FOCI Prediction

10/06/02

2002 Pollock Year-Class Prediction: Weak to Average Recruitment

DATA

This forecast is based on five data sources: three physical properties and two biological data sets. The sources are: 1) observed 2002 Kodiak monthly precipitation, 2) wind mixing energy at [57N, 156W] estimated from 2002 sea-level pressure analyses, 3) advection of ocean water in the vicinity of Shelikof Strait inferred from drogued drifters deployed during the spring of 2002, 4) rough counts of pollock larvae from a survey conducted in May 2002, and 5) estimates of age 2 pollock abundance from this year's assessment.

ANALYSIS

Kodiak Precipitation: The winter started wet this year (Table 1), but the spring was relatively dry. April rainfall was at a new low (0.29 inches) for the period of the recruitment time series record (1962-present). That amount of rain is just 7% of the 30-yr average (1962-1991) for April. Although precipitation increased thereafter, especially during June, that is considered too late to aid larval survival.

TABLE 1. Kodiak precipitation for 2002

Month	% 30-yr average
Jan	172
Feb	185
Mar	85
Apr	7
May	75
June	155

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 rainfall has a score of 1.87. This is "average" on the continuum from 1 (weak) to 3 (strong).

Wind Mixing: Wind mixing followed a similar pattern established in 1997 when the PDO changed sign. Mixing is significantly below the 30-yr mean. Weak mixing in winter is not conducive to high survival rates, while weak mixing in spring favors recruitment

TABLE 2. Wind mixing at the exit of Shelikof Strait for 2002

Month	% 30-yr average
Jan	35
Feb	46
Mar	30
Apr	47
May	29
June	51

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 2.30, which equates to "average".

Advection: From an examination of drifter trajectories and wind forcing, the transport in Shelikof Strait for spring of 2002 was very weak. It is difficult at this time to quantify advection since data for the Line 8 moorings has not been analyzed, but as an early estimate, it is among the weakest on record.

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 1.0.

Relating Larval Index to Recruitment: 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 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	0.19314
1985	80.4266	0.561484
1987	324.9025	0.369731
1988	255.586	1.70276
1989	537.2943	1.09101
1990	335.0086	0.432056
1991	54.2223	0.252929
1992	563.6741	0.135936
1993	45.80764	0.212
1994	124.9386	0.78524
1995	600.9925	0.329781
1996	472.0225	0.082934
1997	561.1063	0.157118

1998	73.07128	0.383759
1999	102.3862	2.47685
2000	535.4901	0.23056
2001	136.2054	
2002	167.1542	

The neural network model, which used the first 16 observation pairs of Table 3 were fit to the model and had a R^2 of 0.497. 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.

