# Evaluation of Fraser sockeye timing estimates

PSC
Vancouver, February 2018



## Timing estimates

- Timing = migration date = 50% date
- A timing estimate refers to the date half (50%) of the run would have passed a certain geographical location, assuming all the salmon migrate via that route.
- Area 20 timing: an index of marine migration timing, assuming the entire run migrates through Area 20 in Juan de Fuca Strait.
- Alternative timing estimates: upstream timing, Mission timing, etc.
- This presentation will focus on Area 20 timing estimates and for the purpose of this presentation will be referred to as timing estimates



## What are timing estimates used for?

1. Planning of test fisheries
2. Planning of fisheries
   - In the fisheries planning model
   - Through the criteria for fisheries decisions table
3. Predicting daily abundances
   - To create expected run size curves
   - As priors on timing within the run size model
4. Communication on timing of the run
   - Panel adopted timing estimates



## Different ways to obtain timing estimates

- Historic medians or cycle line medians
  - o In case of limited data, the number of days offset between two stocks can be used to preserve the overlap in group timings.
- Forecast based on environmental data
  - o Produced for Early Stuart and Chilko only.
  - o Historic pre-season forecasts relied on current velocity derived from the OSCURS model and Sea Surface Temperature (SST).
  - o New forecast methods[1] using current velocity (obtained from the OSCAR or NEPSTAR models) and SST in an ensemble modelling approach.
- Regression analyses using the timing of other stocks
  - o To predict timing of stocks other than Early Stuart and Chilko.
  - o To predict the timing of later timed stocks based on in-season estimate of earlier timed stocks such as Early Stuart.

[1]Folkes, M.J.P., Thomson, R.E. and Hourston, R.A. 2017. Evaluating models to forecast return timing and diversion rate of Fraser sockeye salmon. DFO Can. Sci. Advis. Sec. Res. Doc., 220p.

## Different ways to obtain timing estimates

- In-season run size models[2]
  - o Fit a normal distribution to reconstructed marine daily abundance estimates and/or marine test fishery CPUE data.
  - o The date associated with the 'peak' of the normal distribution will determine the timing of the run.
- Reconstructed marine daily abundance estimates
  - o For a given run size (known or hypothetical), the timing is the date when the cumulative reconstructed abundances reach 50% of the total run size.
- Weighted average of stocks within a management group
  - o The timing of management groups may need to be estimated by weighting the timing of stock components by their associated run sizes.
  - o Needed when < 50% of the management group has been reconstructed.

[2]Michielsens, C. and Cave, J. June 2011. (7a_RunSize (incl Area13).

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## Performance evaluation of different timing forecast methods

### Retrospective analysis

- Predict the timing using different forecast methods and all data excluding the year being predicted.
- For new forecast models, rely on results from Folkes at al. (2017)[3] for 1996 to 2012 and add 2016, 2017 (when the new forecast method was used).
- Add additional timing predictions such as cycle line median and regression results based on Early Stuart timing.
- Evaluate the bias (Mean Raw Error, MRE) and precision (Mean Absolute Error, MAE) of the different timing forecast methods.

[3]Folkes, M.J.P., Thomson, R.E. and Hourston, R.A. 2017. Evaluating models to forecast return timing and diversion rate of Fraser sockeye salmon. DFO Can. Sci. Advis. Sec. Res. Doc., 220p.

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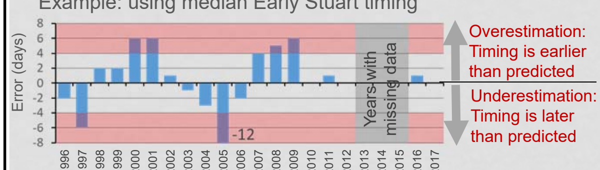
## Performance evaluation of different timing forecast methods

### Bias and precision

Calculate the difference between timing forecast and the actual timing for each year.

Example: using median Early Stuart timing




MRE = 0.4 days = average bias in the timing forecast

MAE = 3.2 days = average deviation from the true timing

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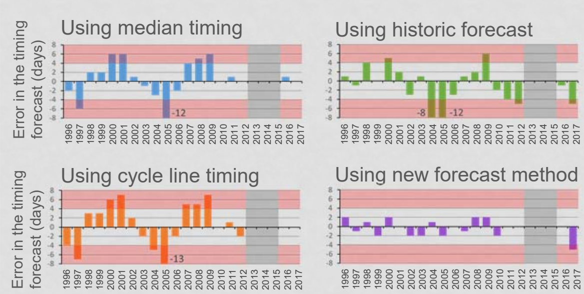
## Results: bias and precision of different Early Stuart timing forecast estimates

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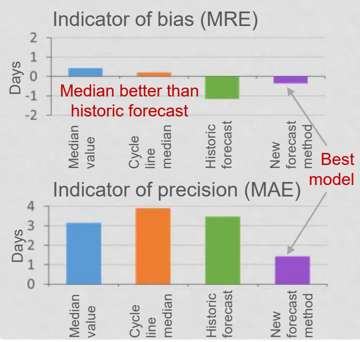
## Results: bias and precision of different Early Stuart timing forecast estimates




- The new timing forecast model of Folkes at al. (2017) produces the best timing forecast.
- On average, the resulting timing is unbiased and differs 1.5 days from the true timing.

