not symmetrically distributed in general (Patterson *et al.*, 2001). In particular, Patterson *et al.* reported a substantial bias towards being overly optimistic in estimating the probability of achieving biomass targets. They recommended using multiple model structures and assumptions combined with model-averaging methods, decision tables, or management procedure simulations to more accurately reflect inherent uncertainties in management advice. Time constraints have not allowed their approach to be used in this report. As a result, it is recommended that projection results be viewed with caution since they may overstate the true probability of achieving biomass targets.

Reference

Patterson, K., R. Cook, C. Darby, S. Gavaris, L. Kell, P. Lewy, B. Mesnil, A. Punt, V. Restrepo, D.W. Skagen, and G. Stefánsson. 2001. Estimating uncertainty in fish stock assessment and forecasting. Fish and Fisheries. 2: 125-157.

6.2 Use of Exploitation Ratios

For stocks where instantaneous rates of fishing mortality cannot be calculated (e.g., age or length data are not sufficient for age- or length-based analytical assessment), proxies for the exploitation rate have been used for reference point determination and status evaluation (NEFSC 2002). These proxies for exploitation rate involve dividing the landings by an annual biomass index determined from trawl survey data. Generally, a three-year moving average of the survey data were used as the annual index to smooth variability from survey sampling. In most cases the indices used in such analyses were the total catch per tow of all size groups combined. This index was used as the denominator of the relative exploitation ratio, with the numerator the catch in weight (usually only the landings are known for the stocks having incomplete age- or length-based data).

Application of this technique should allow a relatively robust evaluation of the *relative* rate of exploitation over time. However, there is a potential mis-match in these ratios since a portion of the biomass index (in the denominator) comprises sizes not contributing to the catch (e.g., juvenile fish). The effect of the use of the total biomass index for all sizes may not be substantial as juvenile fish are likely to have a disproportionately lower influence on the total biomass index owing to their lower average individual weights. For the various stocks so assessed, only the white hake assessment uses catch and survey indices comprising the same size groups (e.g., fish > 60 cm). It is recommended that when calculating such indices in the future, that only size groups likely to be included in the catches (landings and discards) be used to develop indices of exploitation.

Reference

NEFSC 2002. Final report of the Working Group on re-evaluation of biological reference points for New England groundfish. Northeast Fisheries Science Center Reference Document 02-04. 123 p.

6.3. Quality of Catch-at-Age Sampling

Estimates of the age composition of the catch are a primary requisite for age-structured assessment techniques such as virtual population analysis (VPA). Of the 20 groundfish stocks reassessed herein, 10 stocks use age-based assessments (section 2). In order to estimate the catch-at-age, age composition estimates are derived from port sampling of landings, and sea sampling of discards (if sufficient sampling exists). Length and age samples are obtained at the port of landing by sampling at dealer's businesses, fish houses and auctions. The sampling is stratified by market category since increased sampling of large (old) fish is usually the goal, because ages at length are more variable for larger fish.

Port sampling performance is summarized in appropriate tables included in the various species sections. Sampling information for 9 of the 10 stocks is summarized for the past four years (1998-2001) by the number of samples obtained (e.g., number of individual samples aggregated over market categories by species), the number of fish lengths measured, and the number of age structures (e.g., scales or otoliths) aged for the species (Table 6.3; Figure 6.3). One measure of sampling intensity is the number of metric tons of landings per sample obtained. With this metric, more intensive sampling is indicated by a relatively low number (fewer tons represented by each sample).

Overall sampling increased substantially between 1998-1999 and 2000-2001 (Table 6.3; Figure 6.3). The total numbers of samples and ages more than doubled from 1998-1999 to 2000-2001 and the number of lengths increased by over 60%. The sampling increase was most apparent in 2000, but 2001 sampling, particularly for ages, was much higher than in 1998 and 1999. Sampling intensity increased from 75 mt/sample to 41 mt/sample in 2000 and decreased to 69 mt/sample in 2001. Overall landings increased 61% for the nine stocks summarized, thus rates of sampling have more than kept pace with the landings increases. Sampling intensity varied by stock; improved sampling in recent years is most apparent for Gulf of Maine cod, Georges Bank haddock, and Georges Bank yellowtail (although the number of t/sample for Georges Bank yellowtail is higher than for most stocks).

