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Report of the PSARC Groundfish Subcommittee Meeting on Pacific Hake July 9, 1997 and the Steering Committee Meeting August 19, 1997

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PACIFIC STOCK ASSESSMENT REVIEW COMMITTEE

PSARC ADVISORY DOCUMENT 97-3
AUGUST 1997

PACIFIC GROUNDFISH

I. STEERING COMMITTEE REPORT

PSARC Steering Committee met 19 August, 1997 at the Pacific Biological Station, to review the Groundfish Subcommittee report on hake. The report was accepted by the Steering Committee.

Steering Committee provided the following recommendation:

Managers should exercise caution when selecting the yield options from Table 1, due to the indication of a continued decline in stock abundance and the uncertainty regarding the strength of the 1994 year class, due to changing distribution patterns.

II. GROUNDFISH SUBCOMMITTEE REPORT

G97-1 Pacific hake stock assessment for 1997 and recommended yield options for 1998. M. W. Dorn and M. W. Saunders

In previous years, Canadian and the U.S. hake assessment documents were separate working papers. In past years separate Canadian and U.S. assessments were submitted to each nationôs assessment review process, resulting in differing yield options being forwarded to the respective management agencies, while different interpretations of stock status made it difficult to coordinate overall management policy for this transboundary stock.

This year one joint document was presented at a special review meeting convened in Nanaimo on 11 July 1997. The working paper has been submitted for review to both the U.S. Pacific Fisheries Management Council (PFMC) review process and the

Canadian Pacific Stock Assessment Review Committee (PSARC). The working paper has been submitted for review to both the U.S. Pacific Fisheries Management Council (PFMC) review process and the Canadian Pacific Stock Assessment Review Committee (PSARC). This report summarizes the deliberations of the PSARC Groundfish Subcommittee; the PFMC review will occur subsequent to the PSARC meeting.

It should be noted that although the assessment advice is presented in a single document, there remains no agreement between Canada and the U.S. on allocation of the recommended catch, with Canada basing its harvest on the assumption that it is entitled to 30% of the total, while the U.S. assumes that the Canadian share should be 20%. As a result of the lack of agreement over allocation, a harvest of 112% of the recommended catch quota has resulted in the past.

Working Paper Summary

Offshore Pacific hake (*Merluccius productus*) are migratory fish that range from southern California to Queen Charlotte Sound. Hake are present in the Canadian zone from late spring until late fall, when they migrate south to spawn off California. The portion of stock in Canadian waters is composed predominantly of larger, older females. Since 1968, more Pacific hake have been landed than any other species in the groundfish fishery on Canada's west coast.

A stock reconstruction was conducted with the Stock Synthesis model using catch and survey data from 1972-96. Data from the U.S. fishery, the Canadian fishery, NMFS acoustic surveys, NMFS triennial bottom trawl surveys, and DFO acoustic surveys were used. Model results indicated that population biomass rose to a peak in 1987 at 5.7 million t (MT), then declined steadily to a biomass of 1.6 MT in 1995, the lowest in the history of the fishery (Fig. 1).

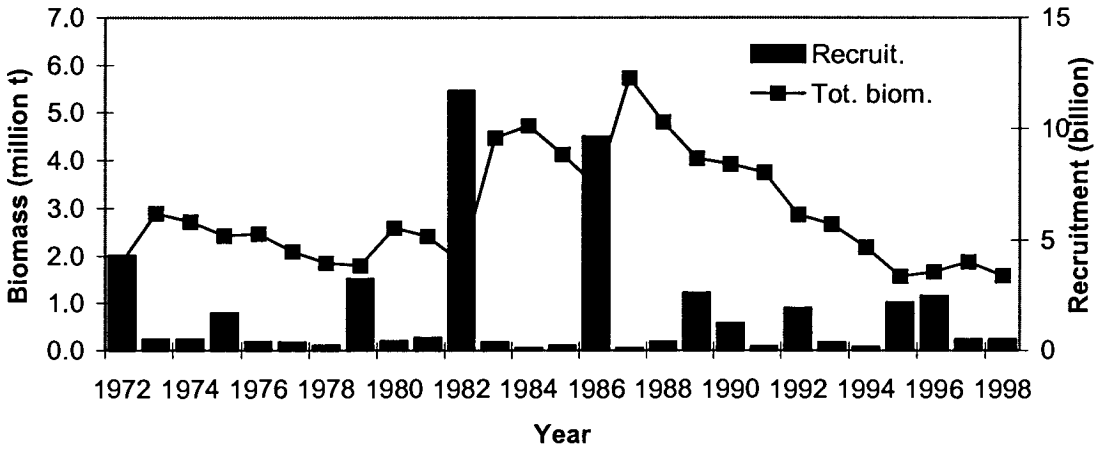

Fig. 1 Time series of hake biomass (million tonnes) and age 2 recruitment (billion) estimated from the stock reconstruction model.

