FOCI Prediction

10/29/03

2003 Pollock Year-Class Prediction: Average Recruitment

DATA

This forecast is based on five data sources: three physical properties and two biological data sets. The sources are: 1) observed 2003 Kodiak monthly precipitation, 2) wind mixing energy at [57N, 156W] estimated from 2003 sea-level pressure analyses, 3) advection of ocean water in the vicinity of Shelikof Strait inferred from drogued drifters deployed during the spring of 2003, 4) rough counts of pollock larvae from a survey conducted in May 2003, and 5) estimates of age 2 pollock abundance from this years assessment.

ANALYSIS

Kodiak Precipitation: Monthly precipitation totals (inches) are prepared by the Kodiak, Alaska, National Weather Service Office from hourly observations. Data were obtained from the NOAA National Climate Data Center, Asheville, North Carolina.

The winter started wet this year (Table 1). Spring started with near normal precipitation, but May, a crucial period in the early life history of pollock, was relatively dry. June saw a return to above average rainfall.

TABLE 1. Kodiak precipitation for 2003

Month	% 30-yr average
Jan	236
Feb	120
Mar	131
Apr	94
May	31
June	122

FOCI believes that Kodiak precipitation is a valid proxy for fresh-water runoff that contributes to the density contrast between coastal and Alaska Coastal Current water in Shelikof Strait. The greater the contrast, the more likely that eddies and other instabilities will form. Such secondary circulations have attributes that make them beneficial to survival of larval pollock. Based on this information, the forecast element for Kodiak 2003 rainfall has a score of 2.24. This is "average to strong" on the continuum from 1 (weak) to 3 (strong).

Wind Mixing: For the first time since 1997, monthly mean mixing exceeded the 30-yr mean (Table 2). This happened during March, the period when pollock are spawning and substantially before the first feeding larvae of the 2003 year class. Mixing during other months was near or below average.

TABLE 2. Wind mixing at the exit of Shelikof Strait for 2003.

Month	% 30-yr average
Jan	87
Feb	30
Mar	158
Apr	80
May	97
June	55

Strong mixing in winter helps transport nutrients into the upper ocean layer to provide a basis for the spring phytoplankton bloom. Weak spring mixing is thought to better enable first feeding pollock larvae to locate and capture food. Weak mixing in winter is not conducive to high survival rates, while weak mixing in spring favors recruitment. This year's scenario produces a wind mixing score of 2.15, which equates to "average".

Advection: From an examination of drifter trajectories and wind forcing, the transport in Shelikof Strait for spring of 2003 was average.

We have hypothesized that very strong transport is bad for pollock survival, and that moderate transport is best and that very weak transport is, while not as disastrous as strong transport, still detrimental to larval survival. Advection was given a score of 2.0.

Relating Larval Index to Recruitment: As in last years analysis, a nonlinear neural network model with one input neuron (larval abundance), 3 hidden neurons, and one output neuron (recruitment) was used to relate larval abundance (catch/m^2) to age 2 recruitment abundance (billions). The model estimated 6 weighting parameters.

TABLE 3. Data used in the neural network model.

Year Class	Average Larval Abundance (catch/m^2)	Age 2 Recruitment (billions)
1982	66.44347	0.192071
1985	80.4266	0.551805
1987	324.9025	0.361285
1988	256.9029	1.65348
1989	537.2943	1.04816
1990	335.0086	0.41271
1991	54.2223	0.238671
1992	563.6741	0.132253
1993	45.80764	0.202603
1994	124.9386	0.787051
1995	600.9925	0.360514
1996	472.0225	0.138638
1997	561.1063	0.16983

1998	72.81539	0.289686
1999	102.3862	1.43102
2000	486.1835	0.66197
2001	174.624	0.115187
2002	276.6972	
2003	90.40014	

The neural network model, which used the first 17 observation pairs of Table 3 were fit to the model and had a R^2 of 0.219. A plot of the observed recruitment (actual) and that predicted from larval abundance (predicted) are given below where row number corresponds to the rows of the data matrix given above.