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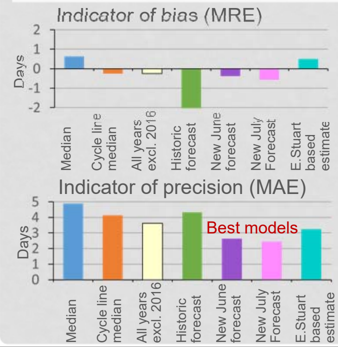
## Results: bias and precision of different Chilko timing forecast estimates




- The new timing forecast models of Folkes at al. (2017) produces the best timing forecasts.
- On average, the resulting timing is unbiased and differs 2.5 days from the true timing.
- The July update may not be worth the effort.

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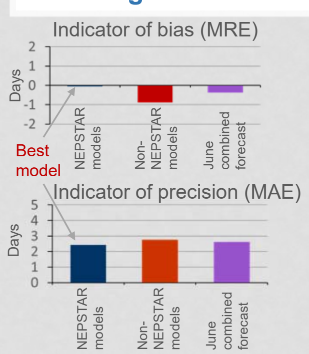
## Results: value of using NEPSTAR Models for Chilko




- On average, the forecast estimates based on NEPSTAR models outperform the forecasts from non-NEPSTAR models as well the ensemble forecast estimates.
- NEPSTAR models however require additional funding to be included

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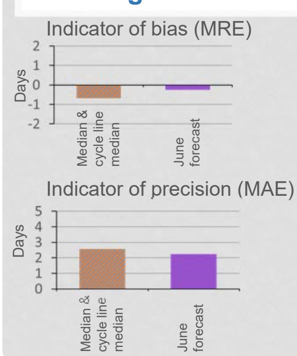
## Results: predicting the overlap in timing between management groups




- Historically, timing forecast estimates have not been evaluated in terms of their ability to predict the timing overlap between management groups.
- On average, the June forecast estimates only provide a slightly better indicator of the overlap in timing (<0.5 day).

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## Value of an unbiased and more precise timing forecast estimate


- The value of an unbiased and more precise timing forecast estimate will depend on what it is used for.
- Depending on its use, it might not be advisable to rely on the best and latest timing estimates.

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## 1 Planning test fisheries

### Default pre-season schedule in April

- The proposed template schedule[4] is based on historic data and remains similar across years or cycle lines.
- This schedule offers an optimal coverage of the run for 75% of the years (optimal = 6 days of matching test fishery & Mission hydro-acoustic data before the peak migration timing).

### Pre-season adjustment in June

- Default: No adjustment compared to default schedule
- Advance entire schedule by 3 days ONLY if:
  - o The June Early Stuart forecast is 4 or more days earlier than the historic median (occurs 1 out of every 10 years)

[4]PSC staff. Jan 2017. Test fishing Considerations for 2018. (5b_Key questions related to test fishing schedule – 2018_FRP)

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## 1 Planning test fisheries

### In-season schedule adjustment in July-August

- Default: no adjustment compared to the June plan.
- Revert back to the original schedule by delaying the opening of purse seine test fisheries by 3 days if:
  - o The schedule in June had been advanced by 3 days because of the pre-season forecast in June,
  - o But the actual Early Stuart timing is 4 or more days later than assumed in June,
  - o And the criteria for fisheries decision table indicates a delay of 4 or more days for Summer run stocks (or much lower than expected abundances) based on Summer run stock ID comparisons.

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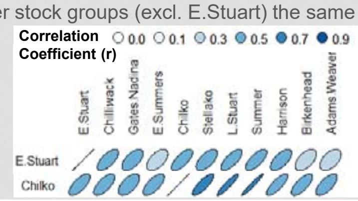
## 2 Timing estimates used in the fisheries planning model

### April planning inputs

- Historic timing forecast estimates would be used.

### June update of planning inputs

- Default: use the superior timing forecasts estimates based on environmental data (Folkes et al. 2017) and shift all other stock groups (excl. E.Stuart) the same way as Chilko.

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## 2 Timing estimates used in the fisheries planning model

April planning inputs
- Historic timing forecast estimates would be used.

June update of planning inputs
- Default: use the superior timing forecasts estimates based on environmental data (Folkes et al. 2017) and shift all other stock groups (excl. E.Stuart) the same way as Chilko.
- Adjust the timing assumptions used in the planning model if forecasts are extreme (earlier or later than 80% of the historic years, e.g. 2005, 2008):
  - o Use the 10th or 90th percentile of the historic timing instead of the extreme timing forecasts.
  - o Evaluate the impact of the extreme timing through a sensitivity analysis with the planning the model.