In 1996 the biomass of age 3 and older fish was estimated to be 1.66 MT in 1996 (confidence interval: 1.3-2.5 MT). Population projections for 1996-98 indicate that biomass will range between 1.5-1.9 million t during this period. Likelihood profiles indicated that there was insufficient information to establish the absolute level of abundance when the assumption of fixed survey catchability of 1.0 was relaxed.

To forecast harvests for 1998-2000, a stochastic age-structured population model for Pacific hake was used. Harvests projections are highly dependent of the estimated size of the 1994 year class, which in turn depends on the selectivity of the age-2 fish in the 1996 fishery. The pattern of recruitment of the 1994 year class has been anomalous. Until 1994, young-of-the-year had never been found north of California. However, the 1994 year class was found from central Oregon to Brooks Peninsula, Vancouver Island, where it has remained and has been exploited by the fishery through 1997. Evidence suggests that the range of this year class has been shifted rather than extended. Therefore the typical pattern of continued recruitment of a year class from the south is in doubt, and interpreting the presence of juveniles in the fishery as sign of a strong year-class may be inappropriate.

Young fish (ages 0,1, and 2 year) are now found farther north, and large numbers of age 1 hake in 1995 and subsequently as age 2 hake in 1996 have been taken in Canadian waters. Cannibalism is high for these age 2 fish. Because of the uncertainties over the 1994 age class, the bounds on the selectivity of the fishery for the age 2 fish is large. In light of this uncertainty, this assessment presents two sets of yield projections for 1998-2000 for different assumptions of age-2 selectivity in 1996:

Table 1. Hybrid F Yield Options from Tables 21 and 22 of Working Paper G97-1. Summary of the projected 1998-2000 annual yields assuming that the 1996 US fishery selectivity coefficient for age-2 hake is (A) equal to the selectivity of age-3 hake, and (B) equal to the selectivity of age-4 hake. These coefficients were applied to investigate the potential consequences of the changed ocean distribution of age-2 hake in 1996, and their consequently greater vulnerability to the commercial fishery. Total yields are the projected median yield from 1,000 simulations using the stochastic population model with median 1972-96 recruitment in 1997, and random recruitment in 1998, 1999, and 2000.

Harvest Strategy		Year	Fishing Mortality	Total Yield (1,000 t)
A. Selectivity = 0.19				
Hybrid F	Low	1998	0.15	208
		1999	0.14	173
		2000	0.15	181
Hybrid F	Moderate	1998	0.24	309
		1999	0.21	222

Harvest Strategy		Year	Fishing Mortality	Total Yield (1,000 t)
A. Selectivity = 0.19 (Cont'd)				
		2000	0.20	218
Hybrid F	High	1998	0.33	410
		1999	0.26	252
		2000	0.25	236
B. Selectivity = 0.53				
Hybrid F	Low	1998	0.12	116
		1999	0.11	98
		2000	0.12	130
Hybrid F	Moderate	1998	0.18	174
		1999	0.16	132
		2000	0.17	167
Hybrid F	High	1998	0.25	233
		1999	0.20	157
		2000	0.22	193

In the first set of projections (A), age-2 selectivity was assumed to be equal to age-3 selectivity in 1996 (0.19), producing an age-2 recruitment estimate of 2.423 billion fish. For this scenario, the hybrid F harvest strategy (used to manage the Pacific hake resource since 1991) results in a 1998 yield of 208,000 t at a low harvest rate, 309,000 t at a moderate harvest rate, and 410,000 t at a high harvest rate.

For the second set of projections (B), age-2 selectivity was assumed equal to the selectivity for age-4 hake in 1996 (0.53), resulting in an age-2 recruitment estimate of only 0.918 billion fish. For this scenario, projected yields in 1998 are 116,000 t at a low harvest rate, 174,000 t at a moderate harvest rate, and 233,000 t at a high harvest rate.

For comparison, the 1995 and 1996 total catch was 248 kt and 301 kt, respectively. Three harvest rates (low, moderate, and high) are presented, which are determined by the probability that female spawning biomass drops below the 0.1 percentile for an unfished population (i.e. on average, one year out of 1,000). At low harvest rate the probability of falling below this level is 0.1; for moderate harvest rate 0.2; and for high harvest rate 0.3. The hybrid F fishing strategy has been the preferred harvest strategy for Pacific hake since 1991. Caution is warranted in selecting a yield option due to the continuing decline in stock abundance and the uncertainty regarding the strength of the

1994 year-class. Note that yields are most likely to decline significantly in 1999 and 2000.

Reviewers' Comments

Reviewer 1 complimented the authors on producing a joint document which facilitated a more consistent and thorough review of the assessment. The reviewer noted that a more balanced discussion of the management of the fishery and a more detailed discussion on the allocation disagreements needs to be presented.

