# SRKW\_Inputs.xlsx File:

This is the file used to supply static input data to the SRKW\_Analysis.R program. It contains 5 tabs (shaded red) that get read as tables into the program:

1. **R\_In\_RunID** – this table tells the R program which FRAM model runs to process from the supplied database. The time series provided in this table (currently 1992 to 2014) will determine the years processed by the R program. Before running the program, ensure that the RunIDs in this table correctly reflect the specific run year and run type (‘Likely’ or ‘No Action’).
2. **R\_In\_kCal-Age** – this table provides the mean fork length (‘MeanFL’), kilocalories per fish (‘kCal’), and kilocalories per fish given a specified size selectivity of SRKW feeding (‘kCal\_Selectivity’) for each stock-age-time step combination. Mean fork length is based on updated Von Bertalanffy growth parameters from the recently updated Chinook FRAM base period, which no longer differ for immature vs. mature fish (Growth Functions Doc). Length-to-kilocalorie conversions are based on O’Neill et al. 2014. Selectivity is currently set to 1.
3. **R\_In\_FishFlag** – this table designates fisheries as either outside Puget Sound (flag = 0), pre-terminal Puget Sound (flag = 1), or terminal Puget Sound (flag = 2). It also contains a ‘Weight’ field, which allows mortalities in a given fishery to be discounted (or excluded) based on the location of the fishery and prior knowledge of SRKW spatial distribution.
4. **R\_In\_Needs** – this table contains SRKW needs information provided by the NWFSC.
5. **R\_In\_Distribution** – this table provides information on the spatial distribution of each stock in the format of the proportion of the total abundance of each stock that occur outside of the SRKW range (‘ppnOutside’), in the Coastal range (‘ppnCoastal’), and in the inland Salish Sea waters (‘ppnInland’). Values were calculated based on the average distribution of fishery catch and escapement for each stock across old FRAM base period years, under the assumption that the catch of a stock across fisheries represents the distribution of that stock because fishing effort in these years was relatively broad and well distributed spatially and temporally. For fishery catch, each fishery was designated as outside, coastal, or inland based on its location. Stock-specific escapements were designated as outside, coastal, or inland based on the location of the stock’s watershed of origin.

# Outputs from SRKW\_Analysis.R File:

1. **SummaryAge3to5Chinook\_Coastal.csv** – this file provides the estimated annual abundance of age 3 through 5 Chinook in the coastal region of SRKW distribution (SUS, WCVI, CBC; based on stock specific catch distributions from previous FRAM base period, see ‘R\_In\_Distribution’ above) by time period and run type (with or without “action” fisheries). When ‘AbundType’ variable in R code is set to 0, these abundance estimates include natural mortality (i.e., cohort size after natural mortality and fishing plus natural mortality).
2. **SummaryAge3to5Chinook\_Inland.csv** – this file provides the estimated annual abundance of age 3 through 5 Chinook in the inland region of SRKW distribution (Salish Sea) by time period and run type (with or without “action” fisheries). For the run with action fisheries “turned on,” the field titled ‘…\_AfterTerm\_T3’ also has fishery mortalities from Puget Sound terminal fisheries (fisheries flagged with “2” in ‘R\_In\_FishFlag’ above; i.e., 7BCD Net, Skagit Net, StSn Net, 8D Spt & Net, 10/11 Net, 10A Spt & Net, 10E Spt & Net, SPS Net @ 28%) removed from the estimated abundance. When ‘AbundType’ variable in R code is set to 0, these abundance estimates include natural mortality.
3. **SummaryKilos\_Coastal.csv** – this file provides the estimated annual number of kilocalories of age 3 through 5 Chinook available to SRKWs in the coastal region of their distribution (SUS, WCVI, CBC) by time period and run type (with or without “action” fisheries). When ‘AbundType’ variable in R code is set to 0, these kilocalorie estimates include natural mortality.
4. **SummaryKilos\_Inland.csv** – this file provides the estimated annual number of kilocalories of age 3 through 5 Chinook available to SRKWs in the inland region of their distribution (Salish Sea) by time period and run type (with or without “action” fisheries). For the run with action fisheries “turned on,” the field titled ‘…\_AfterTerm\_T3’ also has fishery mortalities from Puget Sound terminal fisheries (fisheries flagged with “2” in ‘R\_In\_FishFlag’ above) removed from the estimated kilocalories. When ‘AbundType’ variable in R code is set to 0, these kilocalorie estimates include natural mortality.
5. **SummaryNeeds\_Coastal.csv** – this file presents the ratio of kilocalorie availability to kilocalorie needs by time period and year for four different needs scenarios and each run type (with or without “action” fisheries) in the coastal region of SRKW distribution.
6. **SummaryNeeds\_Inland.csv** – this file presents the ratio of kilocalorie availability to kilocalorie needs by time period and year for four different needs scenarios and each run type (with or without “action” fisheries) in the inland region of SRKW distribution. **Currently terminal fisheries are not removed in time step three…**
7. **SummaryFisheryRedux\_Inland.csv** – this file presents the proportional reduction in estimated available kilocalories by year and time period between the set of runs with action fisheries turned on and the set of fisheries with action fisheries turned off.
8. **AbundanceCharts\_Coastal.jpg** – this figure displays the difference in coastal abundance of Age 3-5 Chinook by run type (with or without “action” fisheries) for each year and time period.
9. **AbundanceCharts\_Inland.jpg** – this figure displays the difference in inland abundance of Age 3-5 Chinook by run type (with or without “action” fisheries) for each year and time period.
10. **KilocalorieCharts\_Coastal.jpg** – this figure displays the difference in coastal kilocalories by run type (with or without “action” fisheries) for each year and time period.
11. **KilocalorieCharts\_Inland.jpg** – this figure displays the difference in inland kilocalories by run type (with or without “action” fisheries) for each year and time period.

