Analysis of Escapement Goals for Bristol Bay Sockeye Salmon taking into Account Biological and Economic Factors

Executive Summary and Introduction from the Study Report



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Executive Summary

At an Alaska Board of Fisheries meeting in December 2012, the Alaska Department of Fish and Game (ADF&G) proposed increasing sockeye escapement goals for several river systems in Bristol Bay. After a movement by industry to get the Board of Fisheries to adopt optimum escapement goals (OEGs) at the then current escapement goal levels, ADF&G agreed to postpone implementing the proposed escapement goals until industry could study the biological and economic implications of changes to existing escapement goals. The industry was to work with ADF&G, fishermen and processors and to report back to the Board of Fisheries in two years, and prior to the 2015 fishing season.

A study was led by the Bristol Bay Science and Research Institute (BBSRI) with financial support from BBEDC (~80%) and the Bristol Bay Regional Seafood Development Association (~20%). Over the last 18 months, fishery scientists and economists from the University of Washington and BBSRI examined the biological and economic impacts of four alternative escapement goal policies, including the current escapement goals. As part of the study, an Advisory Panel (AP) was assembled with representatives of fishermen (set and driftnet), processors, an independent economist, and an ADF&G manager. The AP met five times over the last year to review methods and provide feedback on how to best quantify the impacts of different escapement goal policies.

This report is the second of two reports completed by the study team. In the first report, we examined the process of setting escapement goals believed to maximize catches (also known as BEGs or Biological Escapement Goals) by exploring some approaches different from those used by ADF&G.

Study Approach

We used computer models to simulate the fishery and the individual salmon stocks on a daily basis under alternate harvest policies to understand differences in key variables such as catch, value of harvest to fishermen and processors, and the inter-annual variability in these. Computer models were constructed that mimic the Bay's sockeye stocks, management rules (when to open and close the fishery), harvesting and processing revenues, and the effects of escapement levels on subsequent returns. The model was run for 100-year simulations, and these simulations were repeated 100 times for each escapement goal alternative to characterize differences among policies. We characterized the economic performance (i.e., revenue to harvesters and processors) across all escapement goals examined. All the alternatives we looked at would qualify as either sustainable escapement goals (SEGs) or BEGs, and as such, could be implemented by ADF&G without Board of Fisheries involvement.

Alternative Escapement Goals Examined

1. Current escapement goals (SEGs; in use through 2014)
2. ADF&G proposed SEGs and BEGs (those proposed in December 2012)
3. BEGs developed by ADF&G expected to provide maximum sustained yield (BEGs)
4. Escapement goals that vary with the size of the annual return (total return or TR-based escapement goals).

Key Findings

- Generally, moving to higher escapement goals will produce larger and more variable runs and escapements across Bristol Bay, but this is not expected to translate into larger harvests or revenue to harvesters and processors. In some cases, harvests will be smaller under higher escapement goals.

- We expect a relatively flat plateau of catch and value of catch across a wide range of escapement levels; narrowly defined escapement goals do not seem warranted and, this also has implications for how to define "foregone harvest".

- Current and proposed SEGs are economically robust. In general, the current and the ADF&G proposed escapement goals performed well in terms of harvest and revenue to the harvesting and processing sectors, relative to BEGs.

- Pursuing theoretical maximum yield through traditional BEGs in Bristol Bay will likely lead to less average yield and more variable yield than the current and proposed SEGs, and a TR-based escapement goal policy. Management for BEGs also poses the greatest chance of small Bay-wide annual harvest. Escapement goals that we examined that increased for larger runs (TR-based escapement goals) provided the least variable harvests and lowest probability of small annual Bay-wide harvests.

- Given the dynamics of the Bristol Bay sockeye salmon populations and the fishing industry, the theoretical maximum yield (MSY) is not the practical maximum yield. The fishery cannot take full advantage of occasionally large returns to increase expected catch above alternative policies across many years. As a result, the current and proposed SEGs could be called BEGs, in a more broadly defined version of the term MSY.

