Southeast Sustainable Salmon Fund
Project Completion Form

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Project Title: Taku Wild/Hatchery Chum Study

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Abstract: This study is a cooperative effort between Douglas Island Pink & Chum (DIPAC), the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences (UAF, SFOS), the National Oceanic & Atmospheric Administration, Auke Bay Lab (ABL), and the Alaska Department of Fish & Game (ADF&G) to determine the potential for interactions between DIPAC hatchery chum salmon (*Oncorhynchus keta*) fry and wild chum salmon fry in Taku Inlet, Southeast Alaska. We analyzed patterns in spatial and temporal distribution, size, and condition of juvenile chum salmon collected in the littoral and neritic waters of Taku Inlet in 2004 and 2005. Energy density and diet of wild and hatchery chum salmon fry in Taku Inlet were analyzed and compared to data obtained later in the season for chum salmon stocks caught in Icy Strait. The greatest potential for wild/hatchery interactions was in the outer inlet, directly following early hatchery releases (May 9-11). Peak outmigration for wild chum salmon fry coincided with early hatchery releases; in contrast, most wild chum salmon fry had already emigrated from the estuary by the time of late hatchery fry release (May 22 – June 1). In both years, hatchery fry were rare in the inner inlet, but comprised over 95% of the catch in the outer estuary during the peak of outmigration. Hatchery chum salmon were significantly larger than wild fry in both beach and neritic samples. Wild and early hatchery chum salmon were smaller in the littoral than the neritic habitat, indicating that both groups moved from shallow to deeper water with ontogeny. In spite of large differences in abundance, no negative correlation between abundance of hatchery fish and condition of wild fish was identified. Both wild and early hatchery chum salmon fry showed apparent growth through the season, while late hatchery fry appeared to leave the estuary soon after release. Regardless of origin, most chum salmon juveniles emigrated from the study area in late May and early June, indicating a high probability for mixed-stock schools. Hatchery chum salmon juveniles were initially larger and had greater

energy content than wild fish; however, energetic values converged by mid-June in Taku Inlet. In Icy Strait, energetic condition of wild and hatchery chum salmon juveniles was also similar. Multivariate analysis of 54 prey measures indicated that diets of the two groups were distinctly different throughout the season in all Taku Inlet locations and converged in Icy Strait.

Approach: Sampling was conducted biweekly from late April to late June in 2004 and 2005. Sampling was stratified into inner and outer inlet and into littoral habitat using a beach seine and neritic habitat using a Kodiak Trawl (Table 1).

Habitat	2004	2005
Littoral habitat	198	196
Neritic habitat	77	75

Table 1. Number of casts by sampling year and habitat

Each catch was sub-sampled for subsequent laboratory analysis. At DIPAC, the fish's origin (early hatchery, late hatchery, wild) was determined based on the fishes' otolith thermal marks. Because fry were collected in the Taku River estuary, unmarked fry were assumed to be wild chum salmon from the Taku River. Otolith analysis of 2,604 fry caught in 2004 and 5,017 from 2005 was completed in March 2006. These data were used by UAF scientists for the analysis of spatial and temporal patterns of abundance and body weight and fork length of chum salmon juveniles. In addition, stepwise regression analysis was conducted to determine the effect of environmental and biological factors on abundance and size of wild chum salmon fry. In addition, a sub-sample of chum salmon juveniles was analyzed for diet and energy density by scientists at ABL. Diet and energy density data were compared between groups of origin, by inlet location and season. Finally, data were compared to juvenile chum salmon diet and energy density data observed as part of ABL's Southeast Coastal Monitoring (SECM) program in Icy Strait, Alaska.

Results/Findings: Hatchery fry were most abundant in the outer Taku Inlet, particularly for the three week period following hatchery releases; in the inner inlet only a few hatchery fry were observed. The spatial and temporal distribution of wild fry overlapped with that of early hatchery fry to a much greater extent than with late hatchery fry. Wild chum salmon outmigration peaked at about the same time that early hatchery fry were released. The spatial overlap of wild fry and early hatchery fry occurred in both littoral and neritic habitat; in comparison, only little overlap between wild and late hatchery fry was observed. In the outer inlet, early hatchery fry were significantly more abundant than wild chum salmon fry, indicating the potential for density dependent interactions at this life stage. Early hatchery fry were significantly larger than wild fry in both littoral and neritic samples. Both wild and early hatchery fry were smaller in littoral

habitat than in neritic habitat, suggesting that both groups moved from shallow to deeper water as they grew. While the size of wild fry did not increase in the inner inlet, there was an increase in size of wild and early hatchery fry through the season in the outer inlet. In comparison, late hatchery fry showed no apparent growth, suggesting that they emigrated out of the outer inlet soon after release. Regardless of origin, most fry left the estuary in late May/early June. We observed a positive correlation between abundance of wild fry and abundance of hatchery fry in the outer inlet suggesting the formation of mixed hatchery/wild fry schools. There was a weak positive correlation between condition factor of wild fry and hatchery fry abundance in some locations in the inlet but no correlation in others, suggesting that wild fry caught in the presence of hatchery fry were not less robust than wild fry caught alone. A positive correlation was observed between size of wild fry and abundance of hatchery fry indicating that larger wild fry schooled with hatchery fry to a greater degree than did smaller wild fry. The formation of mixed schools in the early marine life could allow interactions later in life if the schools persist. Diet of wild and hatchery fry differed in the Taku Inlet but these differences disappeared by the time the fish reached Icy Strait. Similarly, energy density was greater for hatchery than for wild chum salmon in Taku Inlet, but converged by the time the juveniles reached Icy Strait. Further analysis is needed to determine if the diet partitioning and energetic differences in Taku Inlet are related to high densities of hatchery fish in outer Taku Inlet.

