HATCHERY RISK ASSESSMENT TOOL (HRAT)

User and Administrator Guide

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OVERVIEW

The Hatchery Risk Analysis Tool (HRAT) is a Microsoft Excel spreadsheet designed to facilitate the comparison of relative risks to wild salmon arising from hatchery enhanced stock in British Columbia. It comprises:

A database of hatchery stocks in the province, with:

- Limited data on some physical characteristics and administrative aspects of hatchery stocks (e.g. Watershed codes, numbers of juvenile releases, etc)
- Scores for each stock / lifestage on a series of 'constructed scales' that collectively help characterize the relative risk posed by the hatchery stock / lifestage to wild salmon.
- A weighted, hierarchical rating-and-weighting structure and value model for organizing, aggregating and comparing the relative risk posed by each hatchery stock / lifestage. Risks posed by any individual hatchery stock / lifestage can be compared to others and to best practices.
- A screening and ranking tool for analyzing this data

The purposes of the tool are:

- To act as a database of hatchery stocks, conditions and operational practices
- To facilitate the comparison of hatchery stocks in order to highlight those that pose greater risk to wild salmon.
- As one input into decision making concerning these hatchery stocks
- To serve as an educational resource

BACKGROUND TO THE DEVELOPMENT OF THE HATCHERY RISK ANALYSIS TOOL (HRAT)

For several years, a major effort has been underway at the federal Department of Fisheries and Oceans (DFO) to develop and to implement a comprehensive and defensible wild salmon policy (WSP), based on the results of scientific analyses and multi-stakeholder consultations. One of the primary stated goals of the WSP is "safeguarding the genetic diversity of wild salmon populations." This includes a commitment to assess the risks of hatchery production to wild salmon through the development of a biological risk assessment framework. At present, no framework exists to allow DFO enhancement managers to make explicit estimates of the risks of enhanced salmon programs to wild stocks.

From 2005 to 2007, the HRAT was designed to be a relatively easy-to-use, computer-based tool that could assist DFO enhancement managers in making consistent and transparent decisions related to minimizing risks to wild salmon from the production of enhanced stocks. The tool is designed to improve communication across different groups working within DFO and, to a lesser extent, to help facilitate and improve communication between DFO and other interested parties.

Consistent with this focus, during its development primary inputs came from a small working group comprised of DFO enhancement biologists, supplemented with limited input from other DFO staff concerned with science and policy issues and selected provincial fisheries staff. The role of the consultants, who functioned as decision analysts, modelers and facilitators, was to organize this knowledge so that it could be used to identify and compare risks to wild salmonid populations due to enhancement activities. This has both a descriptive component, to gain a clear understanding of the implications of current operations, and a prescriptive component, designed to lead to improved enhancement facility operations in the future.

Our scope in this project has been limited to the possible biological risks to local (native and zone of influence) wild salmon stocks resulting from the production of enhanced salmon at hatcheries and managed spawning channels. This includes major hatcheries run by DFO, public involvement hatcheries, community hatcheries, and managed spawning channels. Although it is recognized that enhanced salmon are produced using a variety of techniques besides hatcheries and spawning channels, and that there exist other sources of potential risks to local stocks, this focus was selected to bound this initial stage of the risk assessment work.

Minimizing the risks to wild salmon stocks from enhanced salmon requires a framework for balancing the benefits and costs of different management actions under conditions of (in some cases high) uncertainty. Even if risks alone are the focus of attention, as in these initial stages of the framework development, attention must be given to the pros and cons of different options; otherwise, the obvious choice is to stop production of all enhanced stocks and thereby avoid the associated sources of risk to wild stocks (although other risks to wild stocks, for example through extinction, might increase). Because risk is multidimensional, the concern of DFO managers to enhance stocks while not exceeding acceptable risk levels requires tradeoffs both across the diverse risks and benefits of producing enhanced salmon populations and within these categories, thus requiring both benefit-benefit and risk-risk tradeoffs.

Several types of enhancement risks have been noted in the literature in the context of possible impacts on wild salmon stocks: genetic consequences, ecological effects, demographic effects, disease transmission, and operational (catastrophic) effects to enhancement facilities. Benefits are also multidimensional: conservation is the leading reason for enhancing populations, but increases to salmonid populations also would benefit fish harvests, stock assessments, and some mitigation activities. Thus there are also economic and social and cultural risks and benefits, in addition to the biological concerns that are the focus here. Examples of these categories of risks and benefits are summarized in Table 1.

Table 1: Some risks and benefits of salmon enhancement

	Type	Description
Risks	Genetic	Genetic effects due to inbreeding (leading to changes in fitness), outbreeding effects (involving straying), and domestication
	Ecological	Effects of hatchery juveniles on wild juveniles (e.g., during freshwater residency), related to habitat carrying capacity
	Demographic	Effects resulting from changes in harvest effort on co-migrating wild fish
	Disease	Increases in the incidence or severity of diseases in wild stocks
	Facility operations	Potential catastrophic losses of hatchery stocks due to problems involving water supplies, releases, or

		other aspects of hatchery operations
Benefits	Conservation of at-risk stocks	Reductions in the probability of extinction for threatened or endangered stocks
	Economic benefits from harvest increases	Increases in the allowable sustainable harvest due to the production and release of hatchery fish
	Stock assessment	Information about stock status and distribution that can be used for the assessment and management of wild salmon populations
	Mitigation	Preservation of stocks that otherwise would be lost or at risk due to the construction of dams or other blockages
	Social and cultural: First Nations, Partners	Maintenance of jobs (direct and indirect), cultural uses of salmon, education, and contributions to associated objectives of other federal and provincial groups

There is currently no explicit framework for linking the different aspects of risk to either the specific operations of enhancement activities or to a more generalized framework for evaluating potential costs against benefits. It is unlikely that a comprehensive quantitative risk assessment approach will be undertaken in the immediate future. As a result, it is currently not possible to answer defensibly questions such as the following:

- Which of the risks to wild stocks currently is the most significant concern for operations at DFO hatcheries?
- What could be done to decrease any of the risks, and to what extent would that simply result in a transfer of risks from one type to another?
- If production is shifted from facility X to facility Y or if production is shifted between stocks (at the same facility), how might risks be altered?
- If production levels at Facility X are altered (either increased or decreased), how will the overall level of risk, and its distribution among the different types of risk, be affected?
- If staffing at Facility X is cut by half, and as a result specific changes in operations (e.g., relating to the broodstock collection practices) occur, how might risks to both enhanced and wild stocks be affected?

While definitive answers to these questions cannot imminently be expected from scientific research, decisions need to be made regarding them on an going basis. It is not true, however, to think that because research has not yet quantified the degree of risk to wild salmon posed by a particular activity that practitioners have no idea how to make management decisions that effectively balance risk and benefits. DFO enhancement managers have for decades made judgments on these issues based on the best available science, and have accumulated much knowledge and experience in doing so. Also, it is not strictly necessary to know the precise degree of probability or consequences associated with a particular course of action; from a managerial perspective, it is often enough just to know which of two comparable situations constitutes the most 'risk'. By shifting to a 'relative risk' paradigm (e.g. 'in a given situation, how much worse is doing X rather than Y?'), we can begin to model the existing knowledge and experience of enhancement managers and thus make it transparent, consistent and open to peer review and ongoing learning.

There are at least two common ways of implementing this approach. One is a so-called 'rating-and-weighting' approach in which the factors that are considered to confer 'risk' are converted into well-

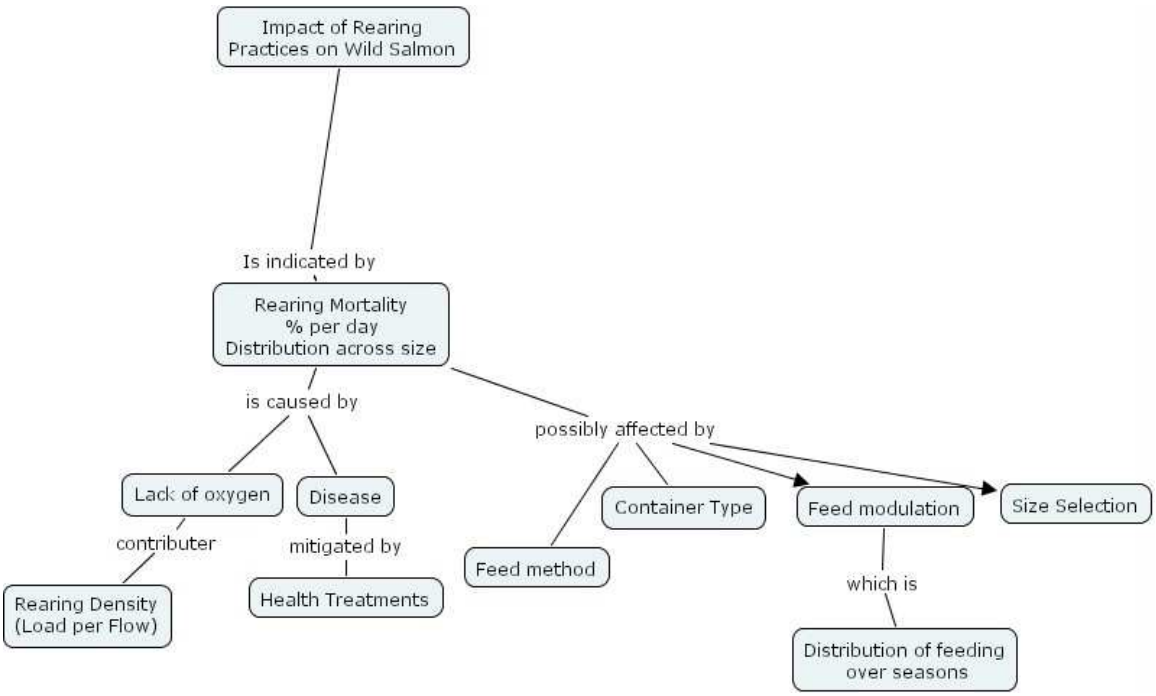
defined constructed scales, which are then organized hierarchically and weighted. Various particular hatcheries or hatchery stocks are then be 'rated' or 'scored' according to each scale, and an aggregated weighted sum calculated (sum of all scores * weights for each hatchery / hatchery stock)

An alternative approach considered by the project team was to establish a model that depicts the relationships between factors that influence risks using graphical causal probabilistic networks, known as Bayesian belief networks (BBN), to model risks. The use of BBN allows managers to make explicit judgments about the relative importance and influence of specific factors (or nodes) to identified components of risk by showing their causal relationships and conditional dependencies. These are similar in spirit to the "flow charts" that have been developed by enhancement mangers to help guide enhancement decisions, although there would be significant additional detail and precision along with explicit probabilistic judgments. The use of causal networks and other tools of decision analysis would permit new insights and substantial additional quantitative capabilities: as the probability associated with the node changes, for example because of a change in the probability of one of the variables that influence it, then the probability (and risk) associated with the endpoint also will change. It is this relationship-based, continuously updating aspect of BBN that is most appealing in terms of deriving direct, quantitative estimates of risk. However, the information demands of a BBN approach can be large, and to the extent that distributions for many specific parameters are not known the near-term advantages of this approach (and its potential for facility- or scenario-specific estimates of risk) are diminished, although it deserves consideration as an approach to be implemented over a longer time frame.

Accordingly, DFO chose to adopt a 'rating-and-weighting' approach for this work.