- Escapement goal policies should provide for flexibility to managers given the variable and uncertain fish and fishery dynamics within and across fishing districts in the Bay.

Recommendations from the Study's Advisory Panel

The AP's recommendation to the Board of Fisheries (Appendix D) built upon the results presented here and, essentially, hybridized three of the escapement policies we examined: the lower bound of the current SEGs, the upper bounds of the proposed SEGs, and language in management plans that capture the spirit of the TR-based policy. The effect would be to have wider stock-specific escapement goal ranges than either the current or proposed SEGs, and provide guidelines to managers to achieve lower range escapements in small run years and higher range escapements in larger run years. The AP believed that if ADF&G could adopt a these revised SEGs, and the Board of Fisheries amend management plans, implementation of OEGs by the Board of Fisheries would not be necessary.

On March 16, 2015, ADF&G formally adopted the AP-recommended goals (RC013; Appendix E). On March 17, the Board of Fisheries adopted regulatory language mirroring that recommended by the AP (Appendix F).

Introduction

In December 2012 the Alaska Board of Fisheries (BoF) struck a committee[1] to oversee the analysis of *optimum escapement goals* (OEGs)[2] for Bristol Bay sockeye salmon. The BoF action was in response to proposed revisions to Bristol Bay sockeye salmon escapement goals by the Alaska Department of Fish and Game (ADF&G; Fair et al. 2012). This report is the outcome of an analysis of escapement goals for Bristol Bay sockeye salmon that take into account biological factors, management uncertainty, and economic factors.

The Bristol Bay Economic Development Corporation (BBEDC) committed to leading an analysis of alternative escapement goals through its non-profit subsidiary, the Bristol Bay Science and Research Institute (BBSRI). BBSRI retained fisheries scientists and economists from the University of Washington to conduct the analyses. Salmon processors in Bristol Bay and the driftnet fleet's Regional Seafood Development Association (RSDA) pledged logistical and/or financial support to the analysis. ADF&G agreed to postpone the implementation of recommended Sustainable and Biological Escapement Goals (SEGs and BEGs) for six sockeye stocks until the 2015 season, pending the results from the analysis, which was expected prior to the 2015 season.

Study Objectives

1. Examine alternative approaches to estimating maximum sustained yield (MSY) escapement goals for Bristol Bay sockeye salmon stocks, and compare to those from Fair et al. (2012).
2. Build a biological model of the population dynamics of 9 Bristol Bay sockeye stocks and simulates daily returns to four of the five Bristol Bay fishing districts (Figure 1) based on previous escapement levels.
3. Build a model of the daily management decisions to mimic fishery manager behavior in Bristol Bay.
4. Build a model that captures key economic factors affecting the value of the catch from the Bristol Bay salmon fishery.
5. Conduct a management strategy evaluation by simulating the daily management, harvesting, and processing over replicate 100-year simulations. Compare alternative escapement goal policies by characterizing at catch, escapement, and harvester and processor revenue among alternatives.

The first objective was addressed and reported by Cunningham et al. (2015).

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[1] Appendix A describes the mission of the "BoF Committee"; this is different from the Advisory Panel set up to provide input to the study (Appendix B).

[2] OEG is a broad term that encompasses alternative fixed escapement goals and harvest policies that attempt to meet objectives such economic or social, while maintaining biological sustainability. From 5 AAC 39.222 f (25) *""optimal escapement goal" or "OEG" means a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG; an OEG will be sustainable and may be expressed as a range with the lower bound above the level of SET, and will be adopted as a regulation by the board; the department will seek to maintain evenly distributed escapements within the bounds of the OEG."*

