1% Weir Escapement Rule

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June, 2019

Contents

Recipient

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1 Background

The objectives of this analysis were to:

1. Model the tails of the run to quantify a hard ending date for weir operations – the date to which the weir would be required to be operated (e.g., would capture 90% of the escapement 95% of the time on average).

2. Estimate the % of counts missed if the project was operated past the hard ending date until daily counts equaled less than 1% of the cumulative count for 3, 4, or 5 days in a row.

3. Analyze the Situk River and Chilkoot Lake sockeye salmon weir data to determine the hard ending date the weirs should be operated through to capture 90% of the run on average. Estimate the percent of missed counts if the project was operated past the hard ending date until daily counts equaled less than 1% of the cumulative count for 3, 4, or 5 days in a row.

4. For alternate runs (i.e. changes to the x% of the escapement 95% of the time on average), in the functions code, change the f_run_through function perc to desired the percentage, change the f_pred_plot function perc to the desired percentage, and change the f_pred_plot_decade function perc to desired the percentage.

All associated files, data, and code are located at https://github.com/commfish/weiRends. This work is based upon efforts originally developed by Scott Raborn.

1.1 Data

The input data format is two columns with date (preferably in year-mm-dd format) and weir count data.

An example is:
date count
2019-01-20 20

This is for a single species at a single weir. No other values or comments should be included in the file. Data should be provided in .csv format.

1.2 Analysis

Two models were considered:

The Gompertz model

$$p\mathrm{e}^{-e^{-k(t-t_0)}},$$

and the logistic model

$$\frac{p}{1+\mathrm{e}^{-k(t-t_0)}}.$$

The variable p represents the asymptote of the cumulative escapement, k is the steepness of the curve, and t_0 is the inflection point of the curve.

The evaluation process starts by fitting both models, and then the model with the least total variance is chosen for the analysis. *Note that this is a coarse approach and is not a meaningful model comparison.* Cumulative run is predicted from the selected model and then this is converted into the number of estimated fish past the weir for a given day. A reconstructed run is estimated using observed daily data, filling in any data gaps with estimated daily escapement numbers. This reconstructed run is then used to compute a cumulative sum of escapement. The date that a weir should remain in place to capture 90% of the escapement on average is calculated using the reconstructed cumulative sum.

2 Egegik River

As the original workup was for the Egegik River, this analysis was repeated to reflect changes between the current code and the provided spreadsheet (originally developed by Scott Raborn).

2.1 Model fits

The Gompertz and logistic models fit similarly, although the logistic model peformed slightly better (lower overall deviance) and was selected for the remaining analyses (Figure 1). Note that the provided spreadsheet used the Gompertz model.