BASIC ANALYTICAL STRUCTURE

The rating and weighting model developed for this version of the HRAT was developed periodically and iteratively during 2005-2007. The overall structure of the hierarchy of factors was originally sketched out using a 'concept mapping' techniques. The figure below illustrates an early draft of one such map.



Once a framework was developed, work began on developing scales for each factor. Full descriptions of the final versions settled up are presented in an Appendix, but the main structure is summarized here. Again, the development of these scales took place over several months and saw many iterations.

Note: Not all factors that could be considered important are necessarily present in the current stage of the tool - some factors were considered, but rejected for various reasons. Also, some factors may be present in the HRAT that are not necessarily considered important by a majority of DFOstaff – in some cases, factors may be included because they are thought to be important be some people. Because ALL weights for factors can be adjusted (including a weighting of zero), sensitivity analyses can be conducted to particular factors if required.

At the highest level of the hierarchy are the following categories of factors, most of which are weighted indices of subfactors:

TARGET STOCK CONDITION INDEX (TSCI)

- The target stock here refers to the stock being enhanced. Stocks considered 'at risk' are often enhanced in an attempt to prevent their extirpation. The poorer the condition and situation of 'at risk' enhanced stocks, the greater risk deemed to be incurred to wild salmon as a whole since such extirpation would lessen the genetic diversity of salmon as a whole. 'At risk' enhanced stocks score highly on this measure; stocks produced for harvesting purposes score close to zero on most of the constituent criteria.

IMPACTS ON OTHER POPULATIONS INDEX (IOPI)

- The more stray impacts (to other wild salmon stocks) are caused by enhancement of the target stock, the greater this value. Stocks enhanced for harvesting typically score highly in this category.

SCALE INDEX (SI)

- All else being equal, the bigger the scale of enhancement, the higher the potential risks caused by enhancement activities (scale is defined differently for different species). Again, stocks enhanced for harvesting typically score highly in this category.

FACILITY PRACTICES INDEX (FPI)

- This index is used to characterize the risks to wild salmon posed by enhancement facility practices. Facilities that adopt best practices for a particular stock have a low score on this index. Facilities that pay less attention to best practices score highly.

PLANNING INDEX (PI)

- All else being equal, facilities whose production is governed by comprehensive, multi-year and multi-party planning processes are deemed to pose less risk than those that have less considered plans or that have no formal planning at all.

FACILITY INTEGRITY INDEX (FII)

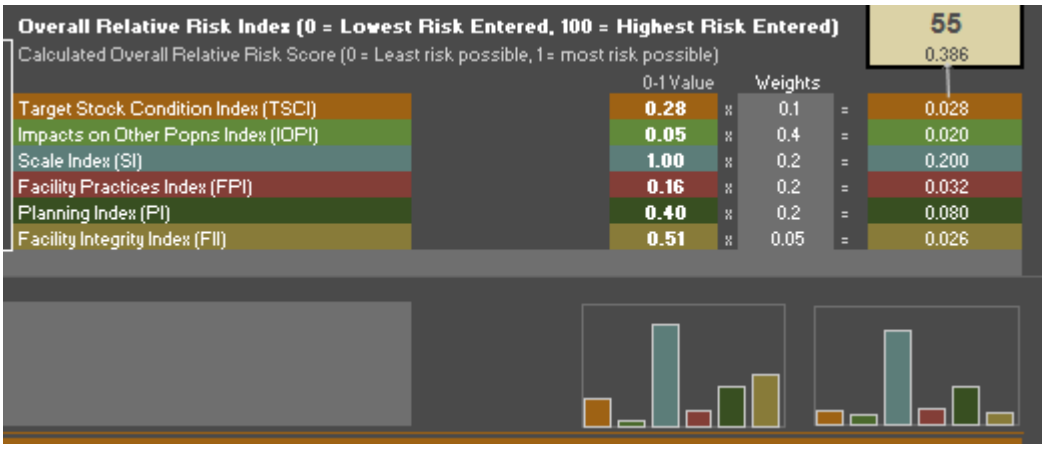
- Facilities that are physically vulnerable to uncontrollable environmental impacts or malicious damage pose greater risk to wild salmon than those that are not. For example, facilities with multiple back-up systems, no requirement for water pumping, highly trained operators and secure fences etc are less prone to accidents that may affect wild salmon than others.

The relative risk associated with a hatchery stock is considered to follow this function:

$$\text{Relative Risk} = (TSCI * W_1) + (IOPI * W_2) + (SI * W_3) + (FPI * W_4) + (PI * W_5) + (FII * W_6)$$

Where W_1 to W_6 are weights assigned to each of the indices. Note that each index and each weight are always normalized to take a value ranging from 0 (least risk concern, or least importance) to 1 (most risk concern, or most importance).

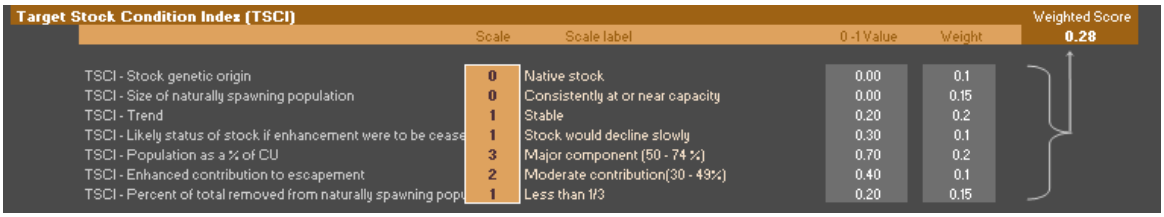
The image below shows how this calculation for a sample record is presented in the interface sheet of the HRAT:



Each Index is calculated as a normalized 0-1 value across all the records in the database (i.e. there is always at least one record with a 0 and a 1 in the database). *The higher the value of any index, the greater the relative risk to wild salmon posed by the enhanced stock / lifestage.* As this illustration makes clear, the 0-1 values are multiplied by corresponding weights, also of 0-1 values, but which in this case always sum to 1 (See the Weighting section below for more information on this). The products of each Index and corresponding weight are shown in the right-hand column. The smaller type in the yellow box above this is the sum of these products. The bold number in the yellow box is a further normalized figure between 0 and 100 and represents the Overall Relative Risk Index, where 0 is the record with the lowest calculated relative risk, and 100 is the record with the highest calculated relative risk. Note: if the database contained only two records, one would have an Overall Relative Risk value of 0 and the other 100 by definition. Note that the two histograms correspond to the unweighted and weighted index score values respectively.

The importance of the Overall Relative Risk Index should not be overstated. For most practical purposes, a more specific querying of the database (see below) should be used, depending on the application at hand.

All levels of the hierarchy (see below) are weighted and normalized similarly. The following illustration of the Interface shows clearly how a sample Index (in this case the Target Stock Condition Index) is calculated:



Scale values for each of the component entries are displayed in the orange box, and the corresponding scale labels are shown beside them (see below for details on how to edit these values). A scale value of 0 simply means, "the first option in the scale", 1 is the "second option in the scale" and so on. Scales may have between 2 and 10 possible options. In the 0-1 value column, the scale values are normalized to 0 to 1. (By default this relationship is linear, though non-linear relationships between scale values and 0-1 values can be entered – see the Administrator's Guide section). Each 0-1 value is then muliplied by a corresponding weight (See the Weighting section) and the sum of these products gives the Index value.

Each index and its underlying factors are summarized below. Note that the Scale Index (SI) and the Planning Index (PI) do not have any sub-factors while the Facility Practices Index (FPI) has two levels of structural hierarchy. Again, details of each of these component scales is provided in an Appendix.

Target Stock Condition Index (TSCI) [1]
- TSCI - Stock genetic origin
- TSCI - Size of naturally spawning population
- TSCI - Trend
- TSCI - Likely status of stock if enhancement were to be ceased
- TSCI - Population as a % of CU
- TSCI - Enhanced contribution to escapement
- TSCI - Percent of total removed from naturally spawning population

Impacts on Other Popns Index (IOPI)
- IOPI - Freshwater adult interactions
- IOPI - Target Stock fishery impacts
- IOPI - Target Stock stray impact

Scale Index (SI)

Facility Practices Index (FPI)
- FPI - Broodstock Mgmt & Spawning - Genetic Risk (BMS)
  - FPI-BMS - Production of juveniles in target stock from strays
  - FPI-BMS - Broodstock collection period
  - FPI-BMS - Broodstock size/age selection
  - FPI-BMS - Number of broodstock
  - FPI-BMS - Spawning duration proportionality
  - FPI-BMS - Appropriateness of spawning protocols
  - FPI-BMS - Prespawn mortality
  - FPI-BMS - Broodstock mortality pattern
  - FPI-BMS - Captive broodstock protocols
  - FPI-BMS - Inclusion of wild in broodstock
- FPI - Incubation and Rearing (IR)
  - FPI-IR - Incubation and ponding mortality
  - FPI-IR - Rearing to release mortality
  - FPI-IR - Juvenile mortality pattern
  - FPI-IR - Size selection during rearing

[1] In addition, three indicators are placed in this category that do not contribute to the calculation of TSCI. These indicators do, however, pertain to the target stock, and can be used to query the database. The three additional indicators are:

TSCI - Status of target stock with enhancement

TSCI - Contribution of harvest impacts to stock status

TSCI - Contribution of habitat impacts to stock status

FPI - Disease Management (DM)
- FPI-DM - Adult disease management
- FPI-DM - Juvenile health treatment practices
- FPI-DM - Carcass placement
- FPI-DM - Ability to maintain quarantine conditions
- FPI-DM - Effluent treatment

FPI - Release (R)
- FPI-R - Fish health at release
- FPI-R - Release Matrix score - same species
- FPI-R - Hatchery release method
- FPI-R - Release impacts - different species

Planning Index (PI)

Facility Integrity Index (FII)
- FII - Site security
- FII - Water source
- FII - Reliability (backup / water systems)
- FII - Water quality
- FII - Operator experience
- FII - Biological, scientific and engineering support

EXAMPLE OF RATING A HATCHERY STOCK:

The following is an example of how each individual constructed scale is used. The first sub-component of the TSCI index , "TSCI - Stock genetic origin", is the following constructed scale:

Scale No	0	1	2	3	4
Label	Native stock	Transplant - new species or run timing	Transplant - native population extirpated	Cross with remnant native stock	Transplant in presence of existing stock
Description	Native stock	Native species with same run timing never present	Native species with same run timing extirpated	Cross with remnant native stock	Existing viable stock of native species/run timing
Scale Value	0	0.25	0.5	0.75	1

For any given hatchery stock the appropriate selection is made from this scale (0 to 4) and is translated for calculation purposes into a value between 0 and 1. Scales are always organized in terms of increasing presumed risk, so that a value of 0 means 'least concern' and 1 means 'most concern'. Scale Values may be non-linear; i.e. the difference in scale value used in calculations between each category need not be constant (though at the point of writing most actually are constant). See the Administrator Guide for more information on non-linear scale values.

Not all the criteria listed here are the result of single constructed scales of this type. A small number of factors are the result of the specific combinations of several criteria. For example, the Scale Index is a function of both species and number of releases as shown below:

Scale	CM	CN	CO	CT	PK	SK	ST
<1,000	0	0	0	0	0	0	0
1,000 - 5,000	0	0	1	1	0	0	1
5,000 - 10,000	1	1	2	2	1	1	2
10,000 - 50,000	2	2	3	3	2	2	3
50,000 - 100,000	3	3	4	4	3	3	4
>100,000	4	4	4	4	4	4	4

Only when both criteria are known can a Scale score be deduced. Other criteria that follow this format are detailed in the A*p*pendix.

