Slide 1

Evaluation of
Fraser sockeye timing estimates

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Slide 2

Timing estimates

- Timing = migration date = 50% date

- A20 timing estimate refers to the date half (50%) of the run would have passed the Area 20 test fishing location in Juan de Fuca Strait, assuming all the salmon migrate via that route.

- In-season, timing estimates are obtained as output from the run size assessment models or run reconstructions.

- Pre-season in April, timing estimates are based on historical data (median, cycle line average, days offset).

- Pre-season in June, additional timing forecasts are produced by DFO using environmental data (current velocity and sea surface temperature).

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Slide 3

Multitude of different methods to estimate timing: which one to use?

- Retrospective analyses: use historical data to evaluate how accurate and precise our timing estimates would have been if we had been using a particular method in the past.

- The panel has been presented with retrospective analyses regarding migration timing in the past:
  - FRP meeting, May 2016, item 3e (CSAS Document)
  - FRP meeting, February 2018, item 4 (SharePoint, SP link)
  - FRP meeting, April 2018, item 7 (SP link)

- Results are useful but apply only to the models included.

- Need for an retrospective evaluation tool that can easily be updated with additional models and years of data.

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Slide 4

Introducing:
Retro Evaluation Framework (REF)

- New retrospective analysis framework with a large set of predesigned features:
  - Different graphs: histogram, scatterplot, boxplots
  - Different statistical tests to assess time series trends and differences between cycles and grouping of cycles
  - Retrospective analysis across all years, with the possibility to assess different strategies across cycle lines or different offset strategies
  - Retrospective analysis on individual cycle lines and offsets

- Easily adjustable to accommodate additional stock groups and/or additional years.

- Provides a neutral (referee) point of view on which model to use in case of conflicting predictions.

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Short examples of the REF in action: Early Stuart

Historical 50% migration date for Early Stuart (n=39)

Historical 50% Migration Date
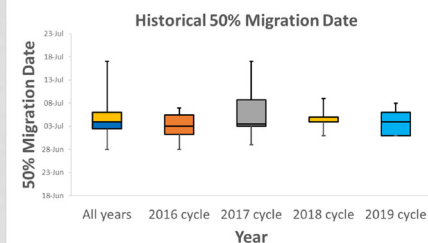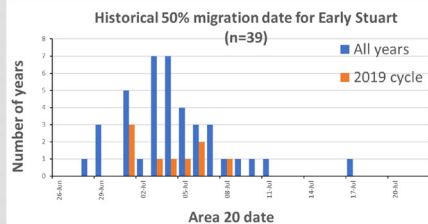
- Histogram indicates a well defined distribution for timing with 9 years of data on the 2019 cycle line.
- Boxplot indicates that while there might be differences between cycles, medians have been similar
- Both the ANOVA and Fisher's Least Significant Difference test (set of individual t-tests) indicate that differences between cycle lines are not statistically significant.

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Short examples of the REF in action: Early Stuart

Measures of Absolute Error (precision)

Measures of Raw Error (bias)
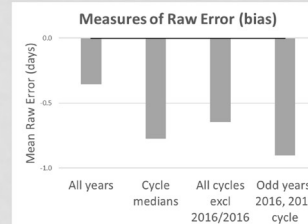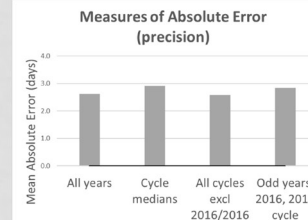
- Using the all years' median results in timing predictions that are as precise as using the medians of all years excluding 2016 cycle years in combination with 2016 cycle medians.
- Using the all years' median however results on average in the smallest bias in the timing predictions.
- Retrospective analyses are consistent with the previous statistical tests.
- A multitude of different combinations to generate a timing forecast can be compared by the REF.