# SRKW\_Analysis.R File:

This is the R program to process a set of FRAM model runs and assess the amount of Chinook prey (in terms of both abundance and kilocalories) available to SRKWs in both coastal and inland Salish Sea waters. To run properly, there are four paths that must be updated at the beginning of the script:

* Path 1 – this identifies the location of the SRKW\_Inputs.xlsx file
* Path 2 – this identifies the location of the FRAM database that contains the model runs with “action” fisheries turned on and the RunIDs specified in column B of the above R\_In\_RunIDs tab
* Path 3 – this identifies the location of the FRAM database that contains the model runs with “action” fisheries turned off and the RunIDs specified in column B of the above R\_In\_RunIDs tab
* Path 4 – this identifies the directory where output tables and figures will be saved

Also be sure to correctly set the ‘RoundFlag’ and ‘AbundType’ variables in the R code. RoundFlag should be set to 0, which disables any rounding and processes the data as-is. AbundType identifies whether or not natural mortality is included in abundance and kilocalorie estimates (0 = Yes, 1 = No).

Below is a description of the general flow that the program follows:

1. Begin by reading in the above tables from the SRKW\_Inputs.xlsx file.
2. Query FRAM databases and pull all records from ‘Cohort’ and ‘Mortality’ tables.
3. Some pre-processing of the cohort and mortality data to:
   1. Exclude time step 4 from analysis.
   2. Calculate total mortality by stock, age, fishery, time-step.
   3. Convert from 78 stock to 39 stock format (combine marked and unmarked components of each stock).

Begin loop through each year (beginning with earliest)…

Begin loop through each run type (‘Likely’ and ‘No Action’)…

1. Filter cohort and mortality data to correct Run ID (year and run type).
2. Determine proportion coastal and proportion inland for each stock (from ‘R\_In\_Distribution’ table) and use to calculate the abundance in each region for each stock-age-time step combination. Cohort abundances used are those after natural mortality and pre-terminal fishery mortalities have been removed.
   1. cohort$InlandAbundance <- cohort$MidCohort.sum \* cohort$ppnInland
   2. cohort$CoastalAbundance <- cohort$MidCohort.sum \* cohort$ppnCoastal
3. Determine kCal/fish for each stock-age-time step combination (from ‘R\_In\_kCal-Age’) and use to convert above abundances to available kCals.
   1. cohort$InlandkCal <- cohort$InlandAbundance \* cohort$kCal\_Selectivity
   2. cohort$CoastalkCal <- cohort$CoastalAbundance \* cohort$kCal\_Selectivity
4. Sum abundances and kCals by time step and age (over all stocks). Append to a summary file that houses data from all years and run types.
5. Sum age 3-5 inland kCals by time step then divide by min and max PER to generate data for kCal-to-Needs table. Append to a summary file that houses data from all years and run types.

If run being processed is a ‘Likely’ run…

1. Summarize mortalities due to Puget Sound terminal fisheries (b/c they have not yet been removed from the above cohort sizes)
   1. Filter mortality data (already filtered to specific RunID) to only fisheries with FishFlag=2 (terminal).
   2. For each record multiply total mortality by the weight value for that fishery from the ‘FishFlag’ table.
   3. Determine kCal/fish for each stock-age-time step combination (from ‘R\_In\_kCal-Age’) and use to convert above mortalities to kCals.
   4. Sum mortalities and kCals by age for time step 3 (over all stocks and fisheries). Append to a summary file that houses data from all years.

End If

End run type loop

End year loop

1. Summarize and reformat data from (7) above to create summary table of Age 3-5 coastal abundances by year and time step for the ‘Likely’ and ‘No Action’ runs.
2. Summarize and reformat data from (7) above to create summary table of Age 3-5 coastal kCals by year and time step for the ‘Likely’ and ‘No Action’ runs.
3. Summarize and reformat data from (7) above to create summary table of Age 3-5 inland abundances by year and time step for the ‘Likely’ and ‘No Action’ runs.
4. Summarize and reformat data from (7) above to create summary table of Age 3-5 inland kCals by year and time step for the ‘Likely’ and ‘No Action’ runs.
5. Summarize mortality and kCal data from (9)d above and subtract from the ‘Likely’ abundances and available kCals for time step 3 from (12) and (13) above to produce ‘Likely’ time step 3 abundance and kCal estimates after both pre-terminal and terminal fisheries. Add column to tables from (12) and (13).
6. Summarize and reformat data from (8) above to create a summary table of available kCal to Needs ratios.
7. Use data from (13) above to calculate percent reduction to available kCals by year and time step between ‘Likely’ and ‘No Action’ runs.
8. Export tables from (10), (11), (12), (13), (15), and (16) above.
9. Generate coastal and inland figures for age 3-5 abundance and kCals.

# Outstanding:

* Get approval on distribution methods
  + Potentially violating the assumption previously used for the old BP of “when fisheries were broadly distributed across time and area”
  + Check ‘FisheryRegion’ and ‘StockRegion’ designations
* Assign energy tiers to each model stock
* Determine appropriate weights, if any, for terminal fishery mortalities
* Get updated estimates of SRKW needs

# References

McHugh P, Johnson G, Schaffler J. 2015. Chinook FRAM Base Period Documentation: Growth Functions.

O’Neill SM, Ylitalo GM, West JE. 2014. Energy Content of Pacific salmon as prey of northern and southern resident killer whales. Endang Species Res 25:265-281