WEIGHTING

The weights assigned to each component in the hierarchy were determined by DFO Enhancement staff. At one stage in the iterative process, six managers were asked individually to assign weights to each of the components in the hierarchy. At a subsequent meeting, the analysts presented these weights in a way that highlighted areas of agreement and disagreement across these individuals. In addition to the relative weights of factors within each category, the analysts also presented the effective weights of each component after being multiplied across the entire hierarchy (for example, the effective weighting for "FPI-R - Fish health at release" is the product of the weightings of "FPI-R - Fish health at release", "FPI - Release (R)" and "Facility Practices Index (FPI)". This compounding effect may sometimes lead to effective weightings that are counter-intuitive and that are an artefact of the particular hierarchy used; therefore steps should be taken to ensure that effective weights reflect those intended by managers.

Two special cases arose in developing a weighting scheme for the HRAT.

First, DFO Enhancement managers felt that the weight that they would wish to apply to the highest level of hierarchy described above could differ depending on the *management objective* that guided production of each stock (e.g. stocks produced for conservation reasons might have a higher weight on Target Stock Condition Index (TSCI) than stocks produced for harvesting purposes). To address this, the highest level of weighting is determined by the following reference table. (Note the actual values are subject to change, but are correct at the time of writing).

	Enhancement Objective						
	H	R	C	M	F	MH	RE
Target Stock Condition Index (TSCI) Weight	0.1	0.3	0.2	0.2	0.2	0.1	0
Impacts On Other Popns Index (IOPI) Weight	0.4	0.2	0	0.1	0.1	0.2	0.3
Scale Index (SI) Weight	0.2	0.1	0	0.05	0.05	0.15	0.05
Facility Practices Index (FPI) Weight	0.2	0.2	0.4	0.35	0.35	0.3	0.35
Planning Index (PI) Weight	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Facility Integrity Index (FII) Weight	0.05	0.15	0.35	0.25	0.25	0.2	0.25
Sum	1	1	1	1	1	1	1

Where:
H = Harvest
R = Rebuilding Depleted Stock
C = Conserving At-Risk Stock
M = Mitigation - Habitat
F = Mitigation - Fishery
MH = Mitigation - Habitat / Harvest
RE = Re-establish Extirpated Stock

The second special case arose in the developments of weights for the four sub-categories of the "FPI - Facility Practices Index":

FPI - Broodstock Mgmt & Spawning - Genetic Risk (BMS)
FPI - Incubation and Rearing (IR)
FPI - Disease Management (DM)
FPI - Release (R)

As with the previous case, DFO managers felt that these weightings may change by enhancement objective. Weights used for each of these categories can therefore be found in similar table in the HRAT. (All weights are entered and can be changed on the 'Weights' sheet of the HRAT tool – see below for details).

BASIC TASKS

GETTING STARTED AND ENABLING MACROS

Requirements:
This spreadsheet was developed on Microsft Excel versions 2000 and 2003 on PCs. It has not been tested on other versions, or on Mac computers.

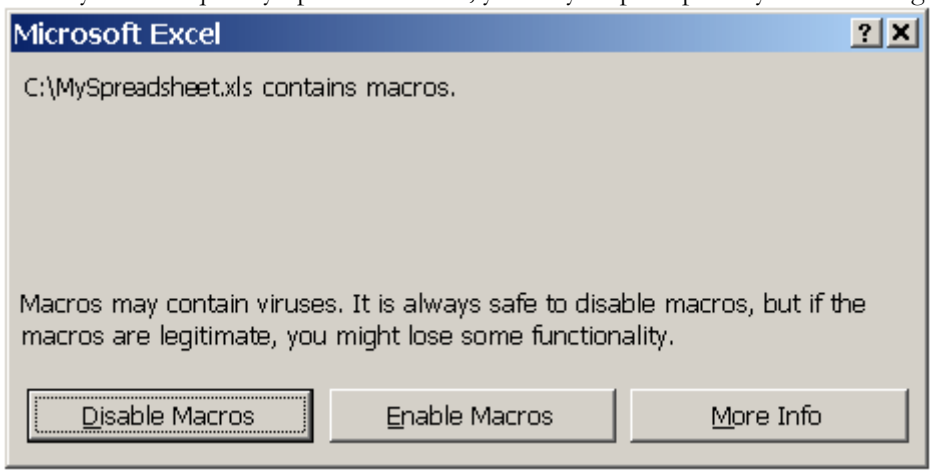
The HRAT requires Excel macros to be enabled. This is a setting associated with an installation of Excel and applies to any spreadsheet opened in that installation. 'Enabling' macros permits essential programming code to run.

Before opening the HRAT, open Excel and check the security status.

Excel 2000
Start Microsoft Excel.
Click on Tools, highlight Macro and click on Security.
Click on either Medium or Low.
Click OK.

Excel 2002 (XP) / 2003
Start Excel.
Click on Tools and select Options.
Select the Security tab and click on the Macro Security button.
Click on either Medium or Low.
Click OK.

When you subsequently open the HRAT, you may be prompted by the following dialog box:



Click on 'Enable Macros' to start using the HRAT.

VIEWING AND EDITING STOCK-LIFESTAGE INFORMATION

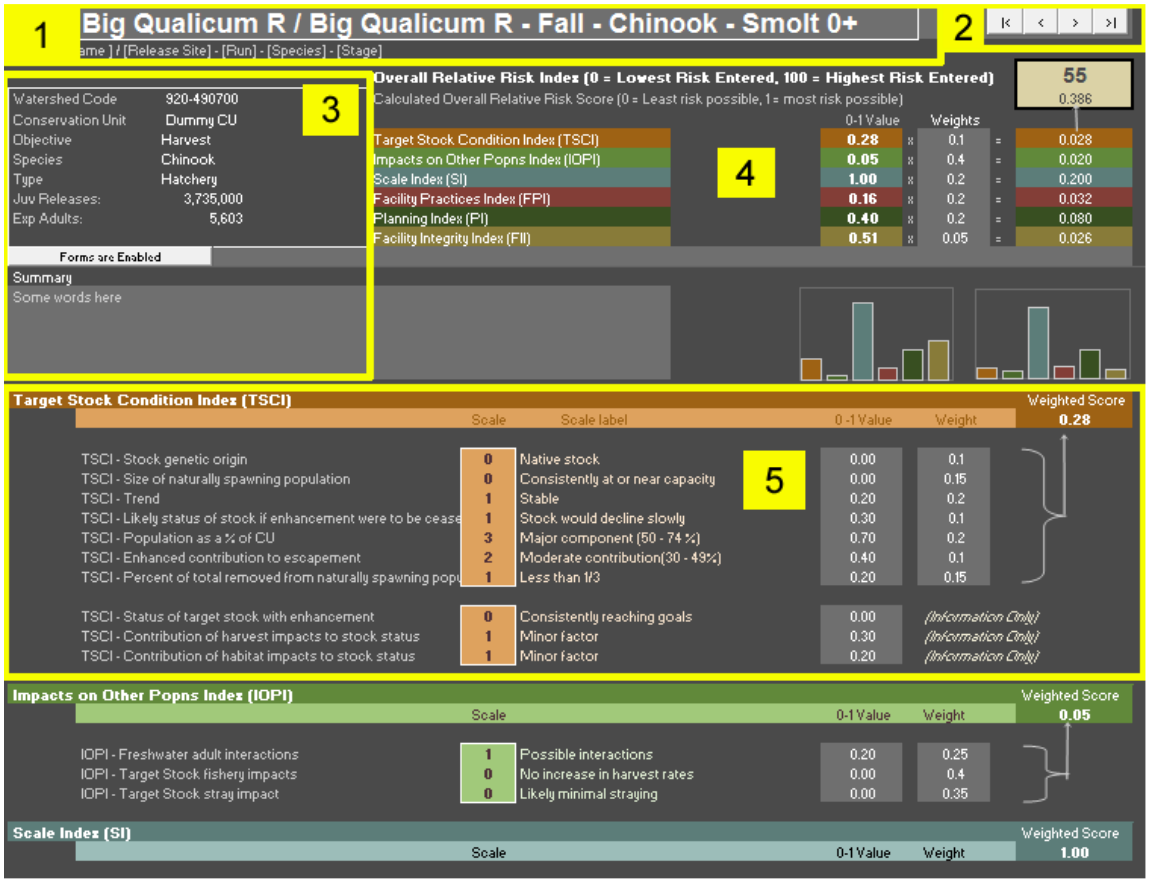
Stock-lifestage data can be viewed on the 'Interface' sheet of the spreadsheet. The sheet can be selected using the appropriate tab at the foot of the screen.

You may need to adjust the Zoom level to fit your monitor. Do this by selecting the following and adjusting as required:

View - Zoom

UNDERSTANDING THE INTERFACE

The image below shows the top portion of the Interface sheet. Each section of the sheet is discussed below.



Box 1: Record Identifier

This is a summary description of the record being summarized in the Interface sheet. As the reminder on the sheet shows, the components of this description are as follows:

[Project Name] / [Release Site] - [Run] - [Species] - [Stage]

Clicking inside this area will trigger a popup dialog box that offers options on project selection. See below for more details on Selecting a Record.

Box 2: Record Selection Buttons

The buttons illustrated in Box 2 are used to select a different record on the Interface sheet.

See "Selecting a Record (2) – Using the Record Selection Buttons" below for more information.

Box 3: Background Information Section

This section displays reference information of significance to the selected record. Clicking inside the bordered area triggers a popup dialog box that can be used to edit this information. See the Administrator's Guide section of this document for more information.

Box 4: High Level Relative Risk Values

Box 4 shows a high-level summary of the relative risk scores and calculations performed for the selected record. This is described in more detail in the Basic Analytical Structure section above.

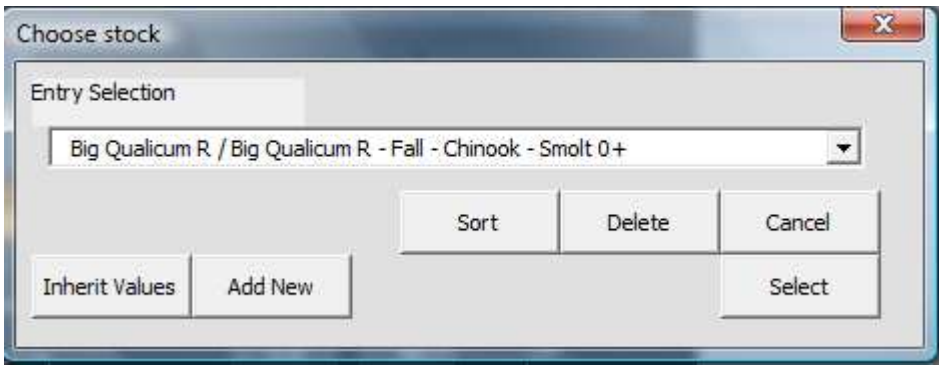
Box 5: Example of an Index: Target Stock Condition Index

Box 5 shows an example of the lower-level relative risk scores and calculations performed for the selected record. This is described in more detail in the Basic Analytical Structure section above.

There are three ways to select a particular record:

SELECTING A RECORD (1) – USING THE "CHOOSE STOCK" DIALOG

Clicking inside the bordered region shown in Box 1 will launch the following dialog box.



