Requirements for assessment and management of salmon stocks
The Data Matrix

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Requirements for assessment and management of salmon stocks

- **Viability of the CWT system for use in PSC management**

- **What is cohort analysis and exploitation rate analysis?**

- **What are the sample design components for use of CWTs?**

- **Data and Process Matrices.**

Viability of the CWT system is vital to Management of chinook and coho salmon

In its 1995 report to the Pacific Salmon Commission, the Ad hoc Selective Fishery Evaluation Committee identified three major components to viability

Viability of the CWT system is vital to Management of chinook and coho salmon

- **The ability to estimate stock-specific exploitation rates by fishery and age**

Viability of the CWT system is vital to Management of chinook and coho salmon

- **The ability to use CWT data for assessment and management of wild stocks of coho and chinook salmon**

Viability of the CWT system is vital to Management of chinook and coho salmon

- **Maintaining the program such that the uncertainty in stock and fishery assessments and their applications does not unacceptably increase management risk.**

What is viability?

- **Viability defines the confidence that managers have in estimates of statistics such as exploitation rates.**

- **This depends on**
    - *The statistical qualities of the estimates, i.e., resolution and uncertainty (precision and bias)*
    - *The definition of statistical criteria by technical staff and managers for those statistical qualities.*

Cohort Analysis

Estimation of stock specific exploitation rates by fishery and age:

- **This requires the capability to reconstruct the cohort of individual stocks.**

What is Cohort or Exploitation Rate Analysis?

$$Cohort = \sum_{f}^{F} \sum_{a}^{A} (LC_{f,a} + IM_{f,a}) + \sum_{a}^{A} (NM_a + PSM_a + Esc_a)$$

$$ER_{f,a} = \frac{(LC_{f,a} + IM_{f,a})}{Cohort}$$

Cohort	*Recruitment cohort size*
$LC_{f,a}$	*Landed Catch in fishery(f) at age (a)*
$IM_{f,a}$	*Non-Landed, Fishery Induced Mortality in fishery(f) at age (a)*
NM_a	*Natural Mortality of age (a) fish*
PSM_a	*Post fishery, pre-spawning Mortality of age (a) fish*
Esc_a	*Spawning Escapement of age (a) fish*
$ER_{f,a}$	*Exploitation rate in fishery(f) of age (a) fish*

Management of chinook and coho founded largely on CWT data.

Assessment and management of wild stocks of coho and Chinook salmon,

- Rely on CWT recoveries in fisheries and in escapement of indicator stocks (usually tagged groups of hatchery fish) to reconstruct cohorts and to make inferences about exploitation rates of associated wild stocks.

Stock – Age Identification for cohort reconstruction.

CWT indicator groups tagged as representatives of associated wild unmarked stocks.

Stock – Age Identification for cohort reconstruction.

Assumptions for stock identification

- **Assumption is that CWT indicator stock and associated wild stock have same migration behavior (path and timing) once they have left terminal areas**

Stock – Age Identification for cohort reconstruction.

Basis for validation

- **Coho salmon wild stock tagging in Puget Sound, Washington coast and Canada.**

- **Chinook salmon – progeny from wild and hatchery brood stock tagged as indicator stock groups.**

Sample Design

Level of resolution required is fishery, period, stock and age.

- **Fishery and period is provided by sample design stratum**

- **Stock is provided by CWT indicator tag group code**

- **Age is provided by CWT indicator tag group code**

Sample Design

Coverage is all fisheries on migration path of the stock and in all escapement locations

- **Coverage is provided by sample design stratum**

Data & Process Matrices

Purpose:

Provide a consistent framework for evaluating the CWT program and alternative and/or supplemental technologies.

Data & Process Matrices

- **Identify the data elements required for cohort reconstruction,**

- **Describe the sample design (indicator stocks, fishery and escapement locations and periods sampled, numbers tagged and proportions of harvest and escapement sampled),**

- **Describe the analytical methods used to estimate exploitation rates and their uncertainty,**

- **Describe the methods and costs of data collection and uncertainties due to these methods**

- **Describe protocols for coordination and reporting to coast wide database**

Data Matrix

- **Data Items**
  - Estimates required
  - Data collected
- **Analysis**
  - Method of estimation
  - Assumptions
- **Sample Design**
  - Stratification
  - Sample size
  - Uncertainties
  - Sample methods

Data Matrix

Data Matrix							
Data Items		**Analysis**		**Sample Design**			
Estimate needed	**Data Collected**	**Estimation Method**	**Assumptions**	**Stratification**	**Sample Size**	**Uncertainties**	**Sample Methods**
Data Collection Method							
Landed Mortalities							
Non-landed Mortalities							
Natural Mortalities							
Post fishery, pre-spawning mortality							
Spawning Escapement							

Data Matrix

Data Matrix CWT Based Method							
Data Items		Analysis		Sample Design			
Estimate needed	Data Collected	Estimation Method	Assumptions	Stratification	Sample Size	Uncertainties	Sample Methods
Landed mortalities Of tagged fish	Number of observed recoveries by tag code in all fishery strata	Observed tags / Sample fraction	Random sample of total harvest All tagged Identied	Fishery and period, and tag group =stock/age	Sample Rate is >20%, in all fisheries	The tag code specifies the group of fish and age, so there is no error in assigning recoveries to specific groups of fish or in determining age of fish. *Precision* is dependent on number of tagged fish recovered, therefore release tag group size, sample rate in escapement. And on whether total is known or estimated. *Bias* depends on assumptions	Visual or electronic sampling in all fisheries
Sample Fraction	Number of fish sampled for in fishery stratum	Sampled Fish /Total harvest in Stratum	Total harvest is known or estimated without bias	Fishery and period			
Total Harvest	Varies with method, including fish tickets, catch record cards angler surveys, creel surveys						