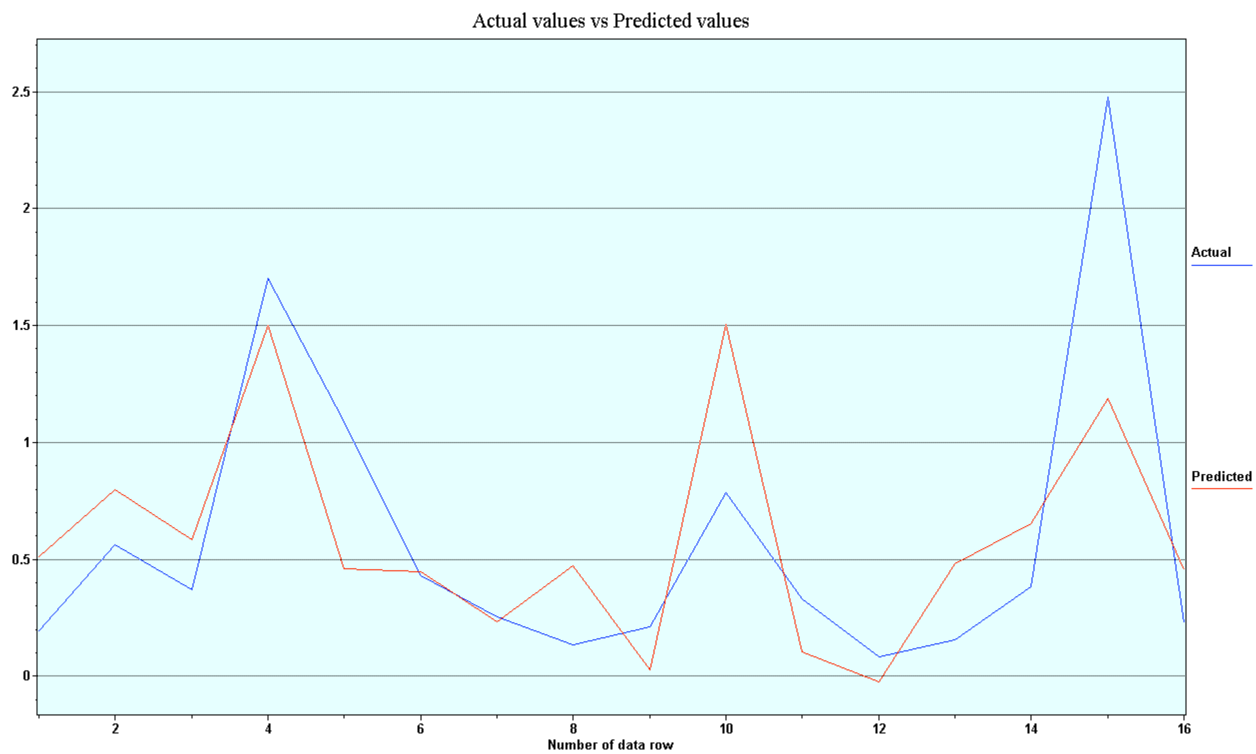

FIGURE 1. Observed and predicted recruitment values form the larval index-recruitment neural network model.

The trained network was then used to predict the recruitment for 2001 and 2002.

The predictions are

Year	Actual Recruitment	Predicted Recruitment
2001	n/a	1.626241
2002	n/a	1.840346

These values, using the 33% and 66% cutoff points given below correspond to a strong 2001 year class and a strong 2002 year class.

Note that the neural net model fit last year to these data predicted the 2000 year class to be average at 0.573 billion fish. Results of this years assessment show the predicted recruitment for the 2000 year class to be 0.231 billion.

Larval Index Counts: Plotting the data by year and binning the data into catch/m^2 categories (given below) provides another view of the data. The pattern for 2002 (based on rough counts) indicates that 2002 is a very bad year for pollock larvae, but this is somewhat misleading.