The GARM considered the port sampling issues in the larger context of the overall level of sampling required to characterize catch-at-age with acceptable levels of precision for use in age-based assessments. This information is particularly important since the overall level of landings of these stocks is expected to increase significantly in the next few years. The GARM recommended that a statistical bootstrapping technique be applied to the landings-at-age data to estimate the variance in landings-at-age and to investigate the stability of such estimates given various sampling rates. The GARM noted that, because of cluster sampling issues, increasing the numbers of different vessel trips sampled, rather than just the total lengths and ages obtained would likely have the most positive impact on the quality of landings-at-age estimates.

Table 6.3. Summary of commercial catch-at-age sampling for VPA stocks, 1998-2001.

stock	year	samples	lengths	ages	Landings (mt)	mt/samp
gb cod	1998	80	7076	1545	6959	87
	1999	68	5987	1503	8061	119
	2000	155	12219	2951	7617	49
	2001	108	8389	2389	10635	98
gb had	1998	24	1692	686	1841	77
	1999	28	2268	595	2775	99
	2000	51	3699	1256	3366	66
	2001	72	5276	1985	4637	64
gb yt	1998	9	1426	293	1823	203
	1999	11	1542	300	2066	188
	2000	11	2762	605	3678	334
	2001	30	3400	814	3768	126
sne yt	1998	10	1134	239	400	40
	1999	9	1167	333	700	78
	2000	28	1146	984	700	25
	2001	18	1454	1224	800	44
ccyt	1998	13	6054	195	1169	90
	1999	8	4247	106	1089	136
	2000	61	11696	1298	2279	37
	2001	24	7440	628	2362	98
gm cod	1998	46	4205	912	4156	90
	1999	15	1305	350	1636	109
	2000	61	4687	1300	3730	61
	2001	113	7326	2436	4416	39
witch	1998	23	1904	242	1849	80
	1999	41	3091	359	2121	52
	2000	110	2439	1314	2439	22
	2001	43	3609	704	3024	70
plaice	1998	53	5434	824	2234	42
	1999	86	8784	1275	1718	20
	2000	108	7113	1155	2497	23
	2001	53	5232	663	2602	49
gm wf	1998	19	1504	341	637	34
	1999	9	1036	149	253	28
	2000	64	5827	883	382	6
	2001	14	3644	246	571	41
total	1998	277	30429	5277	21068	76
	1999	275	29427	4970	20419	74
	2000	649	51588	11746	26688	41
	2001	475	45770	11089	32815	69

