FOCI Recruitment Prediction – 1995: Average to Strong Year Class

Six sources of information were available: quantitative results from a refitting of the nonlinear transfer function time series model, quantitative results of analyzing the time sequence of recruitment data points, and four qualitative sources of information.

1995 Prediction: Quantitative Information

In the last refitting of the nonlinear transfer function time series model, 1990 and 1991 data recruitment and environmental variable time series data were added to the model. Two years were held in reserve in order to provide predictions which included the 1995 year class. Results indicate that the 1995 year class is average (Table 1). We point out once again that the model did not fit as well (R = 0.49) as it did in the previous fitting exercise (R = 0.69). Also, in the refitting, we assume that the variables that were important to predicting recruitment did not change.

We also used the original time sequence of recruitment data points analysis used in the 1993 prediction, but applied the approach to the 1962-1992 series of recruitment values. The data points were lagged two years as this was the lag that had the highest autocorrelation. The main weakness of this approach is that it uses no environmental data. However, strong and weak year classes do appear in runs and this observation was the main motivation to moving to the time series model. Since 1994 is considered strong we calculated the probabilities of a weak, average, and strong year class following a strong. We also used two data partitioning schemes: a two partition (weak and strong) and a three partition (weak, average, and strong) approach. Results are summarized below.

	Number of Observations	Conditional Probability
Weak-Strong Partition		
Weak follows weak	8	0.57
Strong follows weak	6	0.43
Weak follows strong	6	0.40
Strong follows strong	9	0.60

	Number of Observations	Conditional Probability
Weak-Average-Strong Partition		
Weak follows weak	3	0.37
Average follows weak	2	0.25
Strong follows weak	3	0.38
Weak follows average	3	0.30
Average follows average	3	0.30
Strong follows average	4	0.40
Weak follows strong	3	0.30
Average follows strong	4	0.40
Strong follows strong	4	0.40

These data indicate that regardless of the partition scheme, given a strong year class, the highest conditional probability is for a strong year class to follow.

1995 Prediction: Qualitative Information

Rainfall (a source of freshwater input to the Gulf of Alaska) is assumed to be beneficial to recruitment because increased baroclinity arising due to the addition of freshwater to the Gulf of Alaska promotes the formation of eddies and the flow of water onto the shelf. Larval survival appears to be greater in eddies. Data show that rainfall during the spring was high in 1995, thus suggesting the 1995 year class would be average to above average.

Low levels of wind mixing are assumed to be good for recruitment because they favor survival of early feeding larvae on the shelf. Wind mixing was average in 1995. The prediction from wind mixing is that the 1995 year class will be average.

Vigorous advection in late winter is presumed to benefit the nutrient supply to the shelf, while vigorous advection during spring is presumed to be bad for recruitment as it will have a tendency to wash larval pollock off the continental shelf into areas of low productivity. Advection was average in 1995. The prediction from advection is that the 1995 year class will be average.

Information on the larval index of abundance was available. This qualitative information source showed that the 1995 year class had the highest larval rough counts of any in the recorded time series, suggesting a strong year class.

1995 Prediction: Combined

Half of the weights (Table 2) were distributed over the two quantitative data sources. The time series model was given a weight of 0.3 and the time sequence of recruitment data points data sources was given a weight of 0.2. The four remaining qualitative data sources received the remaining 0.5 weights. Since there were no moored current meters deployed in 1995, advection was inferred from wind and drifter records, and the weight for this data sources was set to 0.1. The weights of the remaining qualitative data sources were set to 0.133.

The sum of the weighted scores was 2.19, indicating an average 1995 year class. However this score is close to 2.3, the cut point differentiating average and strong recruitment. This along with the fact that there were very high abundance levels of late larvae, a direct biological observation, argue for making an average to strong combined 1995 year class prediction.

Revised 1994 Year Class Prediction

Since the 1994 prediction, two additional data sources have been added to the information matrix. Information from the 1995 hydroacoustic survey shows that the abundance of the 1 year olds (the 1994 year class) is the highest on record. This year class makes up almost 20% of the assessed biomass. Also information from Tufted Puffin nesting diets shows a strong 1994 year class. This data is somewhat questionable since due to prey selectivity preferences it is difficult to infer population abundance from diet data. In addition the information is from Middleton Island, so using the data also requires the assumption that the indicated patterns of pollock abundance are the same Gulf wide.

Including these two additional data sources in the weighting scheme has the 1994 year class as strong. This revised prediction is consistent with the previous prediction of average to strong.

1996 Prediction

A very tentative prediction of the 1996 year class is possible using the recruitment data from the 1995 stock assessment model, the time sequence of recruitment data points quantitative technique, and the assumption that the 1995 year class is average to strong. If 1995 is strong and using the two-way partition, there is a good likelihood that the 1996 year class will be strong. If 1995 is average and using the three-way partition, there is equal likelihood that the 1996 year class is weak, average or strong. If 1995 is strong, then there is a good probability that the 1996 year class will be strong.

