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SUBJECT: Upper Cook Inlet stocks of concern follow-up on Yentna River sockeye salmon

Upper Cook Inlet stocks of concern recommendation

The Sustainable Salmon Fisheries Policy (SSFP; 5 AAC 39.222) directs the department to provide the Alaska Board of Fisheries (BOF), at regular meetings, with reports on the status of salmon stocks to identify any salmon stocks that present a concern related to yield, management, or conservation. For example, a "yield concern" means a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs. In the Upper Cook Inlet (UCI) Management Area no stock has been identified as a stock of concern. However, with the approaching UCI Alaska Board of Fisheries meeting in February and as a follow up to the September 2007 memorandum, we reviewed the department's stock of concern assessment of the Yentna River sockeye salmon run.

Escapement Assessment and Trends

Initial efforts to estimate the number of sockeye salmon spawning and rearing in the Susitna watershed were limited in scope and duration. Various lakes within the drainage were visited sporadically in the 1950s and 1960s by United States Fish and Wildlife Service and Alaska Department of Fish and Game (ADF&G) personnel to collect salmonid juvenile and adult data. Adult spawner counts were primarily the product of aerial surveys (King and Walker 1997). At various times since the early 1970s, weirs monitored sockeye salmon entering selected tributaries (Chelatna Lake, Fish Lakes, Judd Lake, Larson Lake, Shell Creek, and Talachulitna River) to spawn (King and Walker 1997).

Mark-recapture projects were conducted on the Susitna River in 1974 and 1975 as part of an effort to estimate juvenile and adult anadromous fish populations in the upper Susitna River between Devil's Canyon and the confluence of the Susitna and Chulitna rivers. These studies were part of the pre-authorization investigation for the proposed Susitna Hydroelectric Project (Barrett 1974; Friese 1975). The results of these studies indicated that the majority of sockeye salmon in the Susitna River basin were produced in the Yentna and Skwentna river drainages (Namtvedt et al. 1978). Mark-recapture projects were again conducted on the Susitna River during 1982–1985 to estimate the inriver run of sockeye salmon (Barrett et al. 1985; Thompson et al. 1986).

Adult salmon escapements into the Susitna River were monitored with sonar at Susitna Station (river kilometer [rkm] 52) from 1976 to 1980. However, changes in bottom characteristics at that sonar location precluded continuation of the project after 1980. Because no other site suitable for the existing sonar equipment was found in the mainstem of the Susitna River, the project was moved to the Yentna River, the largest tributary in the drainage. From 1981 to the present, the Yentna River daily sonar estimates have been used as an indicator of the sockeye salmon escapement into the Susitna River drainage. The sockeye salmon escapement bound for the Yentna River has been thought to be approximately one half of the total Susitna River sockeye salmon escapement based on a combination of 1981–1985 capture-recapture abundance estimates passing Sunshine (Susitna River rkm 116), and sonar abundance estimates passing Yentna (Yentna River; rkm 7) and Susitna Station (Westerman and Willette 2006).

Currently, the Yentna River sockeye salmon escapement goal, 90,000 to 160,000 fish, is a sustainable escapement goal (SEG) adopted in 2002 (Bue and Hasbrouck *Unpublished*). In 2007, an interdivisional salmon escapement goal team reviewed salmon escapement goals in the UCI Management Area based on the SSFP and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223). The team recommended that the current Yentna River sockeye salmon escapement goal remain unchanged (Fair et al. 2007).

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Based on Bendix sonar estimates since 1981, the number of Yentna River spawners has ranged from approximately 37,000 to 181,000 sockeye salmon. The sonar estimate of sockeye salmon escapement into the Yentna River has not met the goal in 5 of the past 8 years (Table 1). Unfortunately, the accuracy of escapement enumeration based on sonar in the Yentna River has not been verified. The Yentna River is a large, dynamic glacial river that poses difficulties in assessing salmon escapement using sonar, and significant runs of other salmon species occur, requiring fish wheels to be used to apportion the total sonar count by species. Any one of these issues will create biases in the estimation of species-specific escapement. Whether any of these biases are significant, or if they vary seasonally or annually, is unknown. Additionally, a comparison of historical sockeye salmon escapements in the Yentna River and in four major rearing lakes (Chelatna, Shell, Judd, and Larson) suggests that production may have recently declined in the smaller rearing lakes in the watershed.