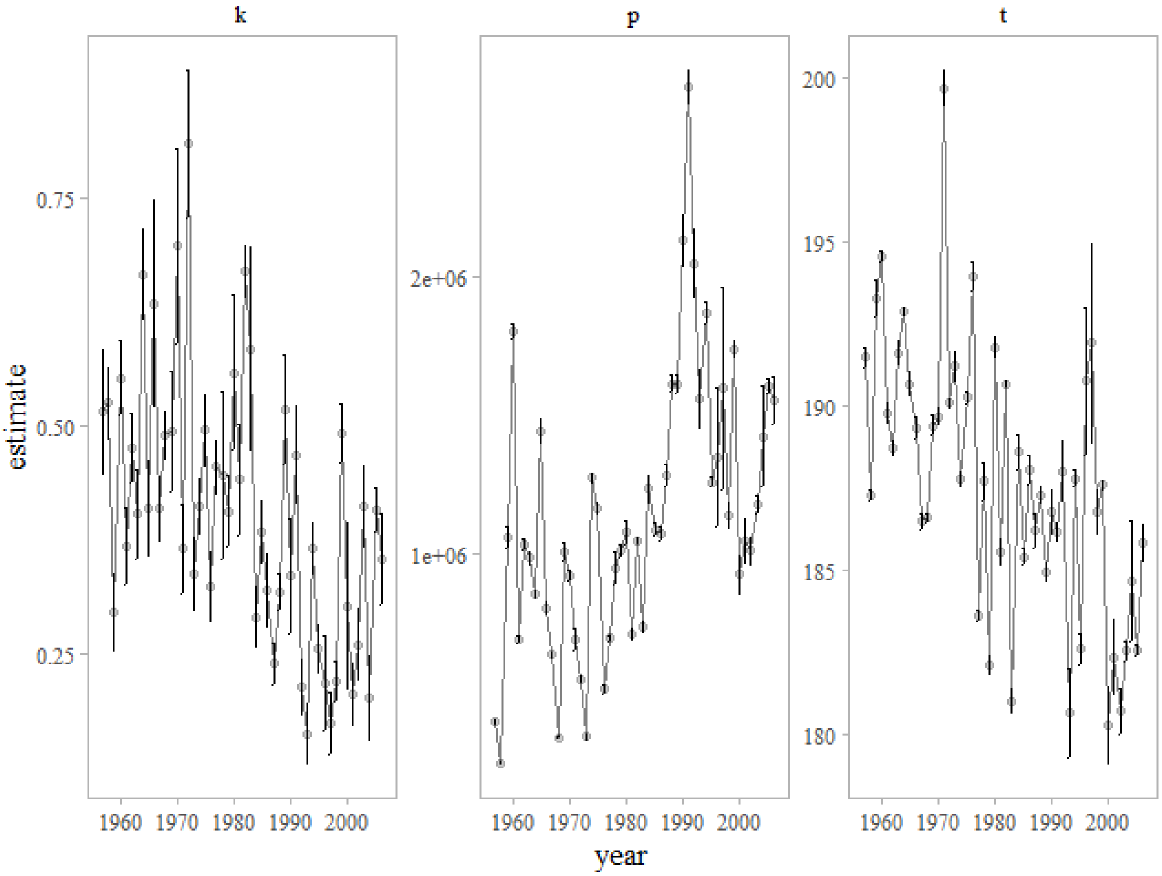

Figure 1: Parameter estimates from the logistic model for the Egegik River.

The predicted data showed a reasonable model fit for most years (Figure 2). Based upon all years of data, the date that 90% of the escapement passes the weir 95% of the time is 2019-07-20. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