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## 2 Timing estimates used in the fisheries planning model

In-season planning inputs
- In-season, the fisheries planning model is used as input into the criteria for fisheries decision table.
- The criteria for fisheries decision table compares in-season abundance and stock proportion estimates against preseason expectations as derived from the fisheries planning model.
- In order to maintain the integrity of the comparisons, no timing adjustment would be made in-season to the fisheries planning model.

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## 3 Timing estimates used for modelling daily abundances

Pre-season and in-season timing estimates
- Default: use the same timing values for the daily migration graphs and as median values for the priors on timing as used for the final agreed upon base-case fisheries planning model.

Update of the timing estimates used in-season
- Only adjust the timing if in-season timing estimates based on the correlation with earlier timed stocks confirm the extreme nature of the timing (earlier or later than 80% of the historic years).
- Use the adjusted timing estimates to update daily migration graphs and priors for timing within the run size model.

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## 4 Panel adopted timing estimates

Default: completely at the discretion of the FRP but normally based on staff recommendations.

Pre-season timing estimates
- The same as the timing estimates used in the fisheries planning model.

In-season timing estimates
- Early in each stock's migration, in-season timing estimates remain the pre-season adopted values until in-season run size estimates are available.
- Later in each stock's migration, timing estimates can be obtained from the run size model, through reconstructions, from weighted averages, through expert judgement, etc.

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## Conclusion

- Medians and cycle line medians of historic timing data outperformed the timing forecast produced in the past, but not the new ensemble forecast methodology (Folkes et al. 2017).
- Timing forecast updates in July offer little improvement from June estimates given the high similarity between the forecast models and data used.
- Independent timing forecasts estimates for Chilko based on regression analysis with observed Early Stuart timing provide an independent estimate, which may confirm or contradict extreme timing forecast estimates.

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## Conclusion: Test fisheries schedule

| | | | |
|---|---|---|---|
| April | Rely on schedule template using historic timing | | |
| June | Default | Early Stuart forecast ≥ 4 days earlier than historic | |
| | Rely on historic schedule template | Move schedule 3 days forward | |
| July August | Default | Default | Timing ≥ 4 days later than June forecast |
| | Rely on historic schedule | Rely on historic schedule | Delay seine test fishery by 3 days |

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## Conclusion: Fisheries planning model

| | | |
|---|---|---|
| April | Rely on historic timing to populate model | |
| June | Default: rely on June timing forecast (Folkes et al. 2017) | Forecast timing more extreme than 80% of the historic years |
| | Move timing of other stock groups based on shift in Chilko timing | Use $10^{\text{th}}$ or $90^{\text{th}}$ percentile of historic timing distribution |
| July August | No in-season adjustments | No in-season adjustments |

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## Conclusion: Daily migration graphs and runs size model priors

| | | | |
|---|---|---|---|
| June | Default | Forecast timing more extreme than 80% of the historic years | |
| | Rely on June timing forecast estimates | Use $10^{\text{th}}$ or $90^{\text{th}}$ percentile of historic timing distribution instead of forecast | |
| July August | Default | Default | Extreme timing confirmed in-season |
| | No in-season adjustments | No in-season adjustments | Update priors and migration graphs |

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## References

Test fishing schedule template

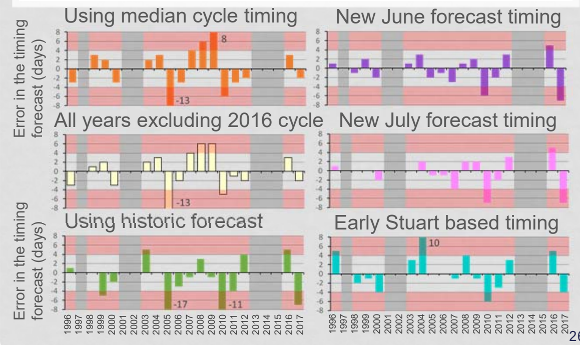
- https://extranet.psc.org/frptc/Documents%202/FRP/2018/2018-01-09_Portland/Presentations/5b_Key questions related to test fishing schedule - 2018_FRP.pptx

In-season run size model and timing input

- https://extranet.psc.org/frptc/Documents%202/FRP/2011/2011-06-15_SunPeaks/7a_RunSize (incl Area13).pptx

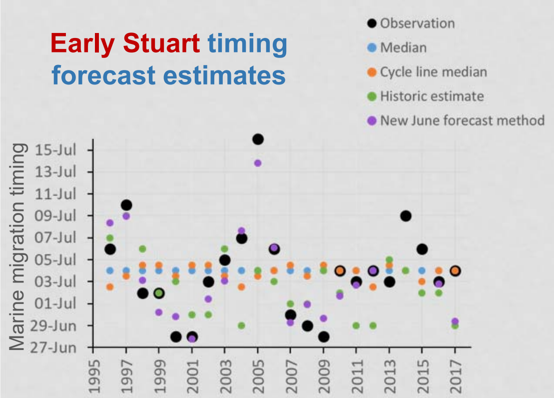


## Results: bias and precision of different Chilko timing forecast estimates






## Early Stuart timing forecast estimates






## Chilko timing forecast estimates