The drop down box contains all the entries in the HRAT. Press the Select button to choose a record. Records can also be sorted or deleted using this dialog. Note: the Inherit Values and Add New buttons were used to load data into the HRAT database; these serve no useful function at this point, but are left on the form should the need to use them again arise.

SELECTING A RECORD (2) – USING THE RECORD SELECTION BUTTONS

The buttons illustrated in Box 2 are used to select a different record on the Interface sheet.

|< Calls up the first record listed in the database

> Scrolls forward to the next record listed in the database

< Scrolls back to the previous record listed in the database

>| Calls up the last record listed in the database

Note: if pressing these buttons has no effect, you may need to enable macros (see Getting Started and Enabling Macros above).

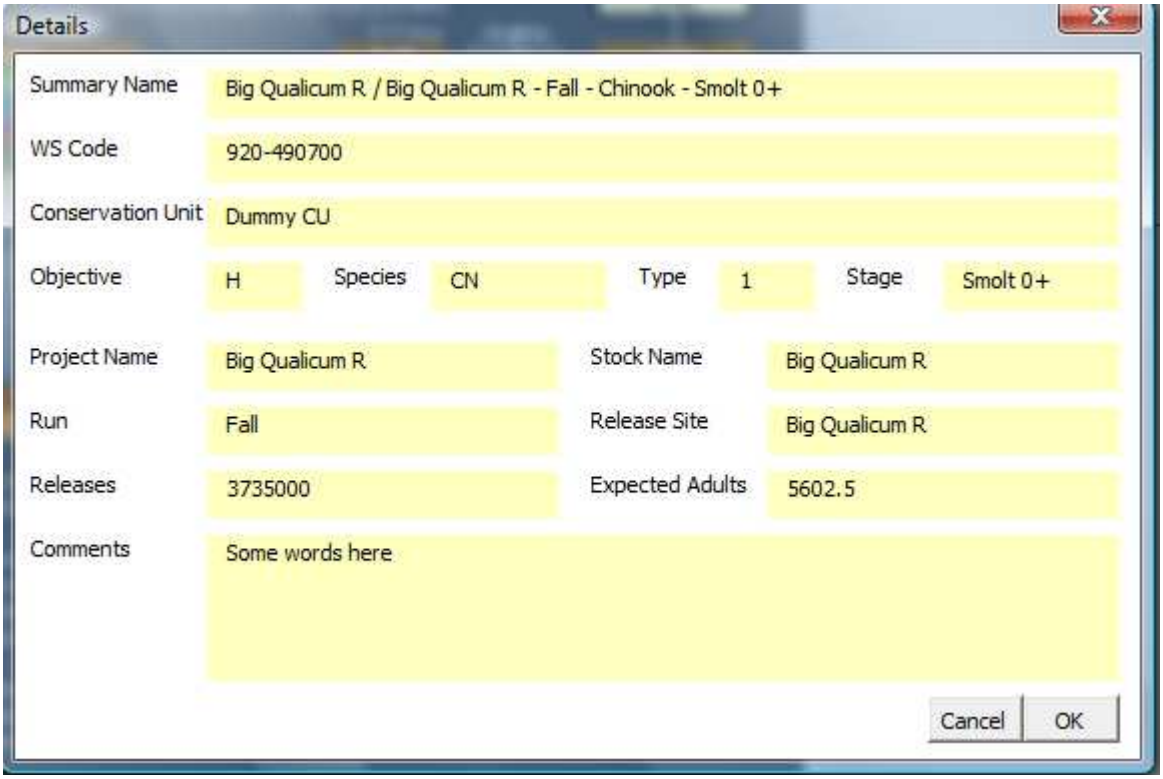
SELECTING A RECORD (3) – DIRECT ENTRY OF THE RECORD NUMBER

If you know the number of the record you want to select, then:

1. Select cell H3 in the Interface sheet.
2. Cancel the popup dialog box
3. Type the required number in cell H3 and hit return.

EDITING THE BACKGROUND INFORMATION

Clicking within the bordered area of Box 3 will launch a popup dialog in which the background data of the record can be edited as shown below. Changes made here will be saved to the **IData** sheet (see Administrator's Guide).



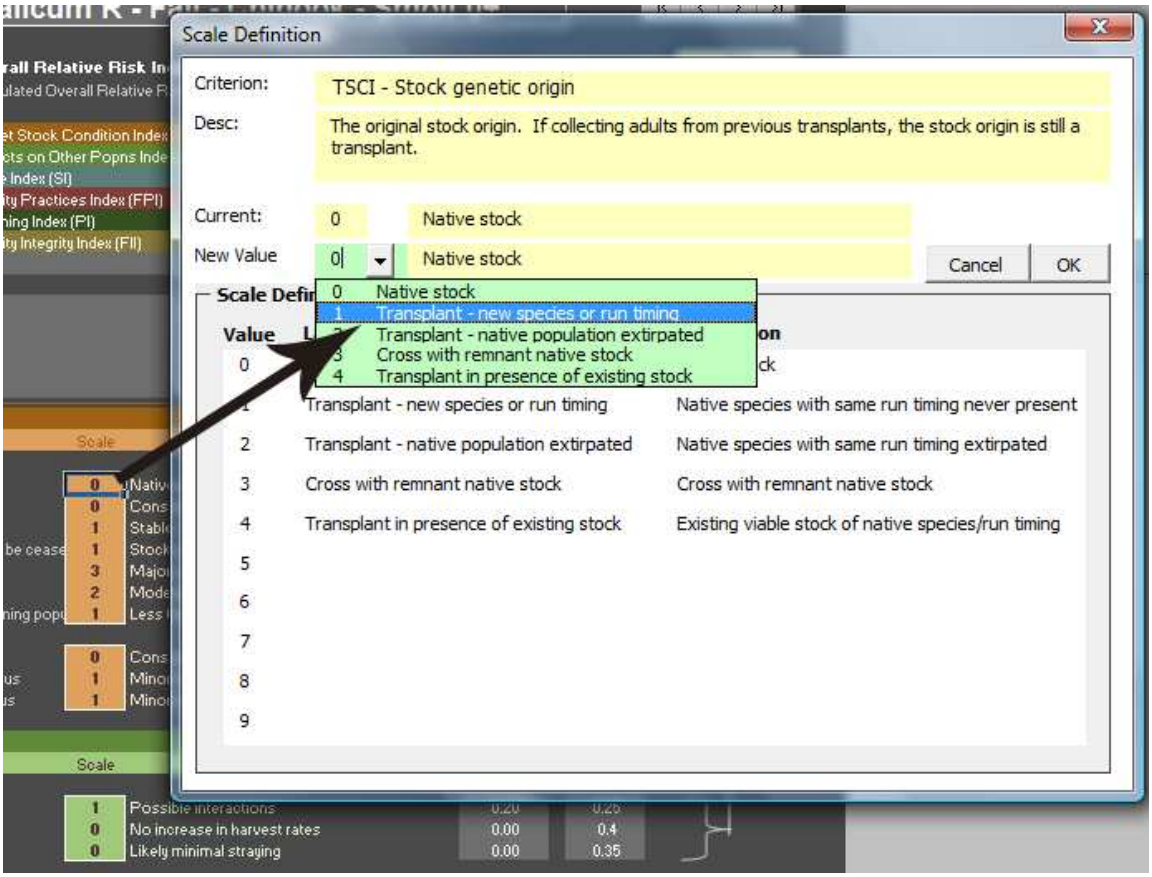
EDITING RECORDS

NOTE: All record editing in the **Interface** sheet occurs through popup that are launched by clicking on parts of the **Interface** sheet – no data is ever stored in this sheet; it is simply used to display information drawn from elsewhere in the Tool. Do not attempt to type values directly anywhere into the **Interface** sheet. If you try to do so when the sheet is in locked mode (which it is by default - see Administrator's Guide below), you will be informed that the cells are protected. If the sheet is unlocked, however, typing directly into the **Interface** sheet may disable the Interface of the HRAT and result in loss of data.

The following sections discuss different types of record editing.

EDITING CRITERIA SELECTIONS FOR A RECORD

Box 5 above shows the first of several Index sections in the HRAT. The values in the coloured, 'scale' column can be edited, and again by clicking within the bordered area. One of several kinds of popup dialog boxes show the options available (see illustration below).



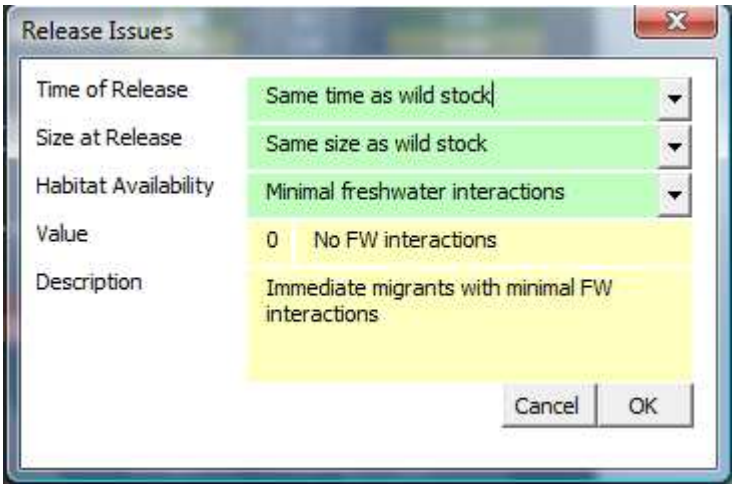
Most of the criteria scales follow the form shown here. A scale definition on the form itself contains the discrete choices available. To edit the value, select a new value from the green drop-down box and click OK.

Note also that there are four special cases in which the data entry form takes on a unique form. This is because these criteria require on multiple sources of data to resolve into a scale value. The scales with unique data entry forms are all in the Facility Practices Index and are:

- FPI-BMS - Spawning duration proportionality
- FPI-BMS - Appropriateness of spawning protocols
- FPI-BMS - Inclusion of wild in broodstock
- FPI-R - Release Matrix score - same species

(The entry for each of these in the Interface sheet is shaded differently for this reason).

The input forms for each of these are unique. For illustration, the form for FPI-R - Release Matrix score - same species is illustrated below:

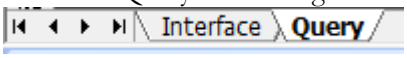


The scale value is calculated as a function of several inputs (For more information, see the Administrator's Guide below).

QUERYING THE DATABASE

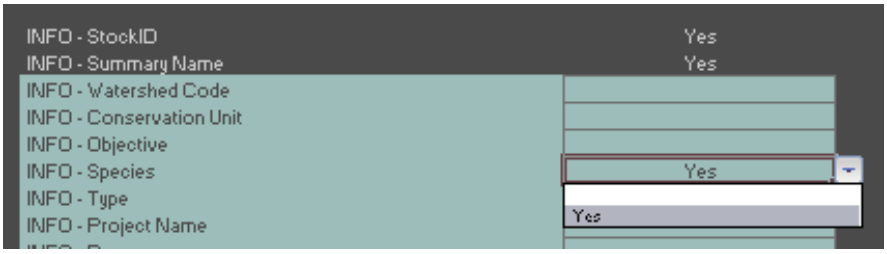
The Query sheet enables the user to compare database entries. Entries may be filtered, sorted and the results charted as desired.