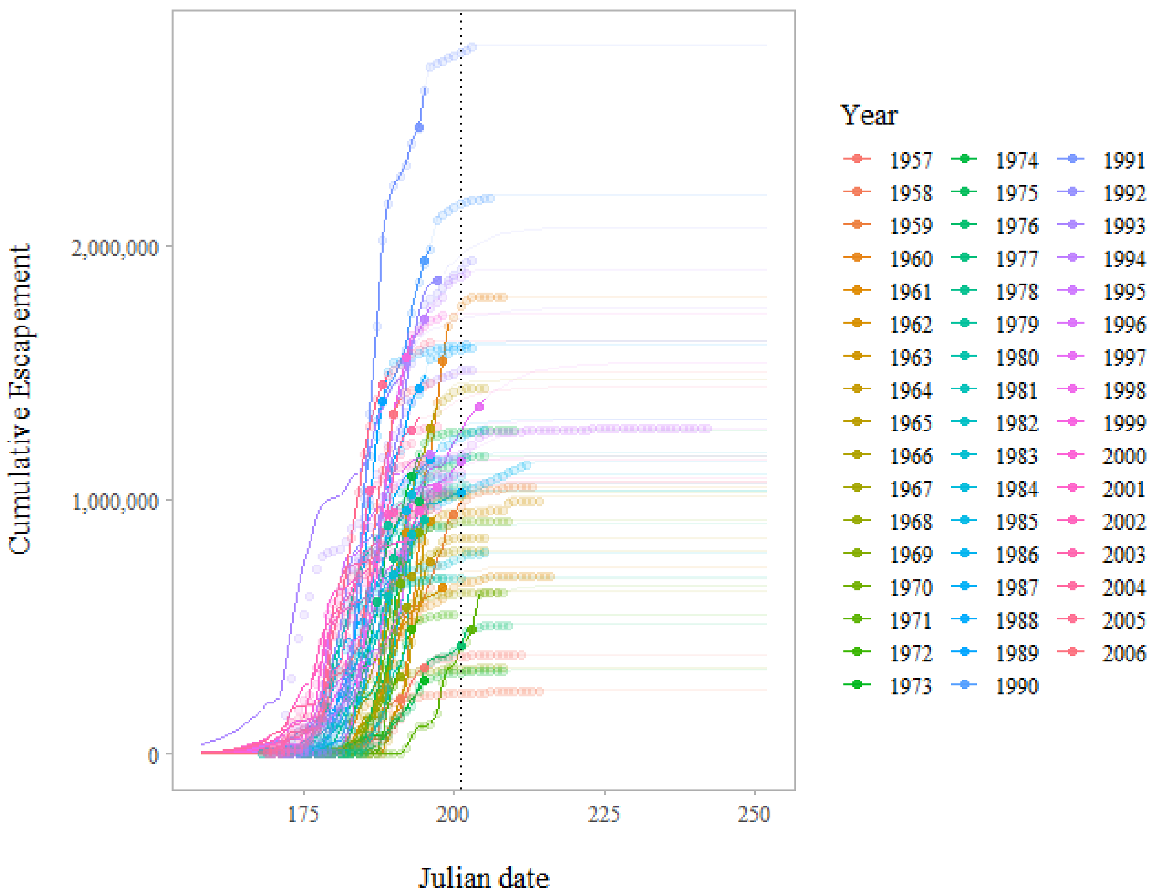

Figure 2: Predicted cumulative escapements by year for the Egegik River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the mean date when 90% of the run has passed the weir. The circles are the cumulative escapement data and the lines are the predicted cumulative escapements.

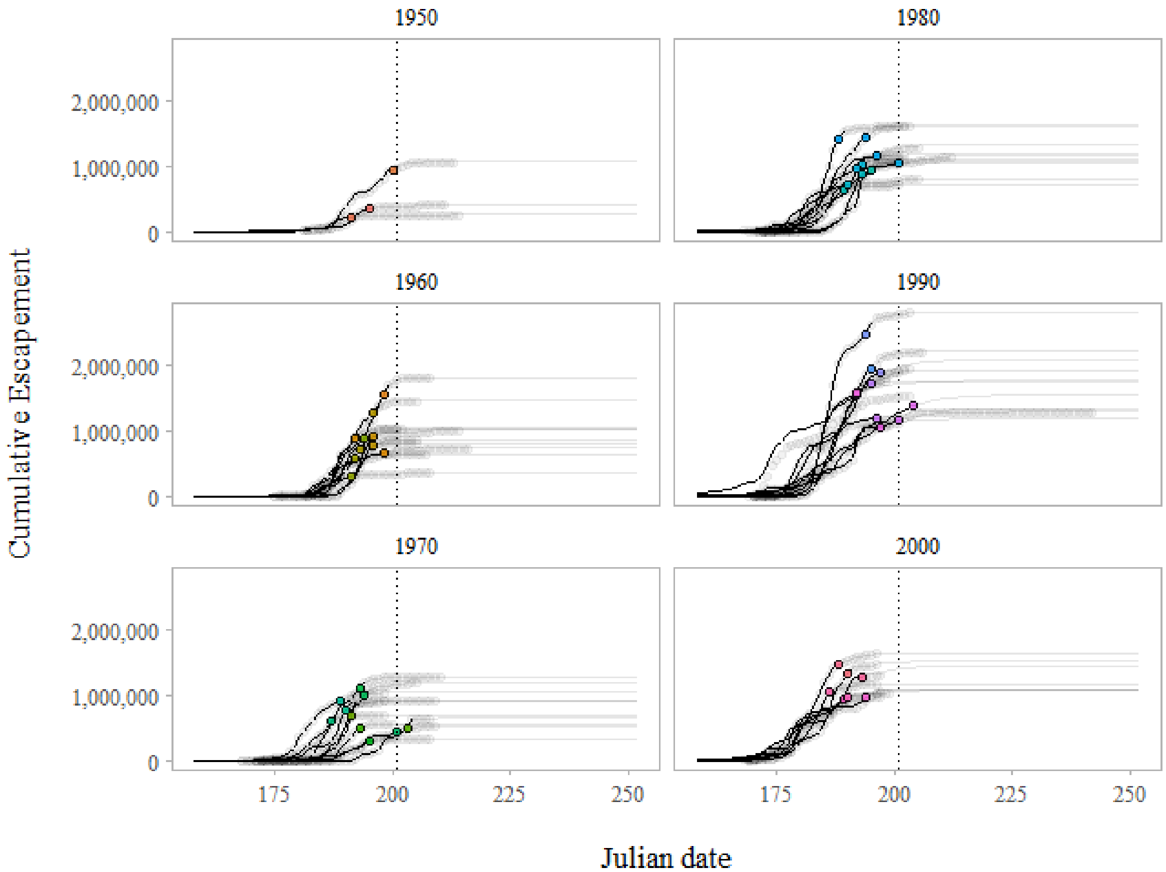

Figure 3: Predicted cumulative escapements by year and decade for the Egegik River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the mean date when 90% of the run has passed the weir.