Data Matrix

Data Matrix CWT Based Method							
Data Items		**Analysis**		**Sample Design**			
Estimate needed	Data Collected	Estimation Method	Assumptions	Stratification	Sample Size	Uncertainties	Sample Methods
Spawning Escapement Of tagged fish	**Tags observed in hatchery return**	**Observed tags / sample fraction**	**Random sample of escapement** **All tagged fish are identified**	**Indicator stock hatchery return by tag group**	**20-100%**	**Precision is dependent on number of tagged fish recovered, therefore release tag group size, sample fraction.**	**Visual or electronic sampling**
	Tags observed on spawning grounds			**Spawning locations with hatchery strays by tag group**	**0-50%**		
Sample fraction	**Number Sampled in escapement**	**Number sampled / Total Escapement to stratum**	**Total is estimated without bias or known**				
Total Escapement	**Hatchery Return**	**Total Hatchery escapement is counted**		**Hatchery**			
	Spawning Ground Total	**Varies with Estimation Method**		**Spawning locations with hatchery strays**	**Varies with Estimation Method**		

Data Matrix

Data Matrix							
Data Items		**Analysis**		**Sample Design**			
Estimate needed	Data Collected	Estimation Method	Assumptions	Stratification	Sample Size	Uncertainties	Sample Methods
CWT Based Method							
Non-landed Mortalities Of tagged fish		Encounters • release mortality rates					
		Proportion of landed mortalities or encounters in non-retention fisheries	Proportion by fishery			Potential bias is dependent on bias in proportion drop off.	
Drop off							
Sub legal mortalities		Estimate proportion vulnerable under sub legal size for encounters	Size and Fishery specific Release Mortality Rate	Fishery, tag group (=stock/age), period		Potential bias is dependent on bias in release mortality rate and estimates of encounters	
Non-Retention legal and sub-legal mortalities		For encounter estimation see cohort analysis methods used by CTC					
Unmarked mortalities in mark-selective fisheries (MSF)	Marked Fish in MSF	Landed mortalities of marked DIT fish in MSF times the unmarked to marked ratio of the DIT group estimates encounters					Electronic sampling in all fisheries

Process Matrix

- **Identify process**

- **Describe what is involved**

- **Specify responsibilities**

- **Coordination mechanisms to ensure data quality, integrity, & timeliness**

Process Matrix

Process Matrix - CWT Based Method				
Process	**What?**	**Who?**	**Costs**	**Coordination**
Identification of major production areas and stocks		**CTC, CoTC, Domestic managers**		
Identify discrete, well-defined groups of fish to represent stocks of interest.	**Selection of appropriate CWT release groups**	**CTC, CoTC, Domestic managers**		**Unique codes identify release agency and tag group**
	Ad-hoc guidelines for tag group size	**CTC, CoTC**		
	Report release group data to PSMFC coast wide database	**Domestic agencies**		**Standardized reporting guidelines and editing procedures**

Process Matrix

Process Matrix - CWT Based Method				
Process	**What?**	**Who?**	**Costs**	**Coordination**
Fishery landed mortalities and hatchery or spawning escapement	**Sample fisheries, hatcheries and spawning grounds**	**Domestic agencies**		**Guidelines for sampling rates, stratification into fisheries and time periods.**
	Recover and read tags. Tag code provides information on release group and age	**Domestic agencies**		**Methods standardized**
	Estimation of tags in harvest by tag code	**Domestic agencies**		**Standardized methods to account for lost heads, no pins, unreadable tags, miss ids in tag recovery process**
	Report sampling and tag recovery information to PSMFC coast wide database	**Domestic agencies**		**PSMFC standards for reporting data**

Process Matrix

Process Matrix - CWT Based Method				
Process	What?	Who?	Costs	Coordination
Estimate non-landed fishing and natural mortalities	See data matrix	CTC, CoTC, Domestic agencies		
Estimate cohort sizes	Sum all mortalities and escapement of tagged fish			Standard methods using agreed parameter estimates.
Estimate exploitation rates by stock, age and fishery	All mortalities for each age and fishery divided by cohort size for a tag group			Standard methods using agreed parameter estimates.

Process Matrix

Process Matrix				
Process	**What?**	**Who?**	**Costs**	**Coordination**
Estimation of impacts on natural populations or stocks of interest	**In the absence of MSF, then assume that estimates of age and fishery specific exploitation rates for CWT indicator stocks can be applied to age-specific estimates of natural escapement (or terminal run) to estimate total recruitment and impacts.**	**CTC, CoTC, Domestic agencies**		**Standard methods using agreed parameter estimates.**
	With MSF it may be possible to use the unmarked DIT group to provide the estimates of exploitation rates for unmarked natural populations. This capability is uncertain for Chinook salmon.			**Standard methods using agreed parameter estimates.**