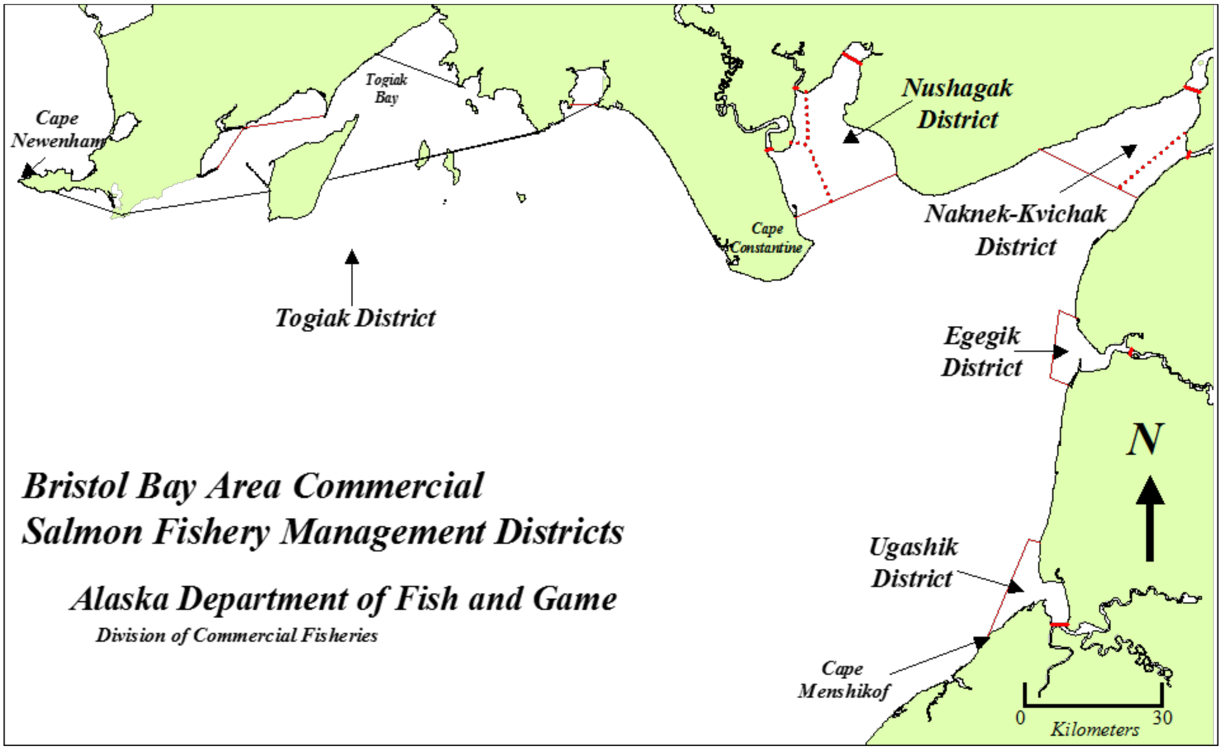

Figure 1. Commercial Salmon Fishery Management Districts, Bristol Bay, Alaska (credit ADF&G).

Study Approach

We used computer models to simulate the fishery and the individual salmon stocks under alternate harvest policies to understand differences in key variables such as catch, value of harvest to fishermen and processors, and the inter-annual variability in these. This is a standard and generally accepted approach referred to in the literature as Management Strategy Evaluation or MSE (Butterworth and Punt 1999; Sainsbury et al. 2000). MSE does not typically seek to prescribe an optimal strategy, but instead provides decision makers with the information on which to base a rational decision, given their objectives, preferences, and attitudes to risk. Computer models were constructed that mimic the Bay's sockeye stocks, management rules (when to open and close the fishery), harvesting and processing revenues, and the effects of escapement levels on subsequent returns. The model was run for 100-year simulations, and these simulations were repeated 100 times for each escapement goal alternative to characterize differences among policies.

We characterized the economic performance (i.e., revenue to harvesters and processors) across all escapement goal alternatives examined. However, all the alternatives we looked at would qualify as either sustainable escapement goals (SEGs) or BEGs and as such, could be implemented by ADF&G without BoF involvement. The term OEG has a relatively narrow application as a management approach that only the BoF can implement, and therefore it was not necessary to use the term OEG to describe any of the alternatives we examined.

Alternative Escapement Goals Examined

We looked at four alternative sockeye salmon escapement goals (EGs) for six river systems in the Bay (Figure 2, Appendix C) including Ugashik, Egegik, Naknek, Nushagak, Wood, and Igushik. Alternative goals for Alagnak, Kvichak, and Togiak were not considered.

