An Evaluation of Alternative Harvest Strategies for Bristol Bay Sockeye Salmon

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Abstract

While the salmon fisheries of Alaska have an enviable record of biological sustainability, their economic viability and profitability have been less successful. Harvest strategies for Alaska salmon fisheries are designed to achieve a predetermined range of escapements that are believed to maximize long-term average catch. Management to achieve this *Maximum Sustained Yield* (*MSY*) minimizes the variation in annual escapement levels and maximizes the interannual variation in catch. Occasionally, economic concerns for specific Alaskan salmon fisheries are addressed by the Alaska Board of Fisheries through the implementation of Optimum Escapement Goals. These *ad hoc* goals typically trade off biological productivity for economic benefits by diverging above or below the escapement levels thought to produce *MSY*.

The economic challenges facing Alaska's salmon fisheries suggest it is prudent to examine different harvest strategies to determine if changes might improve the economic performance of fisheries while protecting biological productivity. We developed an empirically based simulation model of the biological and economic dynamics of the Bristol Bay sockeye salmon stocks and the fishery that harvests them. The model provided useful insights into trade-offs and the short- and long-term implications of alternative harvest strategies for the Bristol Bay salmon fishery and for Alaska fisheries in general.

1. Production Sub-Model

Beverton-Holt Spawner-Recruit Model

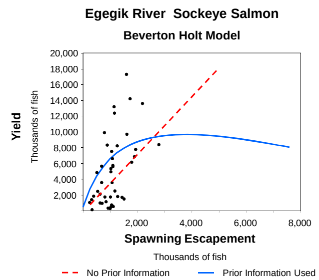
Parameters were estimated using Bayesian methods and the Metroplois algorithm for Markov chain simulation (MCMC)

Accounted for Age Structure of Future Returns

Accounted for Autocorrelation of Residuals

Used Prior Information

Prior knowledge was used to limit the maximum size of the unfished population to 50 million fish or less for Egegik. The effect of this input can be seen in the figure below – An estimate of Maximum Sustainable Yield can now be obtained.



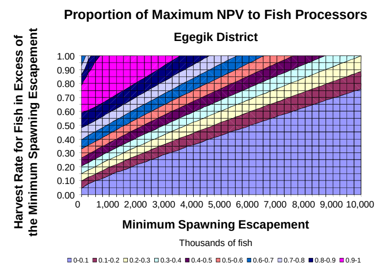
2. Harvest Policy Sub-Model

Simulates a Range of Possible Harvest Policies

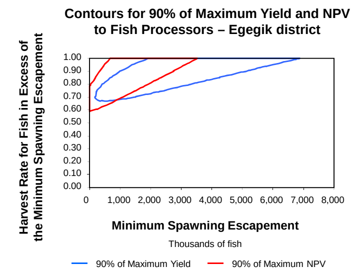
For example:

- A constant harvest rate policy is simulated by a minimum escapement of 0.0 and a selected harvest rate.
- A fixed escapement goal policy is simulated by a harvest rate of 1.0 for returns greater than the minimum escapement.
- A combination policy utilizes both a minimum escapement and harvest rate. Present day Egegik management can be viewed as a minimum escapement goal of 800,000 fish (lower range of BEG) with a high harvest rate for all fish returning in excess of the minimum goal.

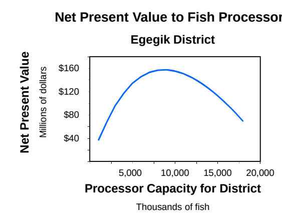
The effect of a harvest policy was assessed using the Production Sub-Model. For the figure below, the proportion of maximum yield was estimated by averaging the harvests for a 100-year simulation for each of 300 MCMC draws.



Findings for Egegik



Net Present Value was maximized for lower harvest rates and lower fixed escapement goals than those which maximized Yield.

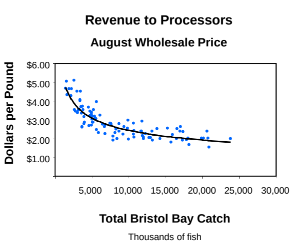


Processor capacity, which relates directly to the number of processors was important to maximizing overall NPV of the catch. Too low of a capacity means lost revenue; too many processors results in high overhead costs.

Bayesian methods using MCMC showed promise for estimating maximum sustained yield for systems like Egegik where no definitive estimate was available using traditional methods.

3. Economic Sub-Model for Fish Processors

Revenue to the fish processors was simulated using the relationship between the Japanese August Wholesale price for Bristol Bay sockeye salmon and the size of the Bristol Bay harvest. Knapp (2004) showed that the August wholesale price was highly correlated with the number of fish in the annual Bristol Bay catch and presented data which were used to estimate the relationship and corresponding variability.

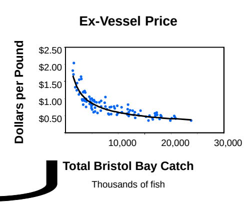


Data points indicate variation for simulations

The cost of processing salmon was modeled directly from information presented in Link et al. (2003). Cost information for both shore based and floating processors was incorporated into the economic model. For this presentation, it was assumed that 75% of the catch would be processed by shorebased operations and the price paid by processors to commercial fisherman for salmon was a function of the total Bristol Bay catch. The ex-vessel price function and it's corresponding uncertainty was estimated using data from Knapp (2004).

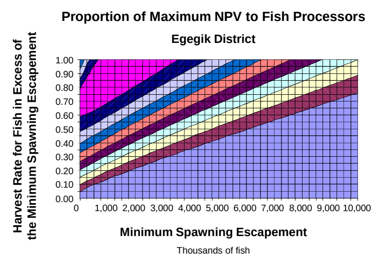
Costs for Processing Bristol Bay Sockeye Salmon

	Processor Type	
	Shore based	Floating
Operating Parameters		
Processor Capacity in fish	1,600,000	800,000
Product Recovery Rate	0.77	0.80
Facility Overhead Costs	$1,900,000	$ 1,500,000
Processing variable costs		
Cost per pound purchased for labor	$ 0.20	$ 0.21
Cost per pound purchased for packaging	$ 0.10	$ 0.05
Cost per pound purchased for miscellaneous	$ 0.01	$ 0.01
Cost per pound purchased for utilities (fuel, water, etc.)	$ 0.04	$ 0.08
Carrying cost	$ 0.01	
FOB Freight	$ 0.04	
Raw Fish Costs		
Tendering costs per lb	$ 0.48	$ 0.13
Fish Taxes per lb	$ 0.02	$ 0.03
Cost per pound for fish (Ex-vessel price)		



Data points indicate variation for simulations

Catches from the Production and Harvest Policy models were combined with the Revenue and Cost models to estimate Net Present Value (NPV) of future catches for different harvest strategies. Net Present Value for a particular harvest strategy was estimated by averaging the NPV for a 100-year simulation across the 300 MCMC draws using a discount rate of 0.07.



Acknowledgement

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Literature Cited

Link, M.R., M.L. Hartley, S.A. Miller, B. Waldrop, J. Wilen, and J. Barnett. 2003. An analysis of options to restructure the Bristol Bay salmon fishery. Unpublished report prepared for the Bristol Bay Economic Development Corporation, Dillingham, Alaska.

Knapp, G. 2004. Projections of future Bristol Bay salmon prices. Prepared for the Commercial Fisheries Entry Commission, Juneau, Alaska.