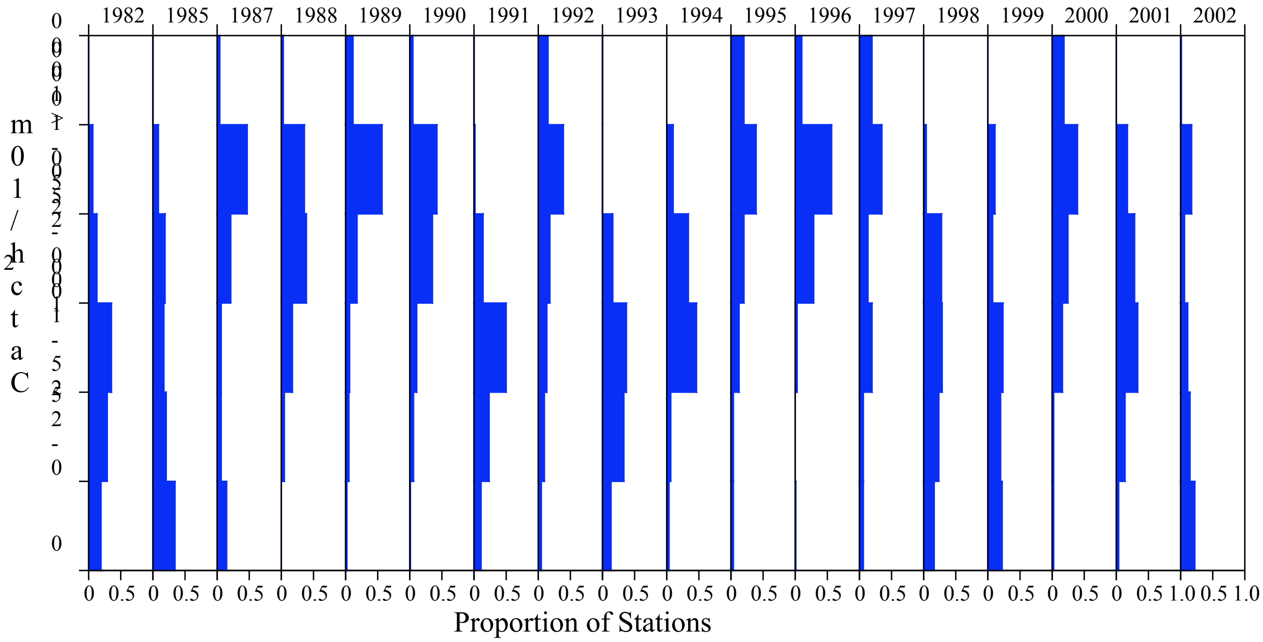

FIGURE 2. A series of histograms for larval walleye pollock densities in late May from 1982 to 2002. Data were binned into catch/m^2 categories. The data from 2000-2002 are rough counts taken at sea, and the 2002 data are from the 4MF02 cruise that was completed on June 1.

The score for larval index is set to the high end of the weak range, 1.5.

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 Figures 3 and 4). However, this year a few stations were cut due to bad weather, and these stations might have increased the proportion of stations in the 100-250 catch/10m^2 bin on the graph. Another factor is that this year's distribution of pollock appears to be more northerly in Shelikof Strait than normal. You can see in the maps that many of the southern stations of 4MF02 within the reference area didn't catch any larvae. Also, many large catches (250-1000 catch/10m^2) are northeast of our typical reference area. This might indicate that the distribution hasn't yet been advected as far southwest as they usually have been by this time – an observation supported by the observed weak advection index. We can't really conclude this, however. We rarely survey this area in late May, hence we don't know if these northeast catches are unusual. Figures 3 and 4 address this issue. Figure 3 shows some very high densities in the area north of Kodiak Island, but these densities are based on very few years (Figure 4) so it's unknown how consistent these high densities are from year to year. It also seems unlikely that these larvae are from the same spawning population as the larvae in our reference area.