1. Current SEGs (sustainable escapement goals; Baker et al. 2006)
2. Proposed SEGs (and BEGs) from Fair et al. (2012)
3. BEGs (biological escapement goals based on maximum sustained yield)
4. Total Return based escapement goals (TR-based EGs).

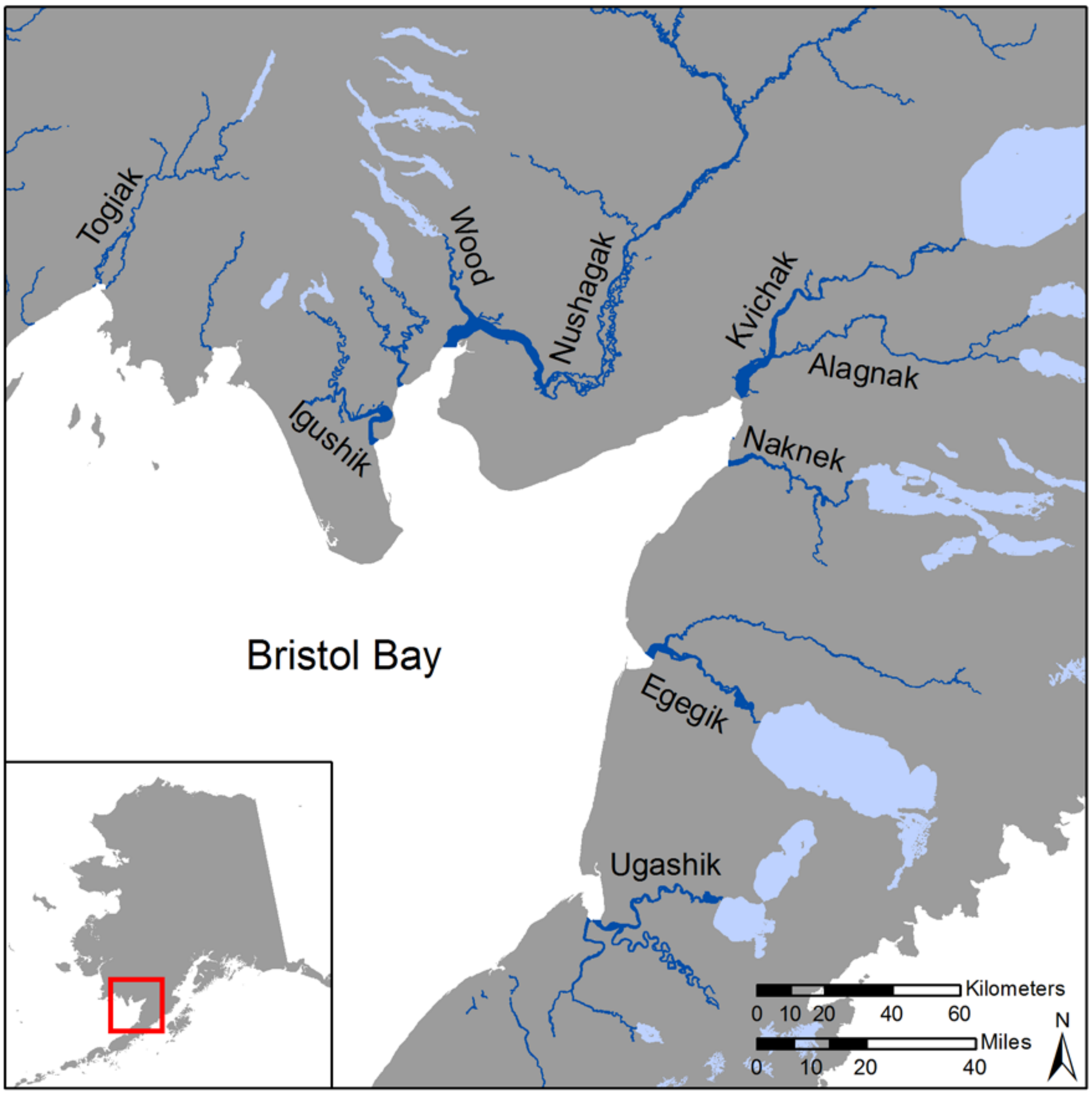

Figure 2. River systems and associated commercial sockeye salmon stocks of Bristol Bay, Alaska.