Yield Assessment

The sustained-yield principal requires an understanding of the relationship between the abundance of spawning fish and the abundance of their offspring that survive to adulthood (known as a brood table) by stock. The number of offspring that survive to adulthood is calculated by adding the number of spawning fish and the number of fish harvested for each parent generation.

Accurately estimating the composition of mixed-stock catch is critical to determining the total run of each stock. Age composition has historically been used to facilitate estimation of stock composition. Stock and age specific catch and escapement data have been the basis for development of long-term brood tables used for both pre-season forecasting and for scientific estimation of escapement goals.

Unfortunately, the allocation methodology used to apportion sockeye salmon catches to component stocks in UCI represents a coarse approximation of the actual catch by stock. Historically, a series of largely untested assumptions have been used to allocate stock composition. ADF&G currently uses age composition estimates from the harvest and escapement, and run timing to allocate the harvest to each stock (Bernard 1983). The current method assumes that the stocks present in a district are equally exploited. This untested assumption could greatly affect the estimated stock compositions. The current method probably underestimates the productivity of some stocks and overestimates the productivity of other stocks. As such, the less abundant stocks such as the Susitna River are prone to the greatest percentage error from the true stock composition of the mixture. To be accurate, the age composition method also requires a representative sampling of the harvest, and accurate estimates of escapement numbers and age composition.

In recent years (2005 to present), ADF&G has developed a genetics program for sockeye salmon in UCI. The primary goal of the program is to develop and apply genetic methods to identify stock composition of mixtures. The first comprehensive baseline using genetic markers in UCI employed microsatellites (Habicht et al. 2007). The need to differentiate among all the stocks led to the development of methods to screen single nucleotide polymorphism (SNP) loci under selection. In a recent study of UCI sockeye salmon genetic diversity, simulations indicated that seven regional groups (Kenai River, Susitna River, Yentna River, West Cook Inlet, Kasilof River, Northeast Cook Inlet, and Knik Arm) could be identified in mixtures at high levels of precision and accuracy (Habicht et al. 2007).

Given the potential errors outlined above for estimating the harvest of Susitna stocks in UCI using catch and escapement age composition information, we are hesitant to estimate the historical yield for Yentna stocks. There are many unsubstantiated assumptions involved in the estimation procedure. Nonetheless, in the context of “stock of concern” we have examined the historical estimates of Yentna River sockeye salmon yield in both the Central and Northern districts.

Conclusions and Recommendations

As explained in the September 2007 memorandum, the recent pattern of low sockeye salmon escapements to the Susitna River drainage has prompted the department to better understand stock productivity, errors in escapement estimation, and harvest in the mixed stock fishery of UCI using genetic markers (Habicht et al. 2007). Sockeye salmon rearing lake investigations are being conducted to estimate embryo-to-smolt survivals in the major lakes in the watershed. Additionally, we are assessing the sockeye salmon escapement into the Susitna River using new and improved methodology. ADF&G, with participation from Cook Inlet Aquaculture Association, is estimating the adult sockeye salmon abundance in the entire Susitna River in 2006, 2007, and 2008 with a mark–recapture and radio telemetry study. Such abundance estimates will allow: (1) estimation of the total annual run of Susitna River sockeye salmon, when abundance estimates and genetics-based harvest allocation estimates are combined, (2) evaluation of the accuracy of the Yentna River sonar estimate, and (3) the proportion of Yentna River sockeye salmon in the entire Susitna River sockeye salmon escapement. Additionally, the department is evaluating the current sockeye salmon escapement assessment tool, a Bendix single beam sonar system, with a more advanced and proven hydroacoustic system known as DIDSON (Dual frequency IDentification SONar). Preliminary spawning abundance estimates based on mark–recapture and DIDSON studies suggest that traditional Bendix estimates are much lower than the actual escapements. As shown in the table below, the high variability that we have observed between the various methods has added considerably greater uncertainty to our previous assessments.

Various sockeye salmon escapement estimates for the Susitna River drainage, 2006 and 2007.