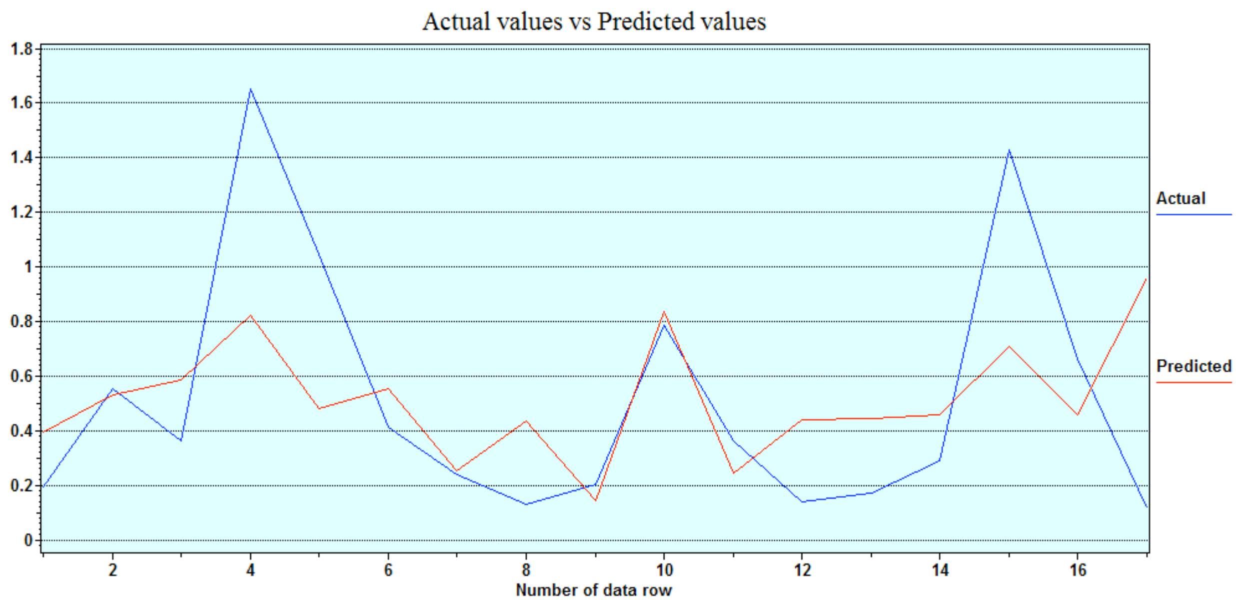

FIGURE 1. Observed and predicted recruitment values from the larval index-recruitment neural network model.

The trained network was then used to predict the recruitment for 2002 and 2003.

The predictions are

Year	Actual Recruitment	Predicted Recruitment
2002	n/a	0.755
2003	n/a	0.619

These values, using the 33% (0.355203) and 66% (0.674798) cutoff points given below correspond to a strong 2002 year class and an average 2003 year class.

Note that the neural net model fit last year to these data predicted the 2002 year class to be strong at 1.84 billion fish.

Larval Index Counts: Plotting the data by year and binning the data into catch/10 m^2 categories (given below) provides another view of the data. The pattern for 2003 (based on rough counts) seems very similar to 1994 in that the two strongest modes fall into the 25-100 and 100-250 catch/10 m^2 bins.