Based upon median removal dates presented in Table 1, there is a 95% chance of capturing 95-97% of the total run, depending on which weir removal rule (# of days) is implemented (Table 2).

Table 1: Median end dates for weir removal based upon number of days to implement the 1% rule for the Egegik River.

days	median	l_25	u_75	date
one	201	201	202	2019-07-20
two	201	201	203	2019-07-20
three	201	201	204	2019-07-20
four	201	201	205	2019-07-20
five	201	201	206	2019-07-20

Table 2: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 1% rule is implemented for the Egegik River.

% Chance	one	two	three	four	five
99	91.9	92.4	92.8	93.2	93.5
95	94.5	95.3	95.8	96.6	96.9
90	95.2	95.7	96.3	96.9	97.4
80	96.7	97.4	97.7	98.1	98.2
70	97.4	98.1	98.2	98.5	98.9
60	98.0	98.4	98.8	98.9	98.9
50	98.4	98.9	99.0	99.3	99.4

This is inversely reflected in the percent risk figure (Figure 4) that shows the risk that a given percentage of the run is missed.

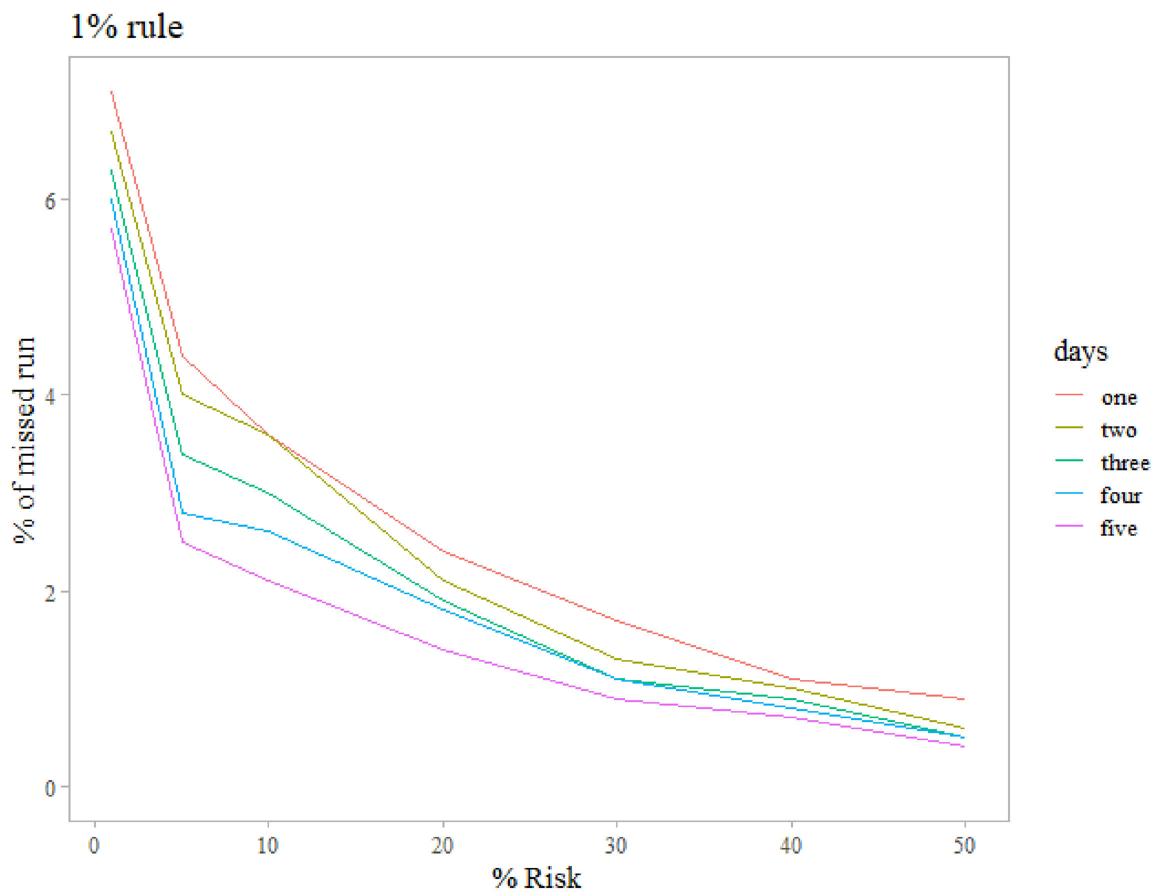

Figure 4: The percent of the run that is missed at a given risk level, e.g., 2.5% of the run will be missed 5% of the time using a five day 1% rule for the Egegik River.