2006				
System	Mark–Recapture	Weirs ^a	Bendix	DIDSON
Yentna	Unknown	126,000	93,000	160,000
Susitna	107,000 (95% CI 59-165)	60,000		
Sum		186,000		

2007^b				
System	Mark–Recapture	Weirs	Bendix	DIDSON
Yentna	250,000	97,000	80,000	130,000
Susitna	85,000	60,000		
Sum		157,000		

^a Weirs monitored escapement at a few select lakes and do not represent total river escapement.

^b The 2007 estimates are preliminary.

Similar to escapement, an accurate assessment of Susitna/Yentna River catch has been problematic given the available methodology (age composition method) and limited resources for catch sampling. The sources of error in estimating the stock-specific catch in UCI are many, and this is especially true for the less abundant stocks such as Yentna River sockeye salmon, which are susceptible to the greatest relative errors (Bernard 1983). Although genetic markers have given us

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the ability to accurately determine stock composition for portions of the past 3 years, this data will not be applied to historical harvests of UCI until the full season analyses have been completed, and we have gained a better understanding of stock vulnerability through time and space.

In the Central District drift fishery, the estimated Yentna River commercial harvest for the most recent 5-year average (2003–2007) is 59% of the previous 10-year (1993–2002) average and 49% of the previous 20-year (1983–2002) average (Table 1). In the Northern District, the most recent 5-year average is 31% of the previous 10-year average and 22% of the previous 20-year average. Since the total UCI commercial harvest averages 2.9 million sockeye salmon and our age composition allocation model estimate of the Yentna sockeye salmon harvest is only 8.4% of the total, we have low confidence in the accuracy of our estimate of the Yentna sockeye salmon harvest. The difference (53,309 fish) between the 5-year (2003–2007) average yield and the 10-year (1993–2002) average yield for the Yentna stock is only 2% of the average UCI commercial harvest. The errors in our stock composition estimates are likely greater than 2%, since we know from comparisons to partial weir counts that the error in our Yentna sonar estimate is at least 28%.

The department continues to treat the persistently low escapements of sockeye salmon to the Yentna River as a serious issue. At this juncture, we are hesitant to make a stock of concern recommendation for Yentna River sockeye salmon given the assumptions and unknowns outlined above, in the memo of September 2007, and in various scientific reports prepared for the BOF meeting in February. With the ongoing studies of escapement assessment and improved stock composition in the catch, we will better understand the productivity and sustainability of the stock. Partial and preliminary information from the DIDSON, mark–recapture, and lake productivity studies will be available to the Board at the Upper Cook Inlet meeting this February.

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Table 1. Yentna River sockeye salmon catch and escapement, 1983–2007.

Year	Commercial Catch ^a		Escapement ^b	Lower
	Central District	Northern District		Escapement Goal
1983	153,417	34,486	104,414	100,000
1984	149,776	49,254	149,375	100,000
1985	150,827	38,473	107,124	100,000
1986	240,686	34,333	92,076	100,000
1987	142,040	18,828	66,054	100,000
1988	120,069	11,545	52,330	100,000
1989	3,343	40,549	96,269	100,000
1990	234,378	19,011	140,290	100,000
1991	107,291	25,193	109,632	100,000
1992	170,969	8,507	66,074	100,000
1993	193,450	20,689	141,694	100,000
1994	131,844	24,349	128,032	100,000
1995	160,320	21,447	121,220	100,000
1996	117,337	13,124	90,660	100,000
1997	136,803	20,814	157,822	100,000
1998	48,113	14,299	119,623	100,000
1999	83,812	12,951	99,029	100,000
2000	66,782	12,144	133,094	100,000
2001	46,431	10,774	83,532	100,000
2002	58,383	5,548	78,591	90,000
2003	116,154	11,535	180,813	90,000
2004	68,546	3,918	71,281	90,000
2005	32,197	3,572	36,921	75,000
2006 ^c	11,610	1,985	92,045	90,000
2007 ^c	80,306	3,333	79,901	90,000
2003-2007 Avg.	61,763	4,869	92,192	
1993-2002 Avg.	104,327	15,614	115,330	
1983-2002 Avg.	125,804	21,816	106,847	

^a Catch estimates are based on age composition methodology that (1) assumes equal exploitation of stocks in the fishery, (2) requires representative sampling of the harvest, and (3) accurate estimates of escapement numbers and age composition.

^b Sonar estimates of escapement are based on Bendix.

^c Preliminary estimates.