In a Nutshell: Coded Wire Tags and the Pacific Salmon Commission's Fishery Regimes for Chinook and Southern Coho Salmon

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The purpose of this brief is to encapsulate the relationship between data derived from Coded Wire Tag (CWT) studies and the development and implementation ofPacific Salmon Commission (PSC) fishery regimes for chinook and coho salmon.

Chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) are species of Pacific salmon. These species are anadromous and semelparous and exhibit a high degree of homing, leading to the development of populations that are relatively reproductively isolated and adapted to local environmental conditions. Year to year freshwater and marine survival rates vary substantially; in marine waters, the vast majority of variability appears to occur prior to the age of first recruitment to fisheries. Both these species are impacted by a variety of commercial and recreational fisheries at various stages of maturity throughout the migratory ranges of individual stocks.

The PSC has established bilateral regimes for the management of stocks that are harvested by fisheries of the United States and Canada, made possible largely by the analysis of CWT data. During the 1970s, huge troll and sport fisheries had developed in various marine areas along the Pacific coast. Catches were sustained by complex and unknown mixtures of hatchery and wild populations that varied from year to year and area to area. Mortality rates by population were unknown, but cumulative fishery impacts resulted in declining trends in spawning escapements. Fishery harvest rates (the proportion of fish available to a fishery which is killed by that fishery) could not be estimated or monitored, except for some fisheries operating in extreme terminal areas. Competitive over-fishing with extensive debate amongst users and agencies, poor data supported denial and extensive delays in management response. By the early 1980s, coastwide concerns for the conservation of chinook salmon were being raised in many forums.

In the mid 1980s, stock and fishery assessment methods based on CWT data provided the means to define exploitation patterns for individual stocks. Cohort analysis methods permitted the estimation of fishery exploitation rates by age, maturation rates, adult equivalents, marine survival rates, and total mortality. These methods quantify and characterize the timing and location of fishery impacts for the entire migratory range and life cycle of individual stocks. Exploitation patterns of natural stocks were drawn by inference using CWT release groups of hatchery fish selected on the basis of brood stock, rearing and release strategies.

The integration of cohort analysis results into simulation models provided the primary means to inform decisions regarding the degree to which fishery impacts needed to be reduced to constrain exploitation rates to levels appropriate for the status and productivity of individual stocks. These models proved instrumental in enabling the U.S. and Canada to reach agreement on a coastwide chinook rebuilding program that became a cornerstone for the 1985 Pacific Salmon Treaty.

By performing cohort analyses on CWT data from stocks that were consistently tagged over time, a means to monitor changes in fishery impacts was developed. CWT indicator stocks were established to monitor implementation of chinook management regimes.

The CWT was so fundamental to salmon management under the Pacific Salmon Treaty that the United States and Canada entered into a memorandum of agreement committing the Parties to maintain a viable CWT program.

Chinook Salmon

Chinook are the largest, and longest lived species of Pacific salmon and tend to spawn in larger river systems. More than a thousand spawning populations (stocks) of this species are found in rivers along the eastern Pacific (several distinct spawning populations - often characterized by river entry timing – e.g., spring, summer, fall, winter - defined by a combination of timing and physical location may be found in a single river system). The PSC fishery regimes for chinook are directed at a subset of stocks originating from northern Oregon through Southeast Alaska. Chinook tend to migrate northward after leaving their rivers of origin, although each stock has its own pattern of migration and fishery exploitation.

PSC fishery regimes for chinook are designed to constrain fishery exploitation so as to achieve spawning escapement goals for individual stocks. Because individual stocks can migrate over thousands of miles and be impacted by fisheries over an extended period of time, PSC fishery regimes incorporate a rather complex set of elements, many of which depend heavily on CWTs.

Aggregate Abundance Based Regimes (AABM) The PSC has established abundance-based regimes for specified complexes of fisheries in Southeast Alaska, Northern British Columbia, and the West Coast of Vancouver Island. These specific fishery complexes were selected because of their impacts on mixtures of hundreds of chinook populations, the composition of which can vary over time, within and between years.

The allowable catch in these complexes is determined annually, based upon forecasts of the aggregate abundance indices (AIs) of fish available to the troll fishery sector in each AABM complex. Many of the abundance forecasts rely on CWT data. AIs represent the ratio between the projected abundance of natural and hatchery stocks and abundance observed during a specified historical base period. AIs are estimated through the use of the chinook model employed by the Chinook Technical Committee (CTC). AIs are computed by dividing the projected catch under a specific set of fishery regulations given the forecast abundance by stock and age in a given year by the catch that would have been expected under the same regulations during a specified historical base period. The CTC model estimates these catches from stock-age-fishery specific exploitation rates derived from cohort analysis of CWT recovery data collected during the model base period.