Select the Query sheet using the tab near the bottom left of the screen:



The Query sheet comprises four steps, each of which are listed in Column E of that sheet:
1) Select Fields to Extract
2) Add Filter(s) (if required)
3) Specify Sort Criteria and Directions (if required)
4) Specify Data to Chart (if required)

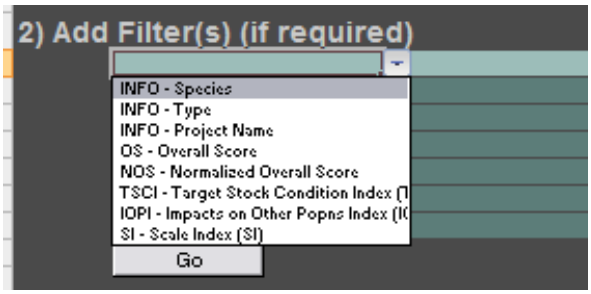
1) Select Fields to Extract
In this section, select the fields you wish to return from a query by selecting the word 'Yes' from the in-cell drop-down list In Column I. There is no maximum number of fields that can be returned, but two fields, 'INFO – StockID' and 'INFO - Summary Name' must always be returned in order for the results to be clearly assigned to a specific database entry.



To reveal the drop-down list, click on any non-grey cell in Column I under the text 'Include in Output table?'

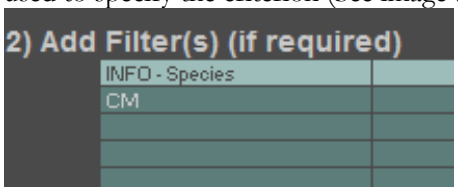
2) Add Filter(s) (if required)

A filtering system is offered that is an automated version of Excel's in-built Advanced Filter functioning. Filtering temporarily removes database entries that are not required for a particular query. For example, suppose you wish to specify that a query return values for only one particular kind of species:



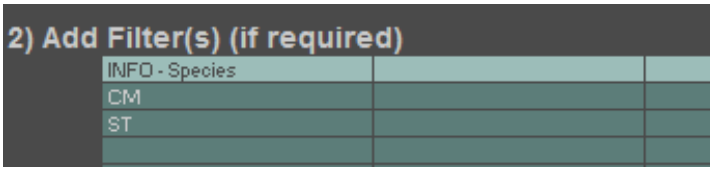
To add this filter, click in the first lighter-shaded box under the heading for 2) as shown in the image. An in-cell drop down box will reveal the options available to filter on. The options shown in this box are those selected previously in step 1) above.

Next, underneath this, enter the conditions you wish to see after filtering. For example, if you want to return only those records that refer to chum, enter CM in the box directly underneath the box you used to specify the criterion (See image below):

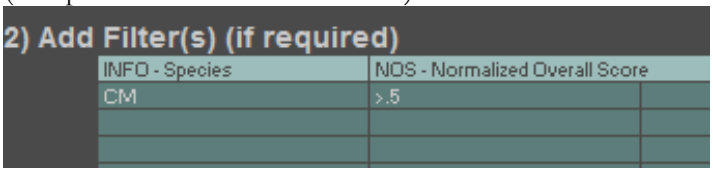


To test the query, click the 'Go' button.

Queries can consider multiple conditions. The operand 'OR' is achieved by placing the criteria values on separate ROWS. For example, the following image shows how we might return entries where species is chum OR steelhead:



The 'AND' operand is achieved by placing the criteria values in separate columns. The following returns only those chum entries that have a NOS – Normalized Overall Score of greater than 0.5. (i.e. Species = CM AND NOS>0.5).

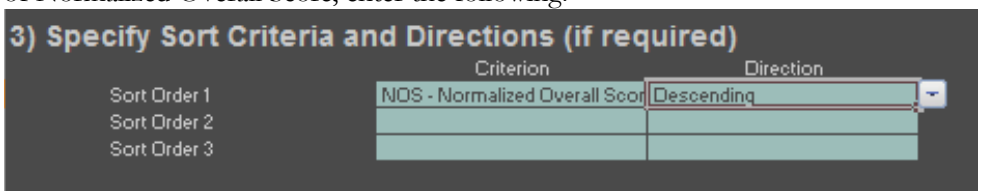


In this way, highly complex filtering criteria can be developed.

Note that filtering is optional. To remove unwanted filters from a previous query, highlight the cells you wish to clear, right click and select 'Clear Contents' from the shortcut menu.

For more information on building complex filtering expressions, see the 'Advanced Filter' entry in the Excel Help menu.

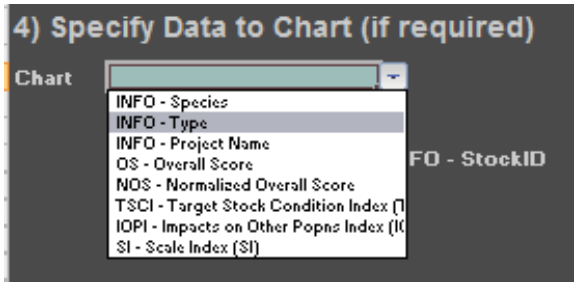
3) Specify Sort Criteria and Directions (if required)
The data returned from a query can be sorted on up to three fields, as shown below (the second criterion is used as a tie-breaker for the first, and so on). Specify both the criterion on which to sort, and the direction on which to sort. For example, to create a ranked list of entries in descending order of Normalized Overall Score, enter the following:



Sorting on a text-based field (e.g. species) will sort alphabetically.

4) Specify Data to Chart (if required)

Select a series to chart using the box provided under this heading. The tool can only chart fields that have numerical values. If you attempt to select data that cannot be charted, a reminder will pop up on screen.



Note that the chart that results is created automatically each time, and can be deleted if desired. If a large number of rows are returned, you may need to adjust the font size on the scales to be able to view every entry.

This section is intended for advanced users or administrators of the HRAT. If contains a description of the structure of the tool itself, plus specific instructions on how to perform tasks associated with the administration of the Tool.

UNLOCKING THE HRAT SPREADSHEET

To avoid unnecessary confusion for casual users, most of the sheets of the HRAT tool are locked and hidden by default. The locking can be toggled on and off using the following key combinations:

To unlock the tool, hold down [shift] and [ctrl] and press the down arrow.
To lock the tool, hold down [shift] and [ctrl] and press the down arrow.

HRAT will always reapply locking on opening, regardless of whether or not it was unlocked state when saved.

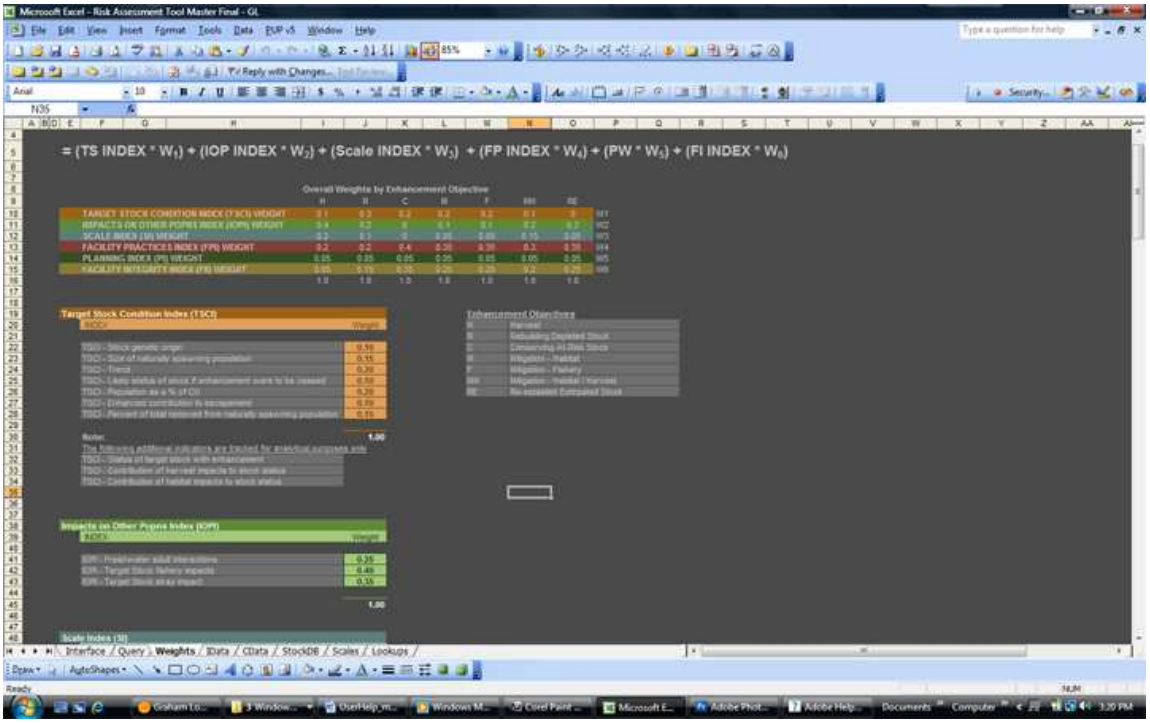
On unlocking the tool, several extra sheets become accessible. These are described below

OVERVIEW OF THE HRAT WORKBOOK FOR ADMINISTRATORS

In addition to Interface and Query described above, the other sheets that comprise the HRAT are as follows:

Weights

The **weights** sheet contains all the weights used in calculations. The sheet is mirrors the analytical hierarchical structure described in the Basic Analytical Structure section. An illustration of the sheet is shown below:

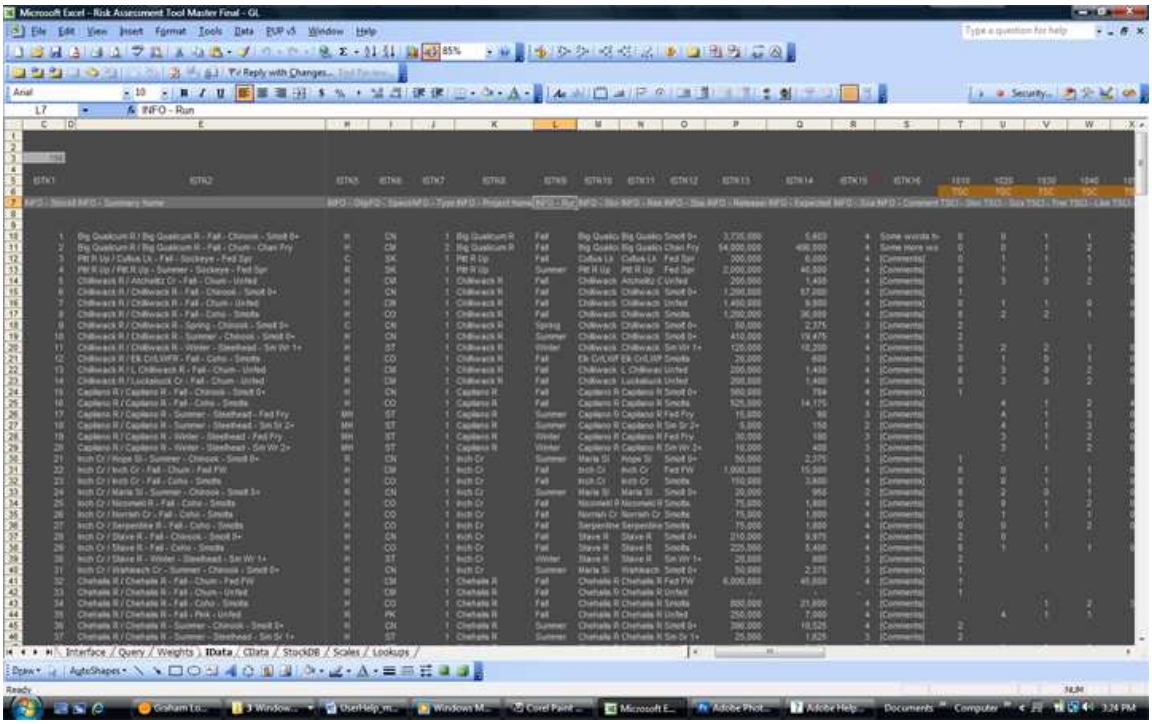


All the weights on this sheet can be amended directly by administrators. Ensure that weights sum to 1 in all cases. Note that this sheet is not exposed to casual users of the HRAT because the intent is to use standard weights determined by senior DFO managers rather than having multiple weighting schemes.

