#### Chilkat Lake Sockeye Salmon

Chilkat Lake, located approximately 44 river km upstream from the city of Haines, supports one of the largest runs of sockeye salmon in Southeast Alaska. Chilkat Lake sockeye salmon are primarily harvested in the District 15 commercial drift gillnet fishery in northern Lynn Canal. Smaller but unknown portions of the Chilkat run are harvested in the commercial purse seine fisheries that target pink salmon in Icy and northern Chatham straits (Ingledue 1989; Gilk-Baumer et al. 2015) and in subsistence fisheries in Chilkat Inlet and in the Chilkat River. As noted above, scale pattern analysis has been used to apportion District 15 commercial harvests of sockeye salmon bound for Chilkat Lake and other systems in the area (McPherson 1990). Chilkat Lake sockeye salmon escapements have been estimated through weir counts (1967–1993), weir counts with concurrent mark–recapture estimates (1994 and 1995, 1999–2007), mark–recapture estimates only (1996–1998), and Dual-frequency Identification Sonar (DIDSON) counts with concurrent mark–recapture estimates (2008–2016) (Eggers et al. 2010; Sogge and Bachman 2014). Visual weir counts provided minimum estimates of escapement due to flow reversals, turbid water, and frequent lowering of a boat gate in the middle of the weir, all of which potentially allowed fish to pass undetected. Conversely, mark–recapture estimates may be greatly inflated, but may provide an index of escapement (Bednarksi et al. *in press*). DIDSON counts are also considered minimum estimates of escapement due to undetected passage of small numbers of fish at night during flow reversals; however, confidence in DIDSON counts is much greater than in the visual weir counts.

The current biological escapement goal range of 70,000–150,000 sockeye salmon (Eggers et al. 2008, 2010) was established in 2009. Eggers et al. (2010) scaled weir counts to mark–recapture estimates, then fit a hierarchal set of stock-recruit models to the Chilkat River recruits from parental escapements of the 1979–2002 brood years using traditional stock-recruit analysis. The biological escapement goal is the escapement range estimated to produce ≥ 90% of maximum sustained yield as determined by an autoregressive Ricker (density dependence with first order autoregressive term) model that incorporated stocking of hatchery fry. This model was selected because it accounted for the bias in assessing wild stock production due to the added production from enhancement stocking of fry that occurred from 1989 to 2003 and was, therefore, considered the most meaningful biological model (Eggers et al. 2010).

In addition to the accumulation of more brood year returns since the escapement goal was last reviewed, all historical information associated with Chilkat Lake sockeye salmon stock assessment was recently reviewed, edited, and updated, including weir counts, DIDSON counts, fish wheel counts, age composition data, and mark–recapture and commercial harvest estimates (Bednarski et al. *in press*). Bednarski et al. (*in press*) recommended the escapement goal be reviewed to ensure that the goal, which was developed using mark–recapture estimates (Eggers et al. 2010), is in the same units as escapement counts, which will continue to be measured with the DIDSON. Miller and Heinl (*in press*) fit age-structured state-space spawner-recruit models to 1976–2016 data on abundance, harvest, age composition, and coefficients of variation to examine the effect of autocorrelation and fry stocking on recruits, to account for multiple overlapping methods of escapement enumeration and missing data (age composition was considered unknown in the model for years 1996–1998 when the weir was not operated). DIDSON escapement counts were treated as the ‘true’ counts and the weir counts and mark–recapture estimates of escapement were treated as indices of escapement in the state-space models.

Despite the additional years of data (brood years 1976−2012), a more sophisticated age-structured model framework, a slightly different Ricker model form, and the exclusion of the fry stocking term, parameter estimates of spawning abundance that produce maximum sustained yield (*S*MSY) were similar to those of Eggers et al. (2010). The estimated spawning abundance that produced maximum sustained yield from Eggers et al. (2010) was 105,000 spawners. The posterior median of escapement leading to maximum sustained yield from the output of the state-space model was 98,370 spawners (95% credibility interval 66,765–223,966 spawners). The probability of achieving 90% of maximum sustained yield (MSY) at the upper and lower bounds of the current escapement goal is estimated to be 62% and 34%, respectively (Appendix Figure B 10), and an average 65% over the entire escapement goal range. Yield would be maximized at escapements near *S*MSY (near 84% probability of achieving 90% of MSY). These probabilities improve substantially with respect to achieving 80% of MSY. The escapement goal review committee recommended maintaining the current biological escapement goal of 70,000–150,000 fish counted with the DIDSON system at the Chilkat Lake weir site.

Appendix B 6.–Chilkat Lake sockeye salmon.

Chilkat Lake is a relatively clear lake located approximately 43 river km upstream from the city of Haines. The Chilkat drainage supports one of the larger runs of sockeye salmon in the region, which is harvested primarily in the District 15 Lynn Canal commercial drift gillnet fishery. Chilkat Lake sockeye salmon escapements have been estimated through weir counts (1967–1993), weir counts with concurrent mark–recapture estimates (1994, 1995, and 1999–2007), mark–recapture estimates only (1996–1998), and DIDSON counts with concurrent mark–recapture estimates (2008–2016) (Eggers et al. 2010; Sogge and Bachman 2014; Bednarski et al. *in press*.).

**Escapement Goals and Stock Status:** The Chilkat Lake sockeye salmon run has been managed for at least five different escapement goals since 1976. Informal goals of 60,000–70,000 fish (1976–1980) and 70,000–90,000 fish (1981–1989) (Bergander et al. 1988) were replaced in 1990 with a biological escapement goal range of 52,000–106,000 sockeye salmon based on a stock-recruit analysis (McPherson 1990). Efforts to update the escapement goal were hindered by lake stocking in the 1990s and concerns regarding accuracy of weir counts (Geiger et al. 2005). Geiger et al. (2005) converted the weir based goal to mark–recapture units and the goal was revised to a sustainable escapement goal range of 80,000–200,000 sockeye salmon from 2006 to 2008. In 2009, the Chilkat Lake escapement goal was revised to the current biological escapement goal range of 70,000–150,000 sockeye salmon (Eggers et al. 2008, 2010). Eggers et al. (2010) scaled weir counts to mark–recapture estimates, then fit a hierarchal set of stock-recruit models to the Chilkat River recruits from parental escapements of the 1979 to 2002 brood years. The biological escapement goal is the escapement range that produces ≥ 90% of maximum sustained yield as determined by an autoregressive Ricker (density dependence with first order autoregressive term) model with fry plants. A recent review (Miller and Heinl *in press*.; and in this report) suggests the escapement goal should remain unchanged. Escapements were within or above the escapement goal range in 5 of the past 5 years (Appendix Figure B 9).



Appendix Figure B 9.–Estimated Chilkat Lake sockeye salmon escapements (and 95% credibility intervals), 1976–2016, and biological escapement goal range of 70,000–150,000 fish. Expanded DIDSON counts are shown as data points, 2008–2016.

Chart, histogram

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Appendix Figure B 10.–Chilkat Lake sockeye salmon 80% and 90% probability profiles for optimal recruitment, optimal yield, and overfishing based on updated brood year escapement and return data, 1976–2016 (Miller and Heinl *in press*). The shaded region shows the current biological escapement goal range of 70,000 to 150,000 and the solid vertical line is the posterior median of spawning abundance at maximum sustained yield (approximately 98,000 fish) from the state-space model.