For each AABM fishery complex, a target harvest rate index (HRI) for the principal mixed stock gear sector (troll) was negotiated for ranges of AI levels. HRIs are also derived from cohort analyses of CWT recovery data. For example, if the negotiated HRI for a fishery and AI value was 0.50, then the allowable harvest rate in that fishery would have to be reduced by 50% from the base period exploitation rates in that fishery (estimated as the average rate over all stocks in that fishery). The relationship between AIs, HRIs, and observed catch levels during the 1985-1996 period was used to translate these indices (HRI and AI values) into an allowable catch level for the AABM fishery complex.

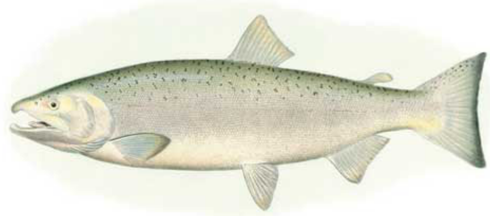
Individual Stock Based Management Regimes (ISBM). All fisheries which are not included in AABM complexes are managed to constrain impacts on individual stocks of naturally spawning chinook. For stocks that are not attaining escapement goals, the Parties are to manage all non-AABM fisheries under their jurisdictions so as to reduce impacts (measured in total fishing mortalities, catch plus incidental mortality loss) by specified percentage amounts from impacts that would have been expected during a given base period. These reduced impacts are expressed as HRI values, analogous to the AABM regimes, and are not to be exceeded in a year. These reductions are to be evaluated using formulas (previously developed by the CTC) that employ stock-age-fishery specific exploitation rates estimated from cohort analysis of CWT recovery data.

The use of CWTs in other aspects of PSC chinook regimes

Many of the standards and statistics embodied in the PSC chinook regime are expressed in terms of *adult equivalents*. Because chinook can be harvested at varying ages and stages under changing fishery regulations, adult equivalents provides a common currency that permits a consistent basis for analysis, monitoring, and evaluation. An adult equivalent is the probability that a fish of a given stock and age will return to its river of origin on its spawning migration in the absence of fishing in the current and all future years. Adult equivalents are derived from cohort analysis of CWT data which reconstructs the pattern of exploitation for a given brood year release from estimated fishery mortalities and spawning escapements. Cohort analysis provides estimates of age-fishery specific exploitation, maturation, and early marine survival rates.

CWT data are used to monitor compliance with requirements of fishery regimes. Additionally, CWT data are commonly employed in stock-recruitment analyses (catch for many natural populations is unknown, but the exploitation rate can be estimated from an associated indicator stock) to identify spawning escapement goals. Lastly, CWT data are employed in estimating survival rates and abundance forecasting.

Coho Salmon



SILVER OR COHO SALMON
Adult male

Compared to chinook, coho salmon spawn in small, even intermittent streams. Several thousand stocks of this species are believed to exist in rivers along the eastern Pacific. This species is characterized by an extended period of freshwater rearing (1 to 2 years) followed by approximately 18 months of rearing in marine areas prior to returning to the rivers to spawn. From Southern British Columbia southward, coho are predominantly produced on a three year life cycle (one year freshwater). In more northerly areas, coho with four year life cycles are common (two years freshwater). Coho are harvested predominantly during the last few months of marine residence. Most coho return to their rivers of origin in late summer and fall, although some stocks are known to have very early or late timing.

Coho tend to be distributed over a much smaller range than chinook. Marine distribution patterns for coho appear to be much more variable than chinook; fish distribution can be both north and south of their natal streams.

PSC fishery regimes for coho have been established only for stocks in the boundary area between Southern British Columbia and Washington State. These regimes are designed to constrain fishery exploitation on specified management units (regional aggregates of stocks) of naturally spawning coho, based on categorical conservation status (abundant, moderate, low).

Under the PSC coho agreement, each party is required to constrain its fisheries so that cumulative exploitation rates do not exceed negotiated limits. Because of a simpler life history pattern than chinook, exploitation rates under the PSC coho agreement are defined as fishing mortality/(fishing mortality plus escapement) during the last year of marine life.

CWT release groups of hatchery fish (1983-1988 brood years) were selected as being representative of naturally spawning management units, based on brood stock and rearing/release strategies. Analysis of recovery data from these CWT release groups were analyzed using cohort analysis methods provided historical perspectives on exploitation patterns and informed decision makers about the magnitude of fishery impact reductions required to meet target exploitation rate constraints.

<u>Implementation of PSC coho agreement</u>

Estimates of exploitation rates for CWT indicator stocks for specific management units are used to estimate spawning escapements, stock compositions, and monitor compliance. Although exploitation rates are derived through cohort analysis procedures, unlike chinook, adult equivalent concepts are not commonly employed for coho because fishery impacts occur predominantly during the last few months of marine residence and in freshwater areas.

CWT data are employed in stock-recruitment analysis to determine appropriate exploitation rates.

CWT data are also being employed to characterize distribution and exploitation patterns of management units in a regional coho fishery planning model. Because of high inter-annual variability, CWT data for several years are being collated to provide information on variability under different environmental conditions and fishing patterns.

In addition, to the model itself, CWT data are used to generate abundance forecasts for pre-season planning.