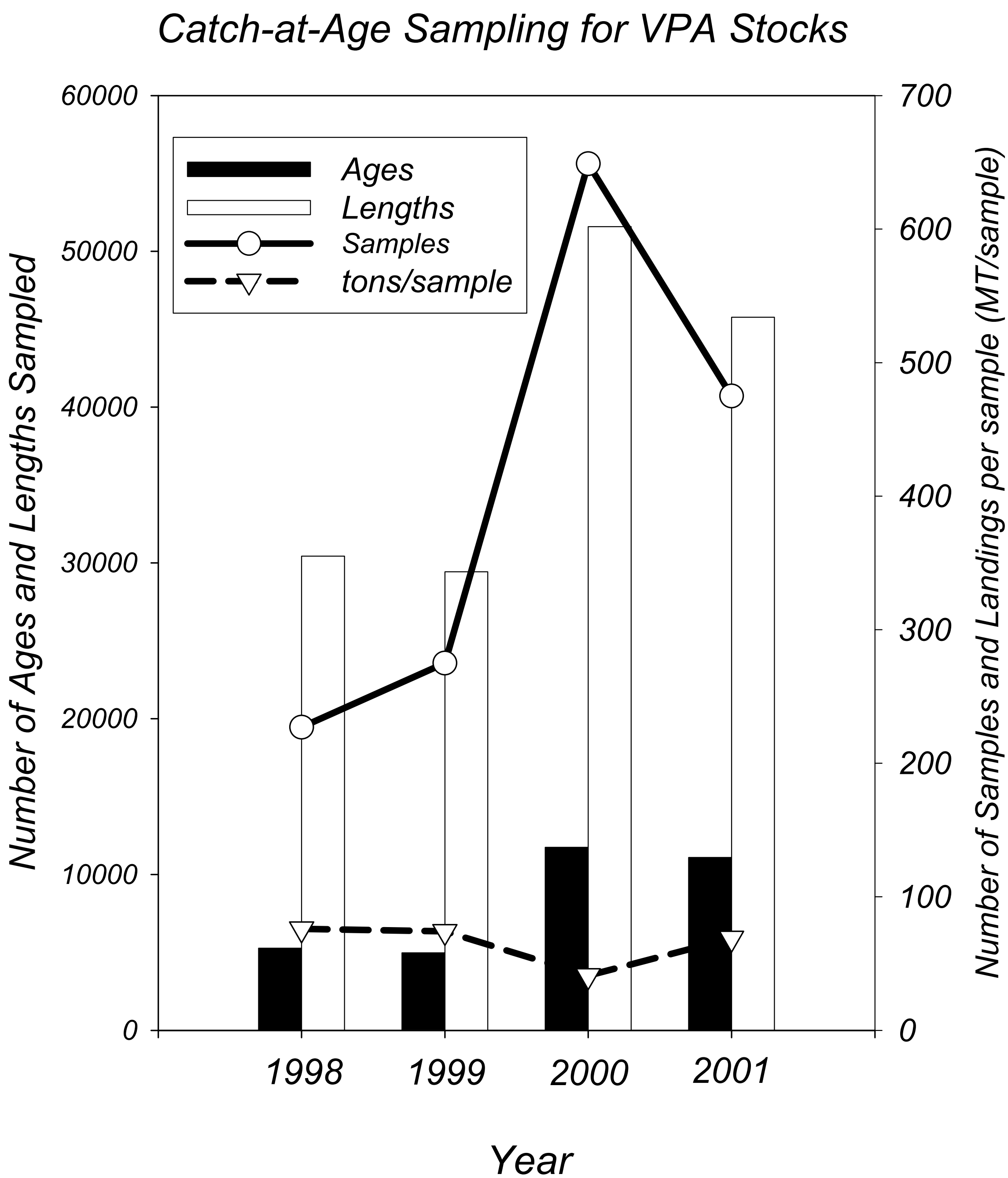

Figure 6.3. Summary of biological sampling for catch-at-age estimation, 1998-2001. Data are the number of samples, number of individual length frequency samples, numbers of fish aged and the sampling intensity (metric tons of landings per sample).

6.4 Recommendations

Research recommendations appropriate to individual stocks are summarized in appropriate chapters in section 2 of this report. Listed below are research recommendations of a more generic nature:

- Based on considerations outlined in section 6.1, a retrospective evaluation of the performance of stock projections used in support of management is recommended. Such an analysis could shed light on the utility of various recruitment assumptions and other sources of uncertainty in stock and landings projection approaches.

- Index methods for biomass and fishing mortality status determination are used for a number of the groundfish stocks for which age- or length-based catch and abundance information are lacking. The performance of these indices should be evaluated and uncertainty measures routinely incorporated in the determination of stock status.

- Port sampling for estimating landings-at-age is an important component of stock assessment. The overall levels of port sampling have increased since 1998, as landings have increased. Maintenance, and in some cases, improvement in the rates of sampling are required to ensure adequate levels of sampling for estimating the catch-at-age. Further, a simulation (re-sampling) study is recommended to evaluate the reliability of catch-at-age estimates in relation to the rates of sampling.

- Estimation of fishery discards remains problematic for these stocks, as the overall level of sea sampling prior to 2002 was low and variable by fishery type. Increased rates of sea sampling coverage (occurring in 2002 and beyond) should allow a statistical evaluation of the reliability of discard estimates, and the development of target sampling rates in order to reliably estimate discard mortalities at age for inclusion in assessments.

- Some stocks might have sufficient age and length-based information to upgrade the assessment type from an index basis to an age structured assessment (e.g., Gulf of Maine haddock). Age-structured modeling, even with partial information, may improve the basis for status determination for these stocks, and these improvements should be investigated.

- The GARM considered a variety of studies, including comparative fishing experiments developed to evaluate ship effects, to better understand the potential effects on survey indices due to the warp offset issue. The GARM notes that in order to evaluate the warp offset issue more directly, appropriately designed experimentation with warp offset and warp aligned tows is considered the most direct method.