	Number of Observations	Conditional Probability
Weak-Strong Partition		
Weak follows weak	9	0.64
Strong follows weak	5	0.36
Weak follows strong	5	0.31
Strong follows strong	11	0.69

	Number of Observations	Conditional Probability
Weak-Average-Strong Partition		
Weak follows weak	3	0.30
Average follows weak	4	0.40
Strong follows weak	3	0.30
Weak follows average	3	0.33
Average follows average	3	0.33
Strong follows average	3	0.33
Weak follows strong	4	0.36
Average follows strong	2	0.18
Strong follows strong	5	0.46

Table 1. Summary of FOCI Recruitment Predictions

	Year Class								
Type of Prediction	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*Year Predicted*	*Method*
Quantitative[1] **1992**	W	W	W-A	S				**92**	S-R data and time sequence of data points
Quantitative[2]			A	A	A			93	Nonlinear transfer function time series model
Qualitative[3]			W	W				93	Subjective observations
Combined 1993			**W**	**W**	**A**			**93**	
Quantitative[4]			S	A	A	A		94	Nonlinear transfer function time series model
Quantitative[5]			A	W	A-S			94	Hydroacoustic length composition
Qualitative[6]			A-S	A	A	A-S		94	Rain
Qualitative[7]			W	A	A	A-S		94	Wind
Qualitative[8]			W	A	A	A-S		94	Advection
Qualitative[9]			W	A-S	W-A	A		94	Larval index of abundance
Combined 1994			**W**	**W**	**A**	**A-S**		**94**	
Quantitative[11]							S	95	S-R data and time uence of data points
Quantitative[4]						A	A	95	Nonlinear transfer function time series model
Quantitative[5]						S		95	Hydroacoustic length composition
Qualitative[6]						A-S	A-S	95	Rain
Qualitative[7]						A-S	A	95	Wind mixing
Qualitative[8]						A-S	A	95	Advection
Qualitative[9]						A	S	95	Larval index of abundance
Qualitative[10]						A-S	na	95	Tufted puffin nesting diet
Combined 1995						**S**	**A**	**95**	
Actual Recruitment	W	W	W	W	W-A				

1 Used recruitment time series 1962-1989 and spawner-recruit data 1969-1989; no environmental data
2 Used recruitment time series 1962-1989 as well as environmental data
3 Used NMFS survey data
4 Used recruitment time series 1962-1991 as well as environmental data in refit of transfer function model
5 Hydroacoustic length composition from Shelikof Strait 1992-1994
6 Average Kodiak rainfall during January and February for 1991-1994
7 Wind energy at 55'N 156'W during April, May and June 1991-1994
8 Advection from moored current meters, drift buoys or wind forcing
9 Late May larval rough counts from ichthyoplankton tows in Shelikof Strait
10 Tufted puffin nesting diet on Middleton Island (Hatch 1984 and unpubl. data)
11 Used recruitment time series 1962-1992 and spawner-recruit data 1969-1992; no environmental data

Table 2. 1995 Recruitment Prediction Worksheet

Time Frame	*Method/Source*	*Type*	*89*	*90*	*91*	*92*	*93*	*94*	*95*
1st 2 years	Time series model	Quantitative			S	A	A	A	A
	Time sequence	Quantitative							S
1st year	Hydro length composition	Quantitative			A	W	A-S	S	
1st 3 months	Rain	Qualitative			A-S	A	A	A-S	A-S
	Wind mixing	Qualitative			W	A	A	A-S	A
	Advection	Qualitative			W	A	A	A-S	A
	Larval index-abundance	Qualitative			W	A-S	W-A	A	S
	Puffin nesting diet	Qualitative						A-S	
		COMBINED 1995			**W**	**W**	**A**	**S**	**A**

Table 2. continued.

	91			*92*			*93*		
	Weights	*Score*	*Total*	*Weights*	*Score*	*Total*	*Weights*	*Score*	*Total*
Time series model	0.2	2.34	0.468	0.2	1.67	0.334	0.2	1.67	0.334
Time sequence	0	0	0	0	0	0	0	0	0
Hydro length composition	0.3	1.67	0.501	0.3	1	0.300	0.3	2.33	0.699
Rain	0.125	2.34	0.293	0.125	1.67	0.209	0.125	1.67	0.208
Wind mixing	0.125	1	0.125	0.125	1.67	0.209	0.125	1.67	0.209
Advection	0.125	1	0.125	0.125	1.67	0.209	0.125	1.67	0.209
Larval index-abundance	0.125	1	0.125	0.125	2.5	0.312	0.125	1.67	0.209
Puffin nesting diet	0	0	0	0	0	0	0	0	0
Total	**1**		**1.637**	**1**		**1.573**	**1**		**1.868**

	94			*95*		
	Weights	*Score*	*Total*	*Weights*	*Score*	*Total*
Time series model	0.2	1.67	0.334	0.3	1.67	0.501
Time sequence	0	0	0	0.2	3	0.600
Hydro length composition	0.3	3	0.900	0	0	0
Rain	0.1	2.34	0.234	0.125	2.34	0.293
Wind mixing	0.1	2.34	0.234	0.125	1.67	0.209
Advection	0.1	2.34	0.234	0.125	1.67	0.209
Larval index-abundance	0.1	2	0.200	0.125	3	0.375
Puffin nesting diet	0.1	2.34	0.234	0	0	0
Total	**1**		**2.370**	**1**		**2.187**