IData

The "I" in **IData** stands for 'Information In'. This sheet is simply a database of unprocessed values entered into the HRAT via the Interface. Most of the data entries on this sheet can be directly edited if required, but do not edit any of the structure of this sheet (e.g. do not delete rows/columns, insert rows columns etc). Doing so is highly likely to cause the tool to fail.

An illustration of the sheet is shown below:



Row 7 (highlighted in the illustration) contains the column titles for each data type. Each data type has a code shown in row 5 that is used by the workbook for lookup purposes. Do not edit any of these values.

Important: Take care not to enter a scale selection value outside the range used for a given criterion. For example, entering a scale selection value of '5' on a scale with only 4 options (as defined on the **Scale** sheet) will cause the HRAT to fail.

CData

The 'C' in **CData** is short for 'Calculation'. This sheet is (and must remain) the parallel of the **IData**. In this sheet, lookup formulas are used to combine data from four sources:

- Scale selection numbers from the **IData** sheet.
- Normalized scale values from the **Scales** sheet.
- Weights from the **Weights** sheet.
- Special lookups from the **Lookups** sheet.

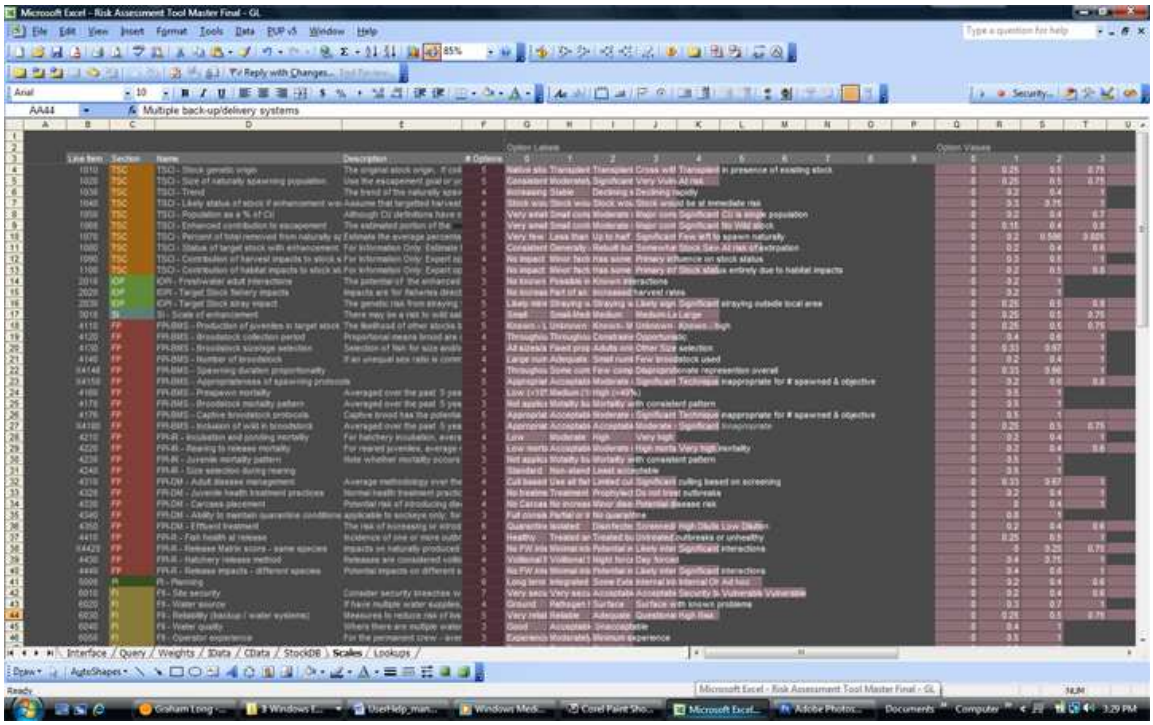
There should be no reason to make any changes in this sheet.

StockDB

This sheet was used initially to help load the database with data. It should serve no further function, but is left here in case the HRAT needs to again be populated from empty.

Scales

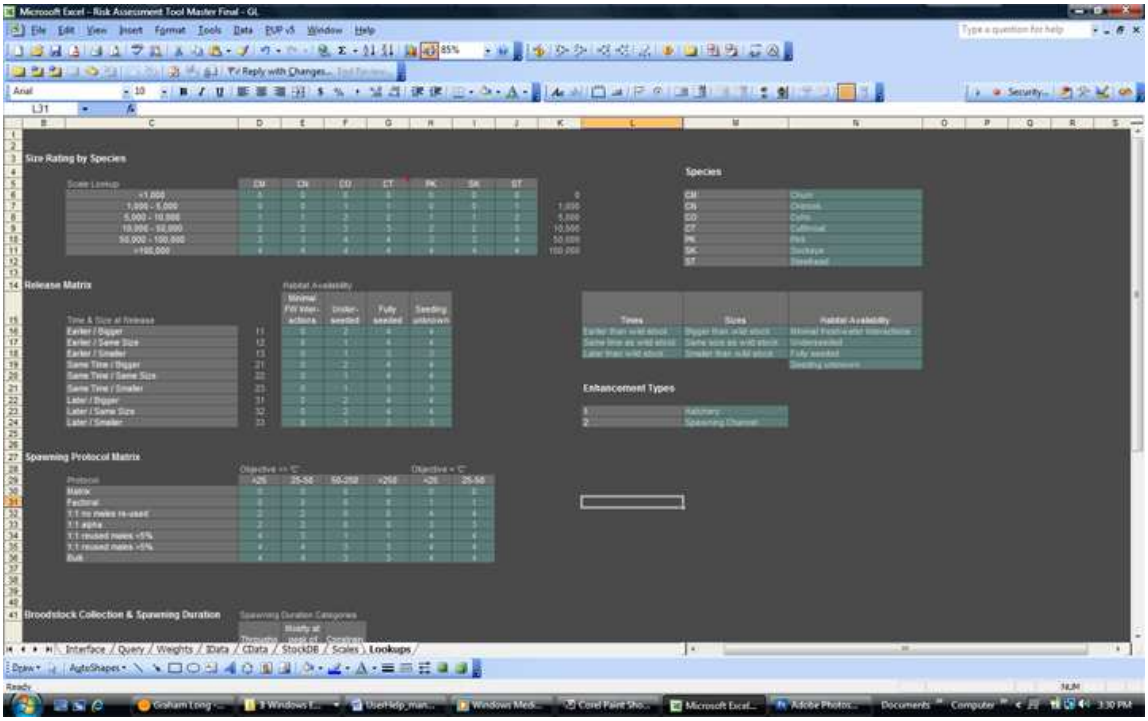
This sheet contains the definitions of the scales used by the Interface and elsewhere. As the illustration below shows, each scale has its own row and is organized according to the colour-coding used on the Interface sheet. Scale labels, values and descriptions can be edited in the purple cells to the right. More information on this is provided below.



Lookups

This sheet contains numerous 'lookup' tables used by various scales as described above. The table values my be edited directly, but do not change the sheet structurally.

An illustration of the sheet is shown below:



CHANGING THE DEFINITIONS OF CRITERIA AND SCALES

In the **Scales** sheet, find the row associated with the criterion you need to edit. To edit, follow the following sequence:

1: Enter the revised number of criterion values

The dark purple column (spreadsheet column 'F') contains the number of values in the scale – it is very important that this value be correct, since normalization calculations are based upon it. This value also drives the conditional formatting of the light purple cells to the right – e.g. entering a '5' in this column will cause the cells under the headings 0 to 4 turn light purple for each of 'Option Labels', 'Option Values' and 'Option Description' sections.

2: Change the text in the corresponding 'Option Labels', 'Option Values' and 'Option Description' sections.

3: Change the text in the Name and Description columns if required (column D and E). Note this information is displayed in the pop-up dialog boxes.

ADDING NON-LINEAR SCALING FUNCTIONS

Consider the following scale:

Scale No	0	1	2	3	4

Label	Label …	Label …	Label …	Label …	Label …
Scale Value (Linear)	0	0.25	0.5	0.75	1
Scale Value (Non-Linear)	0	0.5	0.75	0.95	1

In the linear case, a selection of scale value '2' is taken to be 'half as bad' as a selection of 4. This is unlikely to be true for most scales. It is possible, however, to enter non-linear values to better represent the case. In the illustration, the difference between the first two values is more significant than, say, the difference between the last two.

In the **Scales** sheet, scroll to the right to view the 'Option Values' section. Here are the 0-1 values that correspond to the scale selection values (i.e. the number of the option on a scale that was selected). Since higher numbers ALWAYS imply increased risk, the option values should always be bounded by 0 for first selection and 1 for the last. However, the rate of increase in the value across the range may be non-linear.

ALTERING THE WEIGHTING SCHEMES

Select the **Weights** sheet.

Any of the weight values can be edited directly. Please ensure that weights sum to 1 where appropriate.

ADDING AND REMOVING CRITERIA AND SCALES

While refining an existing scale is easy (see above), inserting or removing a scale is not a trivial issue. Please contact glong@compassrm.com for more information.

APPENDIX: CRITERIA REFERENCE

INFORMATION CRITERIA

These reference criteria are used to identify the stock-lifestage. Some are used in calculations (e.g. the stock-lifestage species is referred to when calculating the scale of operations).

STOCKID

A reference number of the stock-lifestage in the database

SUMMARY NAME

An identification shortcut for the basic unit of the database, the stock-lifestage. The summary name takes the form:

[Project Name] / [Stock Source] - [Run Name] - [Species] - [Lifestage]

e.g. Puntledge R / Puntledge R - Fall - Coho - Smolts

ENHANCEMENT OBJECTIVE

The enhancement management objective of the stock-lifestage.

Abbreviation	Description
H	Harvest
R	Rebuilding Depleted Stock
C	Conserving At-Risk Stock
M	Mitigation - Habitat
F	Mitigation - Fishery
MH	Mitigation - Habitat / Harvest
RE	Re-establish Extirpated Stock

SPECIES

The species of the stock-lifestage.

Abbreviation	Species
CM	Chum
CN	Chinook

CO	Coho
CT	Cutthroat
PK	Pink
SK	Sockeye
ST	Steelhead

TYPE

Refers to whether enhancement occurs at a hatchery (Code = 1) or in a spawning channel (Code = 2).

PROJECT NAME

The name of the enhancement project.

RUN

The run name of the stock-lifestage. Usually an indication of timing, e.g. "fall" or "spring".

STOCK NAME

The name of the source stock.

RELEASE SITE

The name of the release site.

STAGE

The lifestage under consideration.

RELEASES

[[DFO to please define]]

EXPECTED ADULTS

[[DFO to please define]]

SCALE GROUP

The scale group is a species dependent value that conveys the relative scale of operation for a particular stock. The following lookup table is used to select a scale number from 0 to 4.