The first three alternatives stem from current and proposed escapement goals (Baker et al. 2006; Fair et al. 2012). The TR-based EGs were created through work with the Advisory Panel over the last year to develop and refine the study methods and alternative EG policies to examine. Building upon the work of Fair et al. (2012), the group discussed the finding that some of the SEGs in the Bay do not encompass the escapement believed to produce MSY (i.e., the BEG estimate) and, that the industry may be unnecessarily foregoing yield by not reaching some of these higher escapements under the current and proposed SEG regimes. Many on the AP believed that achieving escapement closer to the MSY-based BEG would be more appropriate when runs were large, but to manage for a higher goal in years of low returns would be damaging to the viability of the industry. ADF&G staff noted that they often, through the vagaries of run timing and compression, and the fishing fleet and processing capacity, hit the lower end of the escapement goal ranges in small runs and the upper ends in larger runs.

The AP suggested that we examine an alternative EG policy whereby the escapement goals were a function of run size, similar to what has been done for the Kvichak for many years. The study team created a set of TR-based escapement goals based on:

- Two bins or ranges for the EG, one for annual returns above and one for below the median or 50th percentile of historical returns (1956-2014);
- the lower bin equal to the current SEG bounds; and
- The upper bin designed to encompass or get much closer to the BEG point estimate.

Something important to note about how we modeled management under TR-based EGs is that we essentially mimicked what ADF&G said they often do, but provide for a wider escapement goal range than the current or proposed SEGs. That is, when the runs are large, the modeled management targets the upper end of the range, and vice versa. Whether any TR-based strategy might prefer formal upper and lower bins, or if it would be more beneficial to just provide managers with a single wider EG range to work within, was a topic of discussion for our final AP meeting.

Organization of this Report

The report has been structured as follows.

- Executive Summary: summarize methods and key findings.
- Introduction: impetus for the study, background and previous work on the topic, study design, and the study's Advisory Panel.
- Chapter 1: biological and management model methods and results.
- Chapter 2: economic modeling and results.
- Chapter 3: general conclusions and recommendations.
- Appendices.

The modeling described in Chapters 1 and 2 was tightly interconnected during the analysis, but for accessibility and readability, these components are presented in two standalone documents. Our goal is for each chapter to become the basis for a peer-reviewed journal article.

Background and Previous Work

Fishery scientists and economists, and many of those in the fishing industry, have recognized for some time that economic performance of the Bristol Bay salmon fishery may not be optimized or maximized for escapement levels that, in theory, will provide Maximum Sustained Yield (MSY; i.e., the largest average catch over the long run). Despite large average annual returns and catches, the industry in the Bay had a period of economic losses in the most recent decade, and prompted some to explore opportunities to improve the economic performance of the fishery (Link et al. 2003; Schelle 2004). Further, competition from aquaculture has dramatically reduced prices paid for fish and the profitability of the fishery has declined from its peak in the 1980s. Profitability continues to struggle despite a near record-long series of large catches in the most recent decade.

Link et al. (2003) identified areas of foregone wealth under the current structure of the fishery and suggested a number of methods for improving the economic performance of the fishery, including (1) reducing harvesting capacity, (2) spreading harvesting across time, (3) exploring alternative harvesting methods, (4) improving product quality, (5) improved marketing, and (6) eliminating the race for fish by assigning shares of the harvest to participants. Schelle (2004) found that an optimum number of fishing vessels for economic benefit is considerably less than currently permitted to operate in Bristol Bay.

Hilborn (2006) provided a compelling picture of why a focus on biological yield has led to a biological success story but at the expense of economic success in Bristol Bay. To improve the situation, he points to an obvious need for harvest strategies that maximizes economic return rather than biological return, but notes that there is no party responsible for economic management of the fishery within the State of Alaska.