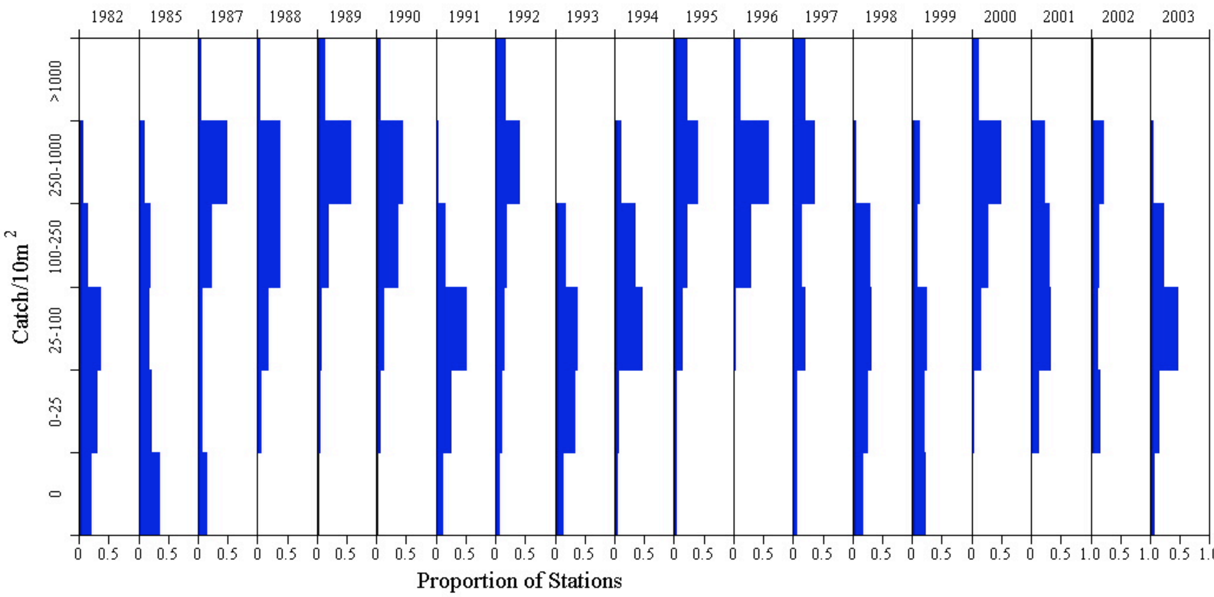

FIGURE 2. A series of histograms for larval walleye pollock densities in late May from 1982 to 2003. Data were binned into catch/10 m^2 categories. The data from 2000-2003 are rough counts taken at sea, and the 2003 data are from the 5MF03 cruise that was completed on June 1.

The data for Figure 2 are taken from a reference area that is routinely sampled and that usually contains the majority of the larvae (the area outlined in blue in Fig. 3. This year's distribution of pollock appears to be centered in the typical reference area. Also the larval abundance figures in the middle of the reference area are somewhat above average.

Given these two pieces of information, the score for larval index is set to the high end of the average, 2.33.

Spawner/Recruit Time Series: The time series of recruitment from this year's assessment was analyzed in the context of a probabilistic transition. The data set consisted of estimates of age 2 abundance from 1961-2003, representing the 1959-2001 year classes. There were a total of 43 recruitment data points. The 33% (0.355203 billion) and 66% (0.674798 billion) percentile cutoff points were calculated from the full time series and used to define the three recruitment states of weak, average and strong. The lower third of the data points were called weak, the middle third average and the upper third strong. Using these definitions, nine transition probabilities were then calculated:

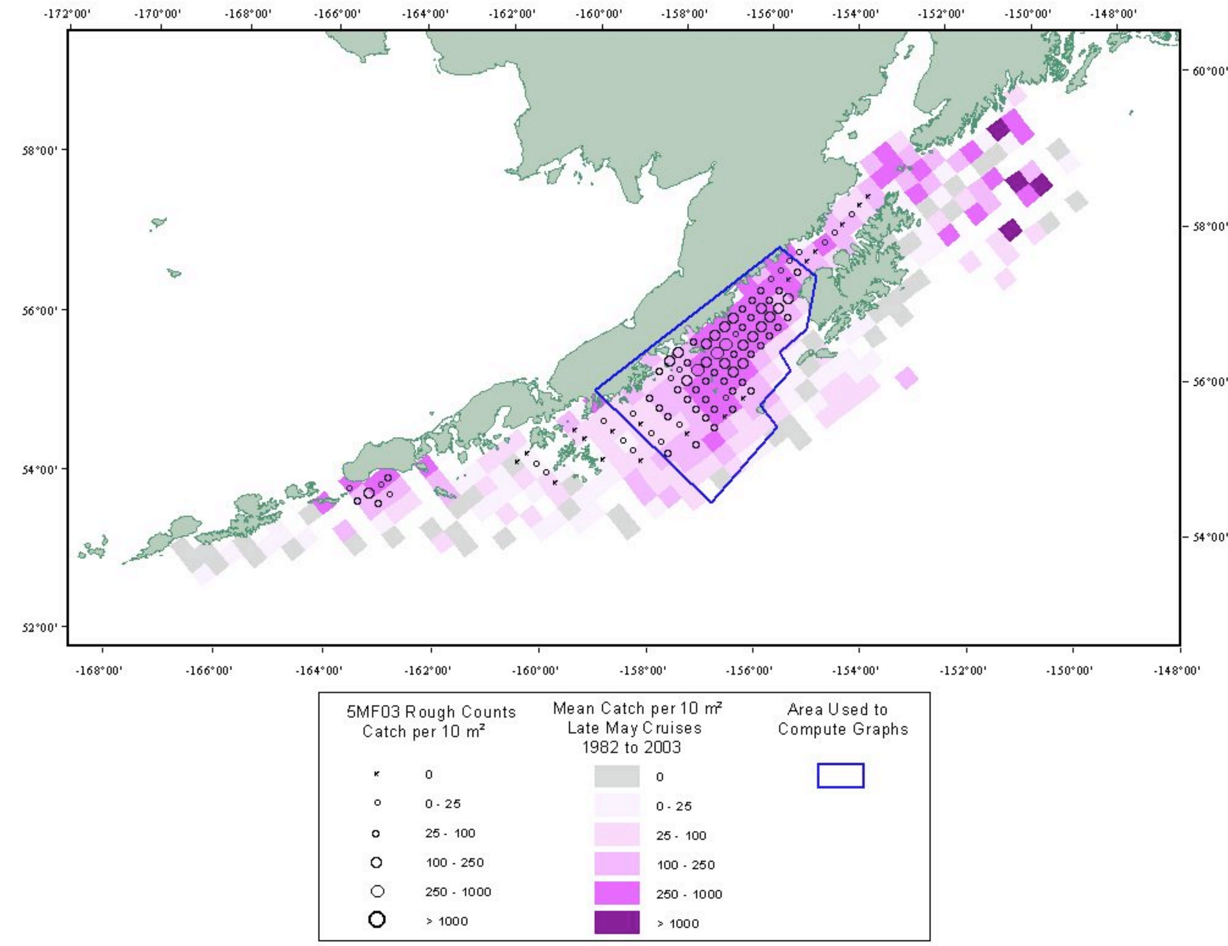

FIGURE 3. Mean catch per 10 m^2 for late May cruises during 1982-2003.

1. Probability of a weak year class following a weak
2. Probability of a weak year class following an average
3. Probability of a weak year class following a strong
4. Probability of an average year class following a weak
5. Probability of an average year class following an average
6. Probability of an average year class following a strong
7. Probability of a strong year class following a weak
8. Probability of a strong year class following an average
9. Probability of a strong year class following a strong

The probabilities were calculated with a time lag of two years so that the 2003 year class could be predicted from the size of the 2001 year class. The 2001 year class was estimated to be 0.115187 billion and was classified as weak. The probabilities of other recruitment states following a weak year class for a lag of 2 years (n=43) are given below:

2003 Year Class		2001 Year Class	Probability	N
Weak	follows	Weak	0.097	4
Average	follows	Weak	0.073	3
Strong	follows	Weak	0.146	6

The probability of a strong year class following a weak year class had the highest probability. We classified this data element as a strong, giving it a score at the low end of strong 2.34.

Each of the data elements was weighted equally.

CONCLUSION

Based on these five elements and the weights assigned in the table below, the FOCI forecast of the 2003 year class is average.

Element	Weights	Score	Total
Time Sequence of R	0.2	2.34	0.468
Rain	0.2	2.24	0.448
Wind Mixing	0.2	2.15	0.43
Advection	0.2	2.00	0.4
Larval Index-abundance	0.2	2.33	0.466
Total	1.0		2.21 = Average