Reviewer 1 questioned the inclusion of the DFO acoustic survey, U.S. acoustic survey and U.S. bottom trawl survey results in the analysis because they were given very low weight in the stock synthesis model, and proposed that they be removed altogether since the authors do not believe that the data reflect abundance trends. (The major survey results used in the analysis are based on mid-water trawling). Reviewer #1 suggested that one way to evaluate the sensitivity of the model results to these data would be to give a weight of 10-20% to the surveys and seeing how the assessment results changed. The authors commented that some experts felt that bottom and mid-water surveys should produce similar patterns of change over time, but the results are clearly different from this expectation (*see below*).

Reviewer 1 agreed with the removal in this year's assessment of aging error from the model formulation, as the data suggest that U.S. age readers may have a tendency to assign older fish to strong year classes. Re-aging of some of these fish may be an interesting study. However, the Canadian fishery data does not appear to suffer from the same age mis-classification problem and does not require the application of lower accumulator age classes.

Reviewer 1 stated that the biggest concern with the assessment is shown in Fig. 13 of the report, which compares the biomasses estimated by the model with the observed NMFS & DFO acoustic surveys and NMFS bottom trawl survey. Estimates of hake abundance based on the stock synthesis model, which relies primarily on midwater trawl results, does not match these indices. With the low weights given the 1983-1989 acoustic biomass estimates, the resulting residuals in the fit of observed versus predicted survey biomass are largely negative. This would likely drop the size of the stock in the most recent years even further.

Overall, Reviewer 2 felt that there needs to be a precise and explicit statement of the structure for the stock synthesis model and a clearer statement of how the forward projections of the population are performed. The reviewer summarized some of his views by noting that the assessment treats the population as a "single pool" (i.e. single, homogeneous population), and that differences in the North-South, inshore-offshore distribution of the hake are not adequately represented by the current approach of using selectivity functions.

Reviewer 2 noted that the uncertainty in the estimated confidence intervals did not incorporate the uncertainty in the true values for catchability and several other model parameters. As a result, correct incorporation of the uncertainty in these aspects of the model would increase the range of plausible population sizes consistent with the data, and might drop the lower range of the confidence interval on population size substantially, possibly to less than 1 MT.

In contrast to Reviewer 1's suggestion to exclude the anomalous survey results from the assessment because of the minimal weighting they currently receive, Reviewer #2 suggested that more emphasis might be placed on the survey results since these are supposed to track abundance trends. Reviewer #2 noted that we still have the appearance of increased abundance of hake from the bottom trawl survey and reduced abundance in the midwater surveys.

Reviewer 2 noted that fishing mortality rate was roughly the same as the estimated natural mortality rate (i.e., F=M, a good sign) but these estimates depend in turn on the estimated population size. However, because estimated population size is at historic lows and catches have remained at historic highs, reviewer #2 felt that there is cause for considerable concern concerning this population.

In summary, Reviewer 2 noted that both the reconstruction stock synthesis model and the forward projection results did not incorporate the large uncertainty in parameters such as selectivities. As a result, there is probably considerably more uncertainty in the population estimates than are reported here. In addition, there are significant inconsistencies in the various data sets available. There are therefore several indications that the results from the stock assessment should be viewed with caution.

Subcommittee Discussion

The Subcommittee recommended that full model descriptions should be appended to working papers every year in order to improve the ability of the reviewers to assess the documents. For this specific document the authors have been requested to append a set of equations describing the stock synthesis model. The editorial comments made by the reviewers are to be incorporated into the revised document. The authors were also requested to refit the model using a higher weighing for the acoustic surveys, in order to evaluate the influence on the analysis. The Canadian fishery age data set could also be incorporated without applying the accumulator age-classes.

The Subcommittee recommends caution in the setting of offshore hake quotas because of uncertainty in estimates of the size of the 1994 year class, the continued decline in estimated population size from 1987 to 1995, and the fact that the model does not appear to fit several important data sets. The data are basically inconsistent with a single pool model, and in several ways the model output is inconsistent with known aspects of the biology of hake, such as the inconsistencies in estimated population trends obtained using the historical age composition data and the survey biomass estimates. The anomalous northward distribution of age 2 hake in recent years and the

higher fishing mortality likely incurred on young (age 2) hake because of the resulting overlap in distribution with the older age groups targeted by the fishery is also of concern.

The population estimates suggest that recent hake biomasses are near the lowest on record, while catches are near maximum. Given the concerns raised above, managers may wish to consider a conservative management strategy until the triennial U.S.-Canada hake survey is completed in 1998. This survey may clarify the strength of the 1994 year class, on which the yields from the fishery will largely depend.

Appendix 1. List of attendees at the July 9, 1997 PSARC Groundfish Subcommittee Meeting.

DFO:

D. Welch (Subcommittee Chair)	Ocean Science and Productivity Division
V. Haist (reviewer)	Stock Assessment Division
G. McFarlane	Stock Assessment Division
N. Olsen	Stock Assessment Division
L. Richards	Stock Assessment Division
M. Saunders (Canadian author)	Stock Assessment Division
J. Schnute (reviewer)	Stock Assessment Division
R. Stanley	Stock Assessment Division
L. Yamanaka.	Stock Assessment Division

External

M. Dorn (U.S. author)	NMFS, Seattle