Bue et al. (2008) examined escapement goal policies to maximize catch and economic returns from the Egegik River stock by taking into account harvesting and processing costs. The analysis was limited to a single fishing district while harvest and processing capacity, and impacts of harvest volume on price, are a Bristol Bay wide phenomena. They found that although a fixed MSY-based escapement goal policy can be expected to maximize catch, revenue will be maximized by periodically harvesting the stock at escapement levels below the MSY level, and that the profit from the fishery would be enhanced by limitations on the harvesting and processing capacity. This work provided some evidence that it may not be economically benefical to maintain capacity to harvest every last fish in occasional large runs.

Valderrama and Anderson (2010) examined market interactions of the Bristol Bay salmon fishery and world aquaculture markets. Their study demonstrated that the initial high profitability of the fishery following limited entry was dissipated by overcapacity in the fishing fleet and price declines caused by aquaculture, further highlighting the need to consider factors beyond MSY if profitability in the fishery is to improve.

Steiner et al. (2011) explored two alternatives to the current fixed escapement goal policy of the Bristol Bay fishery: a fixed harvest rate and a fixed harvest policy, and evaluated whether these could ensure the biological sustainability while enhancing the economic returns. They modeled the dynamics of 9 Bristol Bay stocks under three harvest strategies, the effects of annual Bay and Alaska-wide harvest volume on price, and the future fish price scenarios based on expected aquaculture and natural production. They attempted to isolate whether stabilizing annual catches would lead to greater revenue to the fishery via the inverse relationship between harvest volume and price; they did not attempt to model changes in product mix that might be possible among different harvest strategies, or, most importantly, the intra-season fish and fishery dynamics that affect daily and annual catches and product mixes. Analyses indicated that fixed harvest and harvest rate policies could possibly lead to additional revenue by making higher valued products possible, and might reduce processing costs over those of a fixed escapement goal policy. Steiner et al. (2011) found that transferring the inter-annual variability in catches that occur under a fixed escapement goal policy to the achieved escapement levels under fixed harvest and harvest rate policies could improve the revenue from the fishery, and would not compromise the sustainability of the Bristol Bay stocks.

Valderrama and Anderson (2013) built an econometric model of the Bristol Bay fishery to characterize benefits of management schemes. For example, cooperatives could lower the harvest costs and make the fishery more economically viable in the face of continued competition from the aquaculture sector. Their study predicted that large declines in ex-vessel prices might drive a harvesting cooperative to select escapement targets that exceed MSY BEGs. Their work also predicted that an optimal number of driftnet permits in the fishery is probably closer to 900 vessels from the current 1,860, which is similar to the 800-1,200 recommended as an optimum number by Schelle (2004).

In summary, a growing body of work suggests that the economic performance of the Bristol Bay fishery might be enhanced by shifting emphasis toward economic objectives without harming the long-term biological sustainability of the stocks. No previous work has directly addressed the practicalities of policy implementation given the intra-season dynamics of the fish stocks, fishery and fishery management process. This study set out to include these and other aspects in a comprehensive MSE analysis.

The Study's Advisory Panel

An Advisory Panel (AP) of representatives from harvesting and processing sectors, ADF&G, and independent scientists was formed to provide input to the development of alternative escapement goal strategies and to the economic modeling components of the project. AP input helped to help evaluate the practical consequences of any modifications to escapement goals. The three-person BoF OEG committee members were members of the AP. Appendix B provides the Terms of Reference for the AP, its membership, and the dates and locations of its five meetings over the course of 2014 and 2015.

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- North Pacific Seafoods provided meeting space for the AP meetings in Seattle.
- Alaska Department of Fish and Game generously provided staff time (Regnart) to the AP, and Bristol Bay management and research staff provided feedback on the study as it developed, and reviewed a first draft of the two project reports.
- The Southwest Alaska Vocational and Education Center (SAVEC) provided meeting space for the AP and accommodation for the study team in King Salmon.

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