Peer Review of the California Department of Fish and Game's Commercial Pacific Herring Fishery Management and Use of the Coleraine Fishery Model

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Problem Statement

The California Department of Fish and Game (DFG) has traditionally used spawn surveys and hydroacoustic surveys to assess the stock size of Pacific herring in San Francisco Bay. These surveys have demonstrated a steady downward trend in the stock size over the past 25 years. Beyond the downward trend, during the past several years there was disagreement between the population estimates derived by using these two survey techniques. This year (2003) DFG decided to use currently available statistical modeling techniques to further assess the status of the population and the results that might be expected from different management strategies. The selected model, the Coleraine model, had not previously been used by DFG, and this general purpose model was not specifically designed for assessing San Francisco Bay Pacific herring. DFG requested that California Sea Grant assemble a panel of peer reviewers to determine if it was appropriate to use the Coleraine model, to instruct them in its use, to help its staff in interpreting the results, and possibly to suggest appropriate changes in management strategy. Sea Grant assembled a team of scientists with demonstrated expertise in modeling and assessing fish populations: Alec MacCall; Mark Maunder, and Jake Schweigert. They assembled together with DFG staff for a two-day workshop (August 19 and 20, 2003) designed to accomplish the above stated goals. Following are their findings, conclusions, and recommendations.

Findings

Estimates of stock abundance and trajectory over the available time series by an equilibrium surplus production model, the Coleraine catch-age model, and the Canadian herring catch-age model all result in similar estimates of stock status. The indication is that the San Francisco Bay herring population has been reduced to a level of roughly 20%

of the unfished level and is presently at or near the lowest abundance observed since the early 1970s. All data (survey, CPUE, and catch-at-age) are generally consistent with these findings.

The exploitation rate defined as catch divided by spawning biomass has been over 20% for most of the period since 1990. The fishery tends to catch a very high proportion of the individuals that are vulnerable to the gear.

The age composition of the catch has changed towards younger individuals. At present there are essentially no individuals aged 6 years or older in the catch, while in earlier years these ages made up over 50% of the catch. Due to higher exploitation rates it is expected that the average age in the catch should have reduced. However, there is substantial evidence that the fishery has increasingly targeted younger individuals. The present mesh size limit in the fishery represents a lower limit for the exploitation of this population allowing a proportion of the age 3 and most of the age 2 fish an opportunity to spawn. Any further reduction in the mesh size or increase in the hanging ratio would negatively impact the population.

The spawn survey tends to underestimate spawning biomass by about 10% and the hydroacoustic survey tends to overestimate the spawning biomass by about 20%. The errors (coefficients of variation) in the annual spawning biomass indices are about 40% for the spawn survey and about 75% for the hydroacoustic survey. This indicates that the spawn survey is a better estimate of spawning biomass than the hydroacoustic survey.

The practice (or tendency) of using the higher value of the spawn survey or the acoustic survey as the basis for setting quotas has contributed to overfishing. The target exploitation rate (catch per spawning biomass) of 20% may be higher than optimal, and also has been exceeded frequently over the past decade. Maximum sustainable yields are obtained using an exploitation rate (catch divided by spawning biomass) of about 16%. Simulation analysis suggests that under the current age-specific selectivity pattern of the gear, this may involve harvesting nearly all the vulnerable individuals depending on the shape of the stock-recruitment relationship (which is not well estimated at the present time).

Recommendations

The San Francisco Bay herring population has been reduced to a level of roughly 20% of the unfished level and is presently at or near the lowest abundance observed since the early 1970s. A rebuilding policy should be implemented.

The current harvest strategy for this stock should be re-evaluated and explicitly documented. The current harvest rate policy of 20% appears to be too aggressive under current levels of stock production. A harvest rate in the range of 10-15% appears to be sustainable with the lower level providing a desirable target for stock rebuilding. The CDFG should investigate the suitability of a fishing threshold or cutoff level similar to

that in place in British Columbia and Alaska to conserve spawning biomass and during periods of reduced productivity.

The Department should develop a specialized herring stock assessment model using an approach similar to that in Coleraine. This will make the best use of the variety of data that exists for herring and would better reflect unique biological properties of the San Francisco Bay stock. While this could be done by contract, the Department would benefit greatly by developing this model in-house. This would assure that DFG has staff who understand the techniques and assumptions in such a model, who would be capable of maintaining and updating the model, and who would be capable of applying the technology to other resource management problems.

Spawn surveys provide a sound empirical estimate of current stock size and should be continued on an annual basis as the primary index of abundance and as the biomass estimate for use in setting the fishery quota for the upcoming season until an integrated catch-age model can be developed and verfied. Hydroacoustic surveys should be continued on a developmental basis as resources allow to support the location and timing of spawn assessment surveys and to better understand possible changes in pre-spawning herring behaviour within the bay. Such surveys can be conducted in conjunction with the trawl surveys that are critical for the collection of information on the age structure of the spawning population. The results of this year's Coleraine model runs may provide useful guidance for decision-making, with the understanding that the future specialized model may produce results that differ in unanticipated respects and the two models are unlikely to be exactly equivalent.

The biological sampling program currently in place for estimating the age-structure of the population is not providing an unbiased estimate of the true population age composition. The present system of obtaining age compositions by means of age-length keys should be replaced by direct (random) sampling of ages from the fishery and survey catches. The allocation of age samples would be approximately equal between surveys and fishery catches, and should be based on an approximately constant rate of samples per ton. The DFG may also want to consider the use of scales rather than otoliths to maximize the use of available ageing resources.

We recommend that the Department adopt a stronger policy of documentation. Details of each year's surveys and monitoring should be recorded and archived at least in timely internal reports.

Acknowledgement

We commend the professionalism of the DFG staff in supporting this review. Their dedication to herring research over the past 25 years has made it possible to do the statistical analyses required for sound management.