The percent of the run that would be missed is further examined in Table 3. Overall, this run is well represented by the 1% rule with a low potential for missing 5% or more of the run, and a reasonable risk of missing only 1% of the total run.

Table 3: The percent of risk that a given % of the run is missed for the Egegik River.

bins	one	two	three	four	five
1% run missed	45.7	41.7	38.1	33.8	30.2
5% run missed	4.4	3.1	2.2	1.8	1.1
10% run missed	0.3	0.1	0.1	0.1	0.0
20% run missed	0.0	0.0	0.0	0.0	0.0
30% run missed	0.0	0.0	0.0	0.0	0.0
40% run missed	0.0	0.0	0.0	0.0	0.0
50% run missed	0.0	0.0	0.0	0.0	0.0

3 Chilkoot River

3.1 1% Rule

The logistic model provided an overall better fit to the data than the Gompertz model. None of the parameter estimates had substantial error bars (Figure 5) and the models converged for all years. The predicted data showed a reasonable model fit for most years (Figures 6 & 7). Based upon all years of data, the 90% mean passage weir removal date is 2019-09-15. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

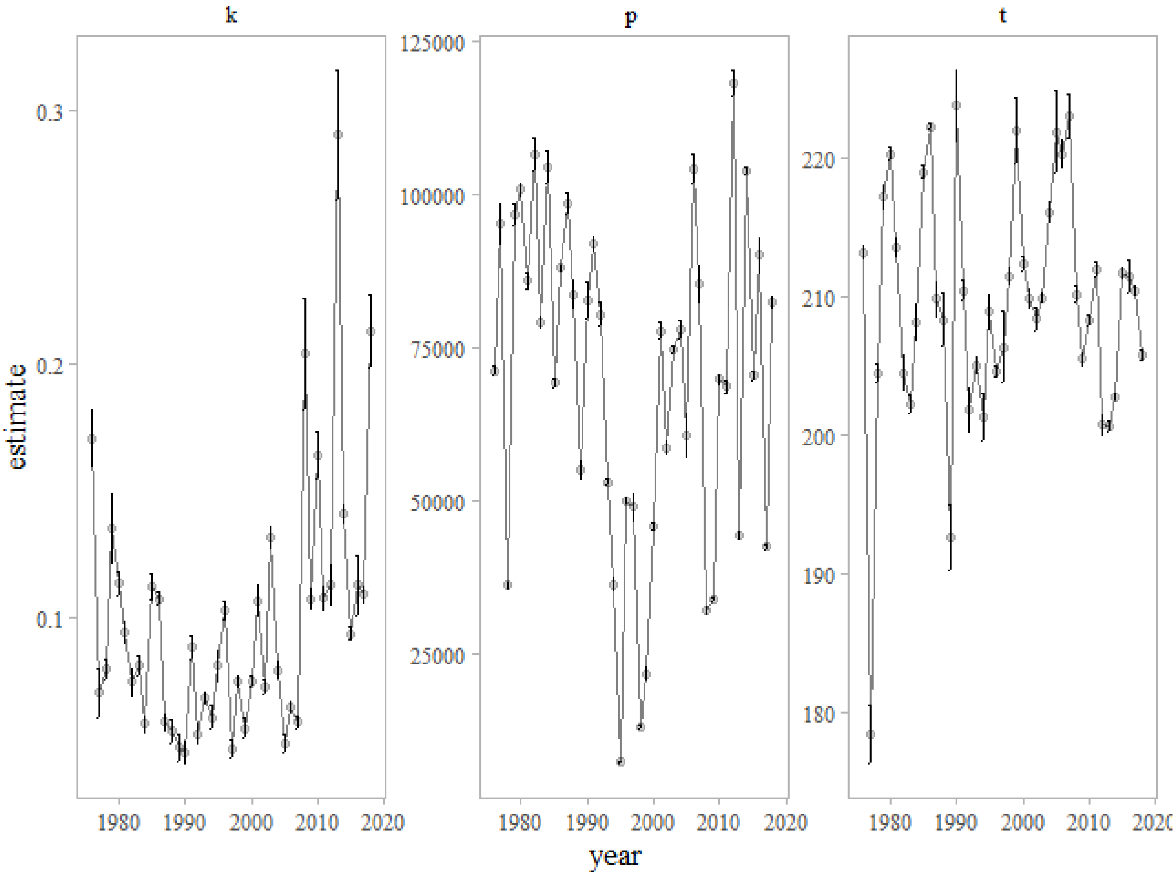

Figure 5: Parameter estimates from the logistic model for the Chilkoot River.

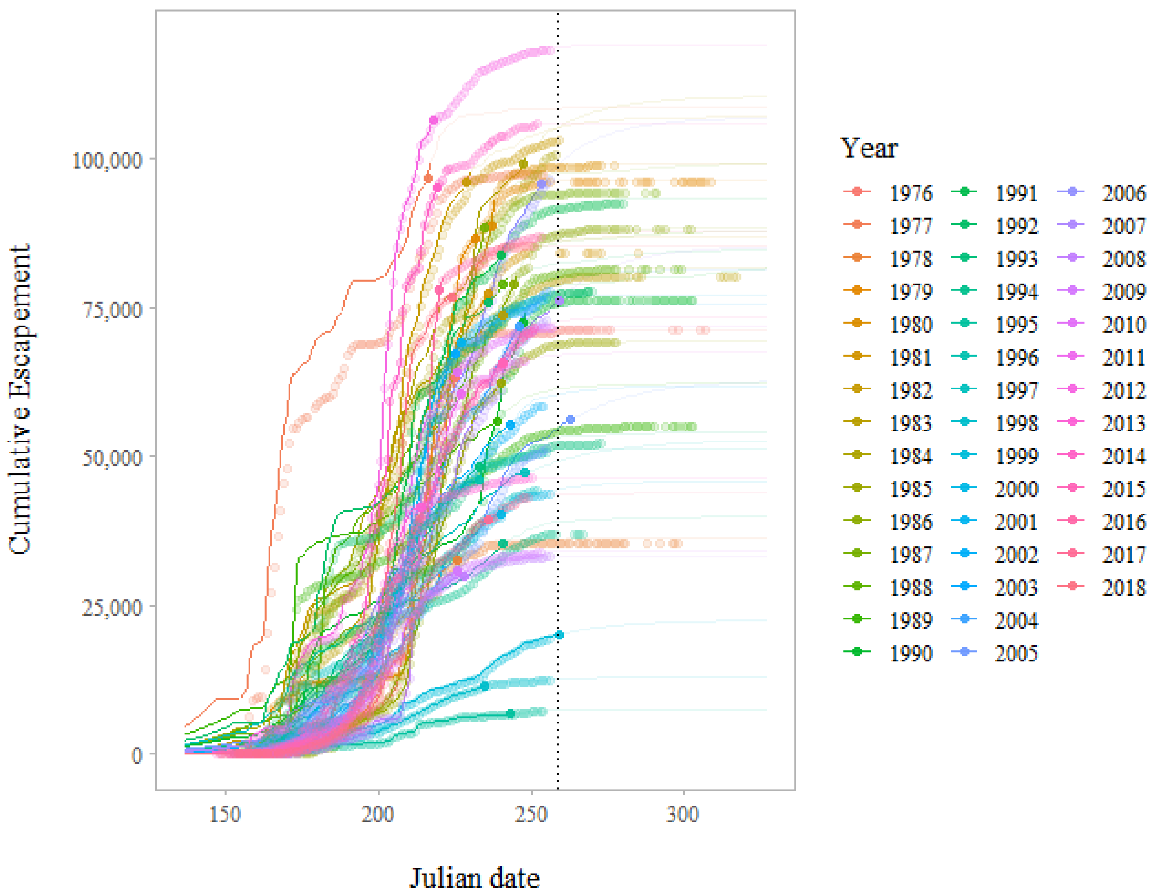

Figure 6: Predicted cumulative escapements by year for the Chilkoot River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the mean date when 90% of the run has passed the weir.The circles are the cumulative escapement data and the lines are the predicted cumulative escapements.

