Model Configuration for PSC Chinook Model Shaker Algorithm

Stock	**Age 4 & 5 PreTerm**	**Age 2 & 3 PreTerm**	**Age 2 & 3 Term**	**Age 4 & 5 Term**
AKS NTH GSQ GST GSH	Open Ocean	North Coast	North Coast 2 & 3 Term	North Coast 4 & 5 Term
FRE FLR		Fraser PreTerm	Fraser 2 & 3 Term	Fraser 4 & 5 Term
RBH RBT		WCVI PreTerm	WCVI 2 & 3 Term	WCVI 4 & 5 Term
NKF PSF PSN PSY NKS SKG STL SNO		Puget Sound PreTerm	Puget Sound 2 & 3 Term	Puget Sound 4 & 5 Term
WCH WCN		WA Coast PreTerm	WA Coast 2 & 3 Term	WA Coast 4 & 5 Term
URB SPR BON CWF CRW WSH CWS SUM LYF MCB		Columbia River PreTerm	Columbia River 2 & 3 Term	Columbia River 4 & 5 Term
ORC		OR Coast PreTerm	OR Coast 2 & 3 Term	OR Coast 4 & 5 Term

Fishery				
1 - 6	All	All	None	None
7-9, 11, 16	None	All	None	All
17	None	All except Fraser	Only Fraser	All
10	None	All except WCVI	Only WCVI	All
12, 13	None	All except Puget Snd	Only Puget Sound	All
14	None	All except WA Coast	Only WA Coast	All
15	None	None	Only Columbia River	Only Columbia River
18, 19 21 - 24	All	All	None	None
20	All	All except WCVI	Only WCVI	Only WCVI
25	All	All except Col R & WA Coast	Only Col R & WA Coast	Only Col R & WA Coast

Fishing Algorithm Code Design

Our current code design to simulate fishing activities is based on the following two fundamental concepts, which we call a "harvest process" and a "fishery process."

Harvest Process. Within a given year, timestep, region, and fishery a harvest process defines the interaction between the amount of fishing effort (i.e., number of people involved) and the number of fish from a given stock and cohort. In this context we define a "fishery" to include all regulations and properties other than the amount of fishing effort (e.g., size limits, bag limits, and selective fishery rules). A cohort is defined to be any group of fish having the same identifying characteristics and demographic features (e.g., parent stock, tag status, mark status, sex, growth group, and genetic group).

In virtually all types of fishery simulation models, there is a line of code (occasionally more than one line) that assigns a legal catch at the year, timestep, region, fishery, stock, and cohort level. In most cases, this line of code represents what we call a harvest process.

At a minimum the input variables to a harvest process are the two variables representing the amount of fishing effort and the abundance of fish. For example, in the PSC Chinook Model the FPs (or harvest rate scalars) represent the amount of fishing effort and the cohort abundance is input directly. Other variables (e.g., base period harvest rates and PNVs) included in the legal harvest equation are considered configured data, or properties, of the particular harvest process.

There are two common examples of harvest processes: linear and non-linear. For example, the PSC Chinook Model assumes that all harvest processes are linear, so that changes in fishing mortalities are linearly related to changes in fishing effort. On the other hand, the Proportional Migration (PM) model assumes a non-linear relationship between fishing effort and fishing mortalities. Non-linear relationships are generally employed to prevent fishing mortalities from exceeding 100% of the available fish.

Fishing Process. For each year, timestep, region, and fishery a fishing process defines the amount of fishing effort to be input into the harvest processes for all cohorts residing in the given time and region in order to satisfy some management objective. Note that under this formulation, a fishing process does not compute any fishing mortalities--it only determines the inputs to the harvest processes. Only harvest processes compute fishing mortalities. Note also that a fishing process applies only to a single year, timestep, region, and fishery.

In the PSC Chinook Model, non-ceilinged fisheries have a fixed harvest rate management objective. Thus, the FPs are set for each fishery at config time and are passed into each harvest process without modification. On the other hand, each simple ceilinged fishery adjusts the effort level for all harvest processes in a given year, region, and timestep by a scalar (called the RT factor) in order to make the sum of the legal catches meet the management objective.

Sample Harvest Algorithms

Algorithm	Type of process	Will it work?
PSC Chinook Model & FRAM		
CatchByFish sub	Harvest	Yes
Fixed individual harvest rates	Fishery	Yes
Unforced quota	Fishery	Yes
Forced quota	Fishery	Yes
Unforced quota + equal effort across timesteps	TimeStep (?)	??
Forced quota + equal effort across timesteps	TimeStep(?)	??
Shakers	Fishery	Yes*
CNR (RT method)	Fishery	Yes
CNR (season length method)	Fishery	Yes
CNR (encounter method)	Fishery	Yes
* requires unusual fishery/region/timestep definitions		
UW additions to PSC Chinook Model		
Fixed escapement (single fishery, strong stock)	Fishery	Yes
Fixed escapement (single fishery, weak stock)	Fishery	Yes
Fixed escapement (single fishery, combined stocks)	Fishery	Yes
Fixed combined harvest rates (single fishery; multiple stks)	Fishery	Yes
Fixed escapement (single timestep; multiple fisheries)	Regional (?)	??
FRAM (special)		
South Puget Sound fisheries	Fishery	??
PSC Selective Fishery Model		
Catch equation (non-linear)	Harvest	Yes
Quota (single timestep)	Fishery	Yes
Fixed Escapement (single timestep)	Fishery	Yes
Others (includes selective fishery, bag limits, size limits)	Fishery	Yes
PM Model		
Catch equation (non-linear)	Harvest	Yes
Fixed individual harvest rates	Fishery	Yes
State Space Model		
Catch equation (non-linear)	Harvest	Yes
Fixed individual harvest rates	Fishery	Yes
Other		
Incidental mortality cap (single fishery)	Fishery	Yes
Max weak stock harvest rate (multiple fisheries & steps)	TimeStep	??
Abundance based quota (multiple fisheries)	TimeStep (?)	??

Code Design Options

1. Nested Hierarchy. Create a nested hierarchy of processes related to fishing activities. For example, the next logical level up from a Fishery Process would be a “Region Process” that controlled multiple fisheries within the same region during a given timestep. And the next level up from there would be a “Time Period Process” that controlled fisheries over multiple timesteps. What would be the inputs and outputs from these types of processes? Perhaps the outputs from higher level processes would be catches for individual fisheries, rather than effort levels.

2. Global Solver. Create a control object at the outermost level that managed ALL the relative effort levels for each fishery in order to meet ALL management constraints. This would require using a technique similar to “simulated annealing” or other optimization routine. This approach would be very similar to a model calibration routine in which the control variables were relative effort levels (instead of EV Scalars, for example) and the objective function was some combination management objectives.

3. Single Timestep Manager. Create a control object that can adjust all relative effort levels at the end of each timestep.

4. Proprietary Managers. Assign control of relative effort levels to different management objects. For example, the effort level in a given timestep for one fishery might be controlled by a Fishery Process in order to meet a forced quota for that fishery, while effort levels for other fisheries are controlled by a higher level process that adjusts efforts in order to meet some escapement goals. This approach would clearly delineate which management objectives had priority over others