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Short examples of the REF in action: Chilko

Historical 50% migration date for Chilko (n=32)

Historical 50% Migration Date
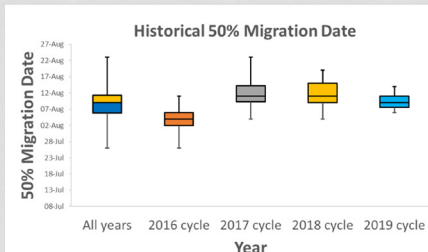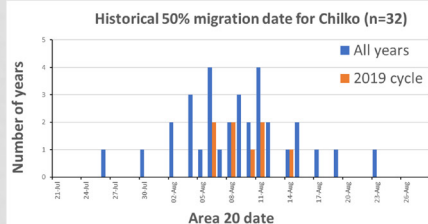
- Histogram indicates a wide distribution for timing with 8 years of data on this cycle.
- Boxplot indicates a clear difference in timing on the 2016 cycle compared to the timing on the other three cycles.
- Both the ANOVA and Fisher's LSD test confirm the timing difference on the 2016 cycle but 2019 cycle line timing does not differ significantly from the timing on the 2017 and 2018 cycle lines.

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Short examples of the REF in action: Chilko

Measures of Absolute Error (precision)

Measures of Raw Error (bias)
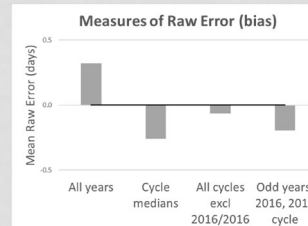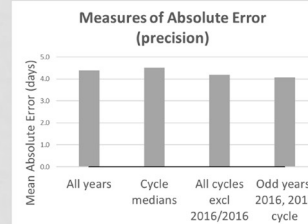
- Using median estimates of the 2016 cycle, the 2018 cycle and the odd year cycles provide, on average, the most precise timing estimates.
- Using the median of all cycles excluding 2016 and using the 2016 cycle median produces the least biased timing estimates.
- Because there was no statistically significant difference between 2018 and the odd year cycle lines, the timing based on all cycles excluding the 2016 cycle is selected.

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Some generic results across stocks

- For 2019, prior to obtaining DFO timing forecast estimates, two main strategies become apparent:
  - Using the median across all years
  - Using the median across all years excluding the 2016 cycle
- On odd years and Late Shuswap years when there is a large abundance of later timed salmon, the "Stay with the school" hypothesis might explain their later timing.
- In general, medians outperform offset (difference in timing between stocks), especially when the timing of the stock against which the offset is calculated is also uncertain.
- Offset strategies work better for stocks that comigrate, e.g. Chilko and Quesnel, compared to stocks with very different timing, e.g. Early Stuart and Late Shuswap.

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Group	February forecast	Forecast approach
Early Stuart	4-July	Historical median using all years
Early Summer	30-July	Timing based on sum of daily abundances
Chilliwack-Pitt group[1]	23 July (12,28 July)	Historical median using all years
Nadina group[2]	27-July	Historical median using all years
Early Thompson	2-Aug	All years median excl. 2016 cycle years
Summer	10-Aug	Timing based on sum of daily abundances
Harrison-Widgeon	7-Aug	All years median excl. 2016 cycle years
Late Stuart-Stellako	8-Aug	All years median excl. 2016 cycle years
Chilko	10-Aug	All years median excl. 2016 cycle years
Quesnel	12-Aug	All years median excl. 2016 cycle years
Raft-North Thompson	18-Aug	All years median excl. 2016 cycle years
Lates	18-Aug	Timing based on sum of daily abundances
Late Shuswap-Portage	16-Aug	All years median excl. 2016 cycle years
Weaver-Cultus	18-Aug	All years median excl. 2016 cycle years
Birkenhead-Big Silver	18-Aug	All years median excl. 2016 cycle years
Pink salmon	28-Aug	Historical median using all years

[1]Pitt, Alouette, Coquitlam
[2]Nadina, Bowron, Gates, Nahatlatch, Taseko

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Conclusions regarding the REF tool

- Provides a neutral (referee) point of view on which model to use in case of conflicting predictions.
- Flexible tool that can be easily update to include additional years or additional stocks.
- Additional methods such as the DFO forecast method can also be accommodated but would require additional retrospective model runs each year.
- Further exploration of the tool is require to explore in-season applications.
- The tool can be adapted for retrospective evaluations of other model inputs such as the spread of the run.

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