Modeling the population dynamics of Prince William Sound Herring

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The specific objectives of this project are to:

a) Determine which datasets provide the most informative information for the ASA model (objective 1).
b) Predict levels of future recruitment, and autocorrelation in recruitment, using information from other herring populations and other species of clupeids (objective 1).
c) Synthesize the data collected from the monitoring program into a holistic model of herring dynamics (objective 2), to determine which life stages the observational program should focus on (objective 3).

Approach

Identify the most informative datasets: conduct a management strategy evaluation (e.g. Butterworth & Punt 1999, Sainsbury et al. 2000) to identify which types of data are most informative for the ASA model. This task will comprise developing an operating model (modeling the "truth") to generate data types used by the ASA model (hydroacoustic survey, surveys of milt production, age composition, etc.), particularly the new time series developed as part of this program. For each model run, one type of data will be omitted, a large number of data sets will be generated (100-1000 depending on the time it takes to run the model), and the ASA model applied to the generated data to produce estimates of abundance. The estimates will then be compared to the underlying "truth" in the operating model to see how well the ASA model performs in the absence of that particular source of data. The end result will be an ordering of input data types from most to least informative, providing critical information to prioritize current and future monitoring efforts.

Predict future levels of recruitment: collate time series of herring abundance and recruitment in Pacific herring stocks, and for stocks of other clupeid species. Conduct a meta-analysis to estimate the average duration that a typical herring stock would be expected to remain at low abundance. Estimate the average level of autocorrelation in herring recruitment from other stocks, to understand how much recruitment covaries from one year to the next. Gather covariates (e.g. length, trophic level, price, latitude, sea surface temperature) to understand which factors influence recruitment in clupeid populations. Much of the data for this task has already been completed in the RAM Legacy stock assessment database (e.g. Branch et al. 2010, 2011, Ricard et al. submitted), but more stocks will be added for the analysis.

Create holistic model of herring dynamics: develop a life stage model to synthesize data from each aspect of the monitoring program, to understand which age groups and sources of mortality are most likely to explain the decline in the abundance of PWS herring. The model will be age-based and include separate terms for each component of mortality. The model will be fitted to time series of abundance at each life history stage and time series of disease prevalence.

These tasks will be conducted on computers by University of Washington students and faculty, who have access to a wide range of in-house fisheries modeling expertise (e.g. faculty members Ray Hilborn, André Punt, Tim Essington). This will allow us to examine statistical modeling, process based modeling, and ecosystem modeling approaches in choosing the best approach for each objective.