In summary, results from this study suggest that interactions between hatchery and wild juvenile chum salmon in Taku Inlet are possible, particularly involving early-release hatchery fry in littoral habitat in the outer part of the inlet. While no direct indications of competitive effects on wild fry, such as poor condition or reduced apparent growth rate in the presence of abundant hatchery fry, were observed, the significant increase in density of early hatchery fry immediately following their release warrants further research. Specifically, a better understanding of the inter-annual variability and long term trends in the spatial and temporal distribution of wild and hatchery fry is needed. Finally, an investigation of the influence of hatchery fry on predator-prey interactions should further elucidate the potential and degree of interaction between hatchery and wild chum salmon fry during their estuarine residence in the Taku Inlet.

Evaluation: The objectives of this study were to gather data about spatial and temporal distribution of wild and hatchery chum salmon fry in the Taku Inlet and to determine the potential for interactions between hatchery and wild Taku River chum salmon fry. These objectives were fully met. Prior to this study, very little was known about the basic ecology of wild or hatchery chum salmon juveniles in the Taku Inlet. The present study fills substantial gaps in our knowledge of spatial and temporal patterns of distribution of wild and hatchery chum salmon fry and the extent to which their ranges overlap. In addition, we obtained data on body size,

condition, and apparent growth for chum salmon fry, and were able to illuminate patterns juvenile chum salmon diet and energetic condition.

Project Products: The results of this study have been disseminated through publications in peer-reviewed journals, presentations at professional meetings, and the UAF web page for this study www.sfos.uaf.edu/research/takuchum/ .

Publications

Reese, C., N. Hillgruber, W. Smoker, A. Wertheimer, M. Sturdevant, R. Focht. *In review*. Spatial and temporal distribution of wild and hatchery chum salmon (*Oncorhynchus keta*) in the Taku Inlet, Alaska: the potential for interactions. Transactions of the American Fisheries Society.

Reese, C., N. Hillgruber, W. Smoker. Potential for interaction between hatchery and wild juvenile chum salmon (*Oncorhynchus keta*) in the Taku River Estuary. Proceeding of the Pacific Salmon Commission, Pink & Chum Salmon Workshop in Ketchikan, Alaska. Page 10. http://www.sfos.uaf.edu/research/takuchum/PSC-Feb05.pdf

Scientists at ABL have completed analysis diet and energy density samples of wild and hatchery chum salmon fry in the Taku Inlet. Statistical analysis of the data is underway and publication of a peer reviewed journal article is expected within one year.

Professional Presentations

Reese, C., N. Hillgruber, W. Smoker, A. Wertheimer, M. Sturdevant, and R. Focht. 2007. Hatchery-wild chum fry interactions in the Taku Inlet, spatial and temporal distribution. Alaska Hatchery Managers Meeting at McCauley Hatchery, January 2007, Juneau, Alaska.

Sturdevant, M., E. Fergusson, C. Reese, A. Wertheimer, N. Hillgruber, and W. Smoker. 2007. Hatchery-wild chum fry interactions in the Taku Inlet, diet and energy density. Alaska Hatchery Managers Meeting at Macaulay Salmon Hatchery, January 2007, Juneau, Alaska.

Sturdevant, M., E. Fergusson, C. Reese, A. Wertheimer, N. Hillgruber, and W. Smoker. 2007. Trophic interactions among wild and hatchery juvenile chum salmon in Taku Inlet, southeastern Alaska. 9th Annual Salmon Ocean Ecology Meeting, March 14-16, 2007, Hatfield Marine Science Center, Newport, Oregon. (Poster).

Reese, C., N. Hillgruber, B. Smoker, A. Wertheimer, M. Sturdevant, and R. Focht. 2006. Spatial and temporal distribution of wild and hatchery chum salmon fry (*Oncorhynchus keta*) of two rearing strategies in the Taku Inlet. 33rd Meeting of the Alaska Chapter, American Fisheries Society, November 13-16, 2006, Fairbanks, Alaska.

Sturdevant, M., E. Fergusson, C. Reese, A. Wertheimer, N. Hillgruber, and W. Smoker. 2006. Trophic interactions among wild and hatchery juvenile chum salmon in Taku Inlet, southeastern Alaska. 33rd Meeting of the Alaska Chapter, American Fisheries Society, November 13-16, 2006, Fairbanks, Alaska.

Marcello, L., N. Hillgruber, and C. Reese. 2006. Does size matter? 13th Ocean Sciences Meeting (joint meeting of ASLO, ERF, TOS and AGU), February 20-24, 2006, Honolulu, Hawaii. (Poster)

Reese, C., N. Hillgruber, and W. Smoker. 2005. Potential for interaction between hatchery and wild juvenile chum salmon in the Taku River estuary, Alaska. 135th Annual Meeting, American Fisheries Society, September 2005, Anchorage, Alaska. (Poster)

Reese, C., N. Hillgruber, and W. Smoker. 2005. Potential for interaction between hatchery and wild juvenile chum salmon (*Oncorhynchus keta*) in the Taku River Estuary. 22nd Northeast Pacific Pink & Chum Salmon Workshop. February 23-25, 2005, Ketchikan, Alaska.

Reese, C., N. Hillgruber, and W. Smoker. 2004. Ecological interactions between juvenile wild and hatchery chum salmon (*Oncorhynchus keta*) in the Taku River Estuary. 31st Meeting of the Alaska Chapter, American Fisheries Society, November 14-18, 2004, Sitka, Alaska.

Key Words: Taku Inlet, Taku River, Southeast Alaska, chum salmon, *Oncorhynchus keta*, hatchery/wild interaction, transboundary river, juveniles, estuary, distribution, abundance, early marine growth, diet, condition, energy density

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