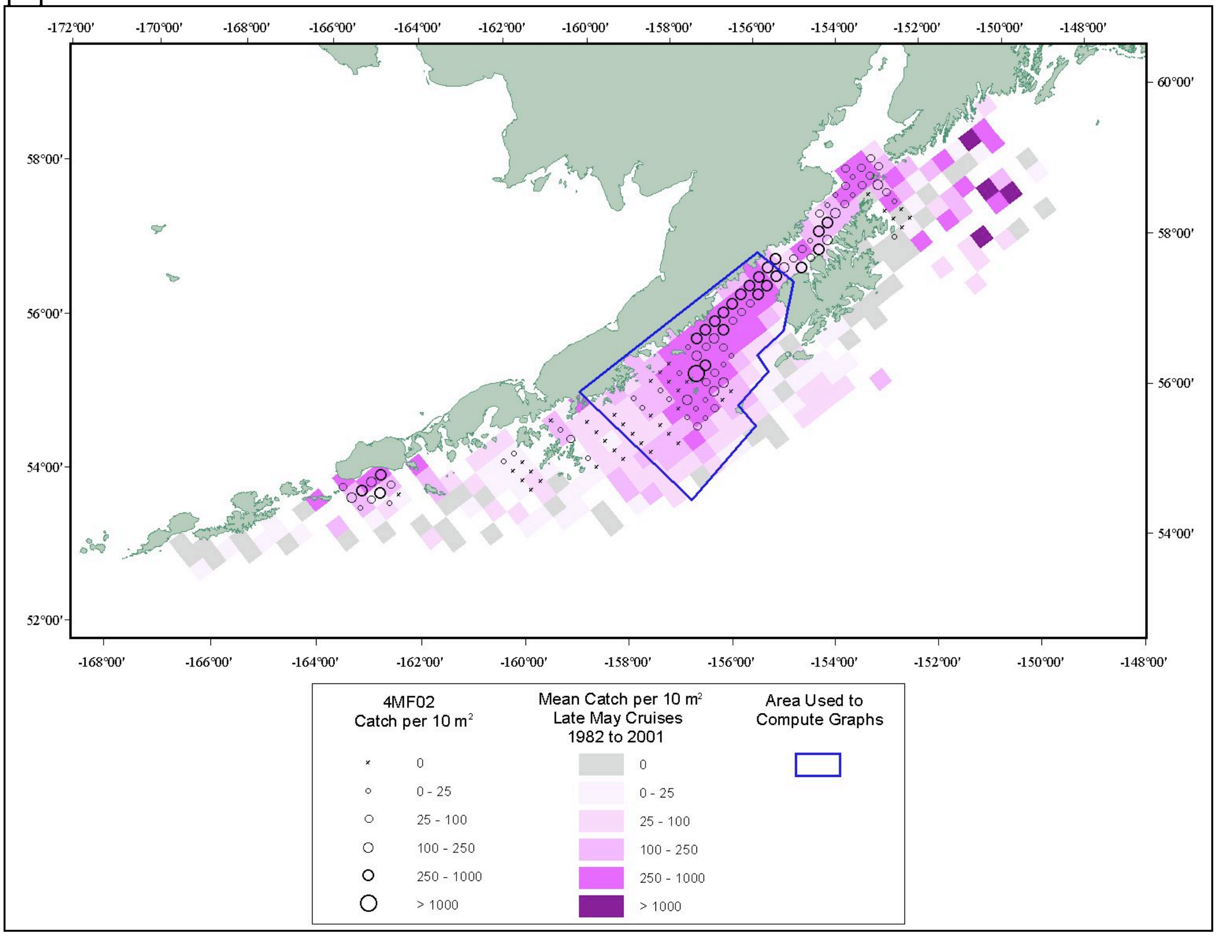

FIGURE 3. Mean catch per $10m^2$ for late May cruises during 1982-2001.