No of fish [[adults?]]	CM	CN	CO	CT	PK	SK	ST
<1,000	0	0	0	0	0	0	0
1,000 - 5,000	0	0	1	1	0	0	1
5,000 - 10,000	1	1	2	2	1	1	2
10,000 - 50,000	2	2	3	3	2	2	3
50,000 - 100,000	3	3	4	4	3	3	4
>100,000	4	4	4	4	4	4	4

The scale number is characterized according to the following scale.

0	1	2	3	4
Small	Small-Medium	Medium	Medium-Large	Large

So for example, an enhancement project that produces 35,000 Coho is assigned a scale group of 3, which is considered "medium-large". When used in calculations, these 0 to 4 ratings are normalized across a range of 0 to 1.

COMMENTS

This criterion can be used by data managers to record any information about the record.

TARGET STOCK CONDITION INDEX (TSC)

The TSC is an index that is used to describe the relative state or condition of the stock being enhanced (as opposed to any stocks that may be indirectly affected by enhancement, which are captured in the Impacts on Other Populations Index (IOP). The TSC index is calculated as the weighted sums of the normalized values of the following:

- Stock genetic origin
- Size of naturally spawning population
- Trend
- Likely status of stock if enhancement were to be ceased
- Population as a % of CU
- Enhanced contribution to escapement
- Percent of total removed from naturally spawning population

In addition, three indicators are placed in this category that do not contribute to the calculation of TSC. These indicators do, however, pertain to the target stock, and can be used to query the database. The three additional indicators are:

- Status of target stock with enhancement
- Contribution of harvest impacts to stock status
- Contribution of habitat impacts to stock status

TSC - Stock genetic origin

The original stock origin. If collecting adults from previous transplants, the stock origin is still a transplant.

Scale Value	0	1	2	3	4
Label	Native stock	Transplant - new species or run timing	Transplant - native population extirpated	Cross with remnant native stock	Transplant in presence of existing stock
Description	Native stock	Native species with same run timing never present	Native species with same run timing extirpated	Cross with remnant native stock	Existing viable stock of native species/run timing

TSC - Size of naturally spawning population

Use the escapement goal or your best estimate as the carrying capacity. Compare the average escapement for the past 5 years to this goal.

Scale Value	0	1	2	3	4
Label	Consistently at or near capacity	Moderately below capacity	Significantly below capacity	Very Vulnerable	At risk
Description	Within 10% of carrying capacity	50 - 89% of carrying capacity	30-49% of carrying capacity	10-29% of carrying capacity	<10% of carrying capacity

TSC - Trend

The trend of the naturally spawning population over the past 5 years.

Scale Value	0	1	2	3
Label	Increasing	Stable	Declining slowly	Declining rapidly

Description	Overall long term - may have some dips	Over the long term	10% over 3 cycles	20% in 2 cycles

TSC - Likely status of stock if enhancement were to be ceased

Assume that targeted harvest levels would be adjusted to reflect discontinuing enhanced production.

Scale Value	0	1	2	3
Label	Stock would remain stable	Stock would decline slowly	Stock would decline quickly	Stock would be at immediate risk
Description	Stock would stabilize at adequate levels	Slow decline over >3 cycles	Likely at risk in <3 cycles	Immediate risk of extirpation

TSC - Population as a % of CU

Although CU definitions have not been finalized, make an estimate based on your current knowledge of the CU. Each sockeye lake generally constitutes its own CU.

Scale Value	0	1	2	3	4	5
Label	Very small (<10%)	Small component (10 -29%)	Moderate component (30 - 49%)	Major component (50 - 74 %)	Significant part of CU (75 - 99%)	CU is single population
Description	<10% of CU	10-29% of CU	30-49% of CU	50-74% of CU	75-99% of CU	100% of CU (Single population CU)

TSC - Enhanced contribution to escapement

The estimated portion of the naturally spawning population which is comprised of enhanced returns (average last 5 years). May be from marking studies or estimated based on level of enhancement effort.

Scale Value	0	1	2	3	4	5
Label	Very small (<10%)	Small contribution (10 -29%)	Moderate contribution (30 - 49%)	Major contribution (50-74 %)	Significant contribution (75 - 99%)	No Wild stock
Description	<10% enhanced	10-29% enhanced	30-49% enhanced	50-74% enhanced	75-99% enhanced	100% enhanced

TSC - Percent of total removed from naturally spawning population

Estimate the average percentage of the population removed for broodstock which would otherwise have spawned naturally in the river. Do not include swim-ins.

Scale Value	0	1	2	3	4
Label	Very few	Less than 1/3	Up to half	Significant removals	Few left to spawn naturally
Description	<10%	10-30%	30-50%	50-80%	>80%

TSC - Status of target stock with enhancement

For Information Only: Estimate the status of population based on your expert opinion.

Scale Value	0	1	2	3	4	5
Label	Consistently reaching goals	Generally achieving goals	Rebuilt but vulnerable	Somewhat depleted	Stock Severely Depressed	At risk of extirpation
Description	Consistently achieving esc target or other goal	Generally achieving esc target or other goal	Vulnerable to habitat events or fishing pressure	Below historic population size	Recovery planning process in place	Identified At Risk of Extirpation

TSC - Contribution of harvest impacts to stock status

For Information Only: Expert opinion on the importance of harvest impacts to stock status

Scale Value	0	1	2	3
Label	No impact	Minor factor	Has some influence	Primary influence on stock status
Description	No harvest impacts	Minor impact of harvest issues on status	Harvest impacts have some influence on stock status	Harvest impacts are the primary influence on the stock

TSC - Contribution of habitat impacts to stock status

For Information Only: Expert opinion on the importance of habitat impacts to stock status

Scale Value	0	1	2	3	4
Label	No impact	Minor factor	Has some influence	Primary influence on stock status	Stock status entirely due to habitat impacts
Description	No habitat impacts	Minor impact of habitat issues on status	Habitat impacts have some influence on stock status	Habitat impacts are the primary influence on the stock	Stock status entirely due to habitat impacts

IMPACTS ON OTHER POPNS INDEX (IOP)

The more stray impacts (to other wild salmon stocks) are caused by enhancement of the target stock, the greater this value. Stocks enhanced for harvesting typically score highly in this category.

IOP - Freshwater adult interactions

The potential of the enhanced population to affect other run timings or species (including freshwater or resident) by competing for spawning area or super-imposition of spawning. Do not consider competition between enhanced & natural spawners within the same stock.

Scale Value	0	1	2
Label	No known interactions	Possible interactions	Known interactions
Description	No known interactions	Other stocks likely use same spawning areas	Other stocks known to use same spawning areas

IOP - Target Stock fishery impacts

Impacts are for fisheries directed at enhanced stock, not incidental catch in other fisheries. Ranked only where enhancement objective is to provide harvest. Score this as 0 for objectives other than harvest

Scale Value	0	1	2
Label	No increase in harvest rates	Part of an aggregate	Increased harvest rates
Description	Harvest rates not affected by enhancement	Increased overall abundance affects harvest rate	Response to increased abundance of TS

IOP - Target Stock stray impact

The genetic risk from straying from the enhanced (i.e target) to other populations. Enhanced salmon may stray at the same rate as wild fish but the number of strays, and therefore the impact, may be greater if the enhanced is much larger than the natural population.

Scale Value	0	1	2	3	4
Label	Likely minimal straying	Straying within stock aggregate	Straying within local area	Likely significant straying within local area	Significant straying outside local area
Description	Minimal contribution to other stocks	Contributes to stock aggregate	Moderate contribution to stocks within local area	Significant contribution to stocks within local area	Significant contribution outside local area

SCALE INDEX (SI)

The scale of enhancement. There may be a risk to wild salmon simply because of the scale of enhanced production. This criterion is under review as risks from size may be captured under other critieria.

Scale Value	0	1	2	3	4	5
Label	Small	Small-Medium	Medium	Medium-Large	Large	Very Large
Description	(Species - specific lookup)	(Species - specific lookup)	(Species - specific lookup)	(Species - specific lookup)	(Species - specific lookup)	(Species - specific lookup)

FACILITY PRACTICES INDEX (FP)

This concerns the state of practices at the hatchery.

FP - Broodstock Mgmt & Spawning - Genetic Risk (FP - BMS)

This is an index of several sub-factors:

FP - BMS - Production of juveniles in target stock from strays
The likelihood of other stocks being included in broodstock, may be increased by the collection method or location. Known rates are where it is possible to identify and exclude strays (eg. by marks) or isolate eggs from suspected strays and destroy if confirmed by genetic testing.

Scale Value	0	1	2	3	4
Label	Known - Low	Unknown -	Known-	Unknown -	Known - high

	level	likely low	Moderate	likely moderate to high	
Description	< 2% of production	< 2% of production	2-5% of production	likely >2% based on collection location eg. Estuary	>5% known strays included

FP - BMS - Broodstock collection period
Proportional means brood are collected throughout the run either by collecting a portion of the fish as they arrive or by setting targets for run component. Disproportional means that some timing segments are disproportionately represented (eg. front end loaded).

Scale Value	0	1	2	3
Label	Throughout period proportional	Throughout period disproportional	Constrained at peak	Opportunistic
Description	Throughout period proportional	Some components disproportionately represented	Collected during peak period only	Collected over a few days

FP - BMS - Broodstock size/age selection
Selection of fish for size and/or age to be used for broodstock. If no jacks are present (eg. chum) then consider if other selectivity is occuring.

Scale Value	0	1	2	3
Label	All sizes/ages proportional to presence	Fixed proportions	Adults only; No Jacks	Other Size selection
Description	All sizes/ages proportional to presence	Fixed proportions. Eg. 10% jacks	Adults only; Jacks excluded although present	Other size selection (eg. largest fish)

FP - BMS - Number of broodstock
If an unequal sex ratio is common, use the number from the least abundant sex.

Scale Value	0	1	2	3
Label	Large numbers used for brood	Adequate numbers used for brood	Small numbers used	Few broodstock used
Description	>250 pairs	50-250 pairs	25-50 pairs	<25 pairs

FP - BMS - Appropriateness of spawning protocols
Evaluating the appropriateness of spawning protocols is complex because 'apprpriateness' depends on a number of independent factors. In this tool, 'appropriateness' is characterized through the use the following scales in a lookup table.

Protocol Used

Label	Description
Matrix	[[DFO please define]]
Factoral	[[DFO please define]]
1:1 no males re-used	[[DFO please define]]
1:1 alpha	[[DFO please define]]
1:1 reused males <5%	[[DFO please define]]
1:1 reused males >5%	[[DFO please define]]
Bulk	[[DFO please define]]

Number of Broodstock pairs (See above)
Enhancement Objective (See above)

These three factors are combined in the following lookup table:

Enhancement Objective	Objective <> 'C'				Objective = 'C'	
No of Broodstock Pairs	<25	25-50	50-250	>250	<25	25-50
Matrix	0	0	0	0	0	0
Factoral	0	0	0	0	1	1
1:1 no males re-used	2	2	0	0	4	4
1:1 alpha	2	2	0	0	3	3
1:1 reused males <5%	4	3	1	1	4	4
1:1 reused males >5%	4	4	3	3	4	4
Bulk	4	4	3	3	4	4

The value obtained from this table is then taken to correspond to this scale:

0	1	2	3	4
Appropriate for # spawned & objective	Acceptable for # spawned & objective	Moderate concerns with technique	Significant concerns with technique	Technique inappropriate for # spawned & objective

FP - BMS - Prespawn mortality
Averaged over the past 5 years.

Scale Value	0	1	2
Label	Low (<10%)	Medium (10 - 40%)	High (>40%)

Description	<10%	10-40%	>40%

FP - BMS - Broodstock mortality pattern
Averaged over the past 5 years.

Scale Value	0	1	2
Label	Not applicable - low mortality	Motality but no pattern	Mortality with consistent pattern
Description	Low Mortality	Mortality but no pattern	Mortality with consistent pattern

FP - BMS - Inclusion of wild in broodstock
This criterion has a value that is calculated in a reference lookup table. There are three lookup dimensions:

The Enhancement Objective
(See above)

Composition of Broodstock
Averaged over the past 5 years.

Label	Description
Predominantly Wild (90%+)	[[Add description]]
Mainly Wild (50-90%)	[[Add description]]
More Hatchery (30-50% wild)	[[Add description]]
Predominantly Hatchery (<30% wild)	[[Add description]]
No wild included	[[Add description]]

Number of Broodstock Pairs
(See above)

	Hatchery Objective = C	Hatchery Objective = H AND Less than 50 Broodstock pairs spawned	Hatchery Objective = H AND more than 50 pairs are spawned OR Hatchery Objective =RE or = MH	Hatchery Objective =R or =MF
Predominantly Wild (90%+)	0	0	0	0
Mainly Wild (50-90%)	1	0	0	0
More Hatchery	2	2	0	2

(30-50% wild)				
Predominantly Hatchery (<30% wild)	3	3	1	3
No wild included	4	4	2	4

The value obtained from this table is then applied to the following scale to obtain a scale value and description.

Scale Value	0	1	2	3	4
Label	Appropriate for objective	Acceptable for objective	Acceptable in certain circumstances	Moderate concerns	Significant concerns
Description	Predominantly Wild (90%+)	Mainly Wild (50-90%)	More Hatchery (30-50% wild)	Predominantly Hatchery (<30% wild)	No wild included

For example, a hatchery stock with a Harvest management objective, using less than 50 broodstock pairs and less than 30% wild broodstock would, from the lookup table, score a 3, meaning that there would be 'moderate concerns'.

FP - Incubation and Rearing (FP - IR)

Introduction

FP - IR -Incubation and ponding mortality
For hatchery incubation, average mortality from adjusted green eggs to just before first feeding; For Spawning Channels, calculate average mortality from deposition to swim-up.

Scale Value	0	1	2	3
Label	Low	Moderate	High	Very high
Description	<10% Hatchery or <20% Spawning Channel	10-30% Hatchery or 20-40% Spawning Channel	30-50% Hatchery or 40-60% Spawning Channel	>50% Hatchery or >60% Spawning Channel

FP - IR -Rearing to release mortality
For reared juveniles, average mortality from first feeding to release. Enter 0 if released unfed.

Scale Value	0	1	2	3	4
Label	Low mortality or released unfed	Acceptable mortality	Moderate mortality	High mortality	Very high mortality
Description	<1%Cm/Pk, 1.8%Cn, 8%yr	<2%Cm/Pk, 3.6%Cn,	<5%Cm/Pk, 9%Cn, 20%yr	<10%Cm/Pk, 18%Cn, 24%yr	Mortality higher

	(<0.02%/day)	16%yr(<0.04%/d)	(0.1% sub, 0.05% yr)	(0.2%sub, 0.06%yr)	

FP - IR -Juvenile mortality pattern
Note whether mortality occurs at different times each year or whether mortality peaks at the same time every year.

Scale Value	0	1	2
Label	Not applicable - low mortality	Mortality but no pattern	Mortality with consistent pattern
Description	Low Mortality	Mortality but no pattern	Mortality with consistent pattern

FP - IR -Size selection during rearing

Scale Value	0	1	2
Label	Standard	Non-standard	Least acceptable
Description	No culling or sorting	Sorted by size group for rearing	Small fish culled

FP - Disease Management (FP - DM)
Average methodology over the past 5 years. Prophylactic treatment allows use of all adults for broodstock.

Scale Value	0	1	2	3
Label	Cull based on external factors	Use all fish	Limited culling based on screening	Significant culling based on screening
Description	Cull moribund or obviously sick broodstock	All fish used including prophylactic treated	<10% destroyed	>10% destroyed

FP - DM - Juvenile health treatment practices
Normal health treatment practices followed over the past 5 years.

Scale Value	0	1	2	3
Label	No treatment required	Treatment As Required	Prophylactic Treatment	Do not treat outbreaks
Description	No disease outbreaks	Disease outbreaks which are treated	Prophylactic treatment for known pathogens	Disease outbreaks which are untreated

FP - DM - Carcass placement
Potential risk of introducing diseases into the natural population from carcasses.

Scale Value	0	1	2	3
Label	No Carcass Placement	No increased disease risk	Minor disease risk	Potential disease risk
Description	No carcass placement (compost, surplus)	Placed in natal stream only	Placed within zone of influence	Placed outside zone of influence

FP - DM - Ability to maintain quarantine conditions
Applicable to sockeye only; for all other species enter 0; the risk of introducing or increasing IHN in the natural population

Scale Value	0	1	2
Label	Full consistent quarantine	Partial or Inconsistent quarantine	No quarantine
Description	Isolation & Treated Effluent	Isolation without quarantine or vice versa	No Quarantine

FP - DM - Effluent treatment
The risk of increasing or introducing diseases from the hatchery into the water through hatchery wastes.

Scale Value	0	1	2	3	4	5
Label	Quarantine	Isolated	Disinfected	Screened/Settled	High Dilution	Low Dilution
Description	Disinfected & goes to ground	Goes to ground without disinfection	Disinfected before going to natural waters	Settled/screened & waste to retention area	Untreated high dilution	Untreated low dilution

FP - Release (FP - R)

FP - R - Fish health at release
Incidence of one or more outbreaks per year over the past 5 years.

Scale Value	0	1	2	3
Label	Healthy	Treated and verified healthy	Treated but uncertain health	Untreated outbreaks or unhealthy

Description	No outbreaks of significant diseases	Treated outbreaks & verified healthy	Treated outbreaks but health uncertain at release	Untreated outbreaks or fish unhealthy at release

FP - R - Release Matrix score - same species
Impacts on naturally produced juveniles of the same species through displacement or competition, considering size and time of release and habitat availability. This criterion is the function of a lookup table that considers three things:

Time of Release Relative to the Wild Stock

Label	Description
Earlier than wild stock	
Same time as wild stock	
Later than wild stock	

Size at Release Relative to the Wild Stock

Label	Description
Bigger than wild stock	
Same size as wild stock	
Smaller than wild stock	

Habitat Availability

Label	Description
Minimal freshwater Inter-actions	
Underseeded	
Fully seeded	
Seeding unknown	

The reference lookup table table used to combine these factors is shown below.

	Minimal FW Inter-actions	Under-seeded	Fully seeded	Seeding unknown
Earlier / Bigger	0	2	4	4
Earlier / Same Size	0	1	4	4
Earlier / Smaller	0	1	3	3
Same Time / Bigger	0	2	4	4
Same Time / Same Size	0	1	4	4
Same Time / Smaller	0	1	3	3
Later / Bigger	0	2	4	4
Later / Same Size	0	2	4	4
Later / Smaller	0	1	3	3

Finally, the value from the lookup table is characterized according to the following scale:

Scale Value	0	1	2	3	4
Label	No FW interactions	Minimal interactions	Potential interactions	Likely interactions	Significant interactions
Description	Immediate migrants with minimal FW interactions	Underseeded	Underseeded but potential interactions	Habitat fully or unknown utilized but smaller	Habitat fully or unknown utilized and same size or larger

For example, a stock release that is smaller than its wild equivalent, released earlier than its wild equivalent and which is underseeded would score a 1 on the lookup table, suggesting that 'minimal interactions' should be expected.

FP - R - Hatchery release method
Releases are considered volitional if there is some time for volitional out-migration, even if followed by forced release of some remaining rearing component.

Scale Value	0	1	2	3
Label	Volitional Extended	Volitional Short	Night forced	Day forced
Description	Opportunity to migrate over more than 1 week	Opportunity to migrate less than 1 week	Night - Transported and released or forced from pond	Day - Transported and released or forced from pond

FP - R - Release impacts - different species
Potential impacts on different species or runs considering habitats utilized, habitat availablility and size of enhanced juveniles relative to other species

Scale Value	0	1	2	3	4
Label	No FW interactions	Minimal interactions	Potential interactions	Likely interactions	Significant interactions
Description	Immediate migrants with minimal FW interactions	Underseeded and/or different habitats	Likely less able to out-compete natural fry	Likely competition with other species	Hatchery fish likely to out-compete

PLANNING INDEX (PI)

All else being equal, the more attention paid to enhancement planning, the lower the presumed risk to wild salmon.

Scale Value	0	1	2	3	4	5
Label	Long term formal strategic plan	Integrated annual plan	Some External Involvement	Internal Integrated	Internal OHEB	Ad hoc

Description	Multi-year: broad internal & external participation	1 Yr Plan: broad internal & external participation	Incl in IFMP or other external involvement	Developed between OHEB and other DFO branches	Involves Hatchery, CA, Support Bios, RHQ	Involves local staff only

FACILITY INTEGRITY (FI) INDEX

Facilities that are physically vulnerable to uncontrollable environmental impacts or malicious damage pose greater risk to wild salmon than those that are not. For example, facilities with multiple back-up systems, no requirement for water pumping, highly trained operators and secure fences etc are less prone to accidents that may affect wild salmon than others.

FI - Site security

Consider security breaches within the past 5 years.

Scale Value	0	1	2	3	4	5	6
Label	Very secure	Very secure but historical breaches	Acceptable security	Acceptable security but historical breaches	Security based on limited access	Vulnerable periods	Vulnerable
Description	24 hour on-site, no security breaches	24-hour on-site but past security breaches	Call-out, no security breaches	Call-out, but history of security breaches	Fenced or limited access when not staffed	Mainly secure but vulnerable times (eg. seapen)	Not fenced and staffed during working hours only

FI - Water source

If have multiple water supplies, evaluate for the water source of greatest concern for potential disease risks. Consider all water sources used anywhere, at any time during enhancement activities.

Scale Value	0	1	2	3
Label	Ground	Pathogen Free Surface	Surface	Surface with known problems
Description	Ground	Pathogen Free Surface	Surface with no history of problems	Surface with known problems

FI - Reliability (backup / water systems)

Measures to reduce risk of losing hatchery water supply at any point during the cycle.

Scale Value	0	1	2	3	4
Label	Very reliable	Reliable	Adequate	Questionable	High Risk
Description	Multiple back-up/delivery systems	Gravity fed system & multiple/alternative sources	Single back-up & water delivery system	Gravity fed from single source only	No back-up & pumped water

FI - Water quality

Where there are multiple water supplies, evaluate for the water source of greatest concern. Consider all water sources used anywhere during enhancement activities.

Scale Value	0	1	2
Label	Good	Acceptable	Unacceptable
Description	Consistently within acceptable criteria	Usually within acceptable criteria	Frequent issues

FI - Operator experience

For the permanent crew - average years/individual of experience.

Scale Value	0	1	2
Label	Experienced	Moderately experienced	Minimum experience
Description	> 10 years	5-10 years	<5 years

FI - Biological, scientific and engineering support

Introduction.

Scale Value	0	1	2
Label	Frequent	Reactive	Sporadic
Description	Good communication, problem solving as required	Only when issues (fire fighting)	Infrequent contact; some problems not passed on