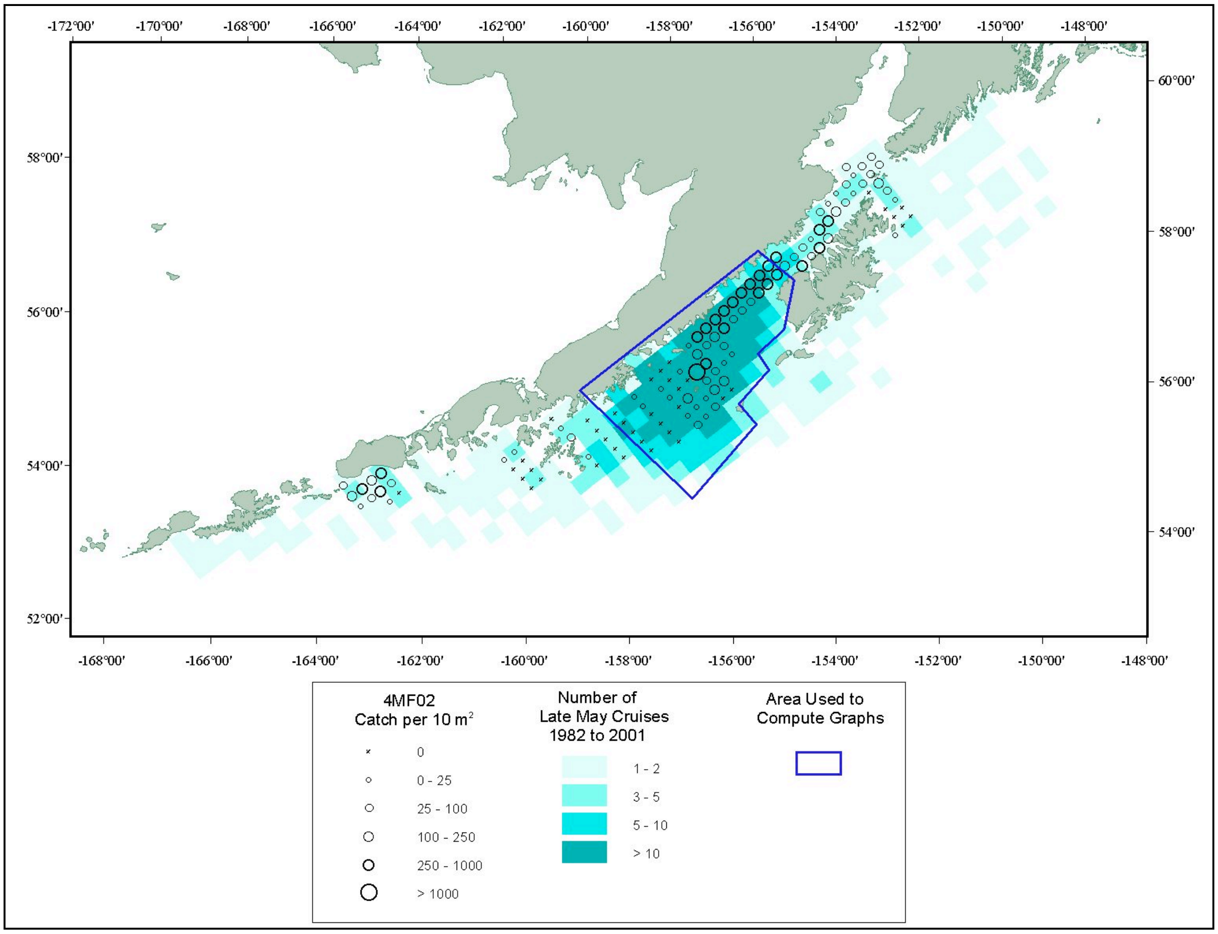

FIGURE 4. Number and location of data sampling effort, 1982-2001.

Due to the ambiguities mentioned, we will classify the larval index data as indicating a weak to average situation and give it a score at the low end of the average range, 1.67.

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 1961-2002, representing the 1959-2000 year classes (see Table XX). There were a total of 42 recruitment data points. The 33% and 66% percentile cutoff points were calculated from the full time series (33%=0.390955 billion, 66%=0.694044 billion) 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:

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 2002 year class could be predicted from the size of the 2000 year class. The 2000 year class was estimated to be 0.23096 billion and was classified as weak. The probabilities of other recruitment states following a weak year class for a lag of 2 years (n=42) are given below:

2002 Year Class		**2000 Year Class**	**Probability**	**N**
Weak	follows	Weak	0.125	5
Average	follows	Weak	0.075	3
Strong	follows	Weak	0.125	5

The probability of a weak or strong year class following a weak year class had the highest probability. The prediction element from this data source was also ambiguous, and we classified this data element as a compromise between the weak and strong, giving it a score of 2.0.

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 2002 year class is weak to average.

Element	**Weights**	**Score**	**Total**
Time Sequence of R	0.2	2.0	0.4
Rain	0.2	1.87	0.374
Wind Mixing	0.2	2.3	0.46
Advection	0.2	1.00	0.2
Larval Index-abundance	0.2	1.67	0.334
Total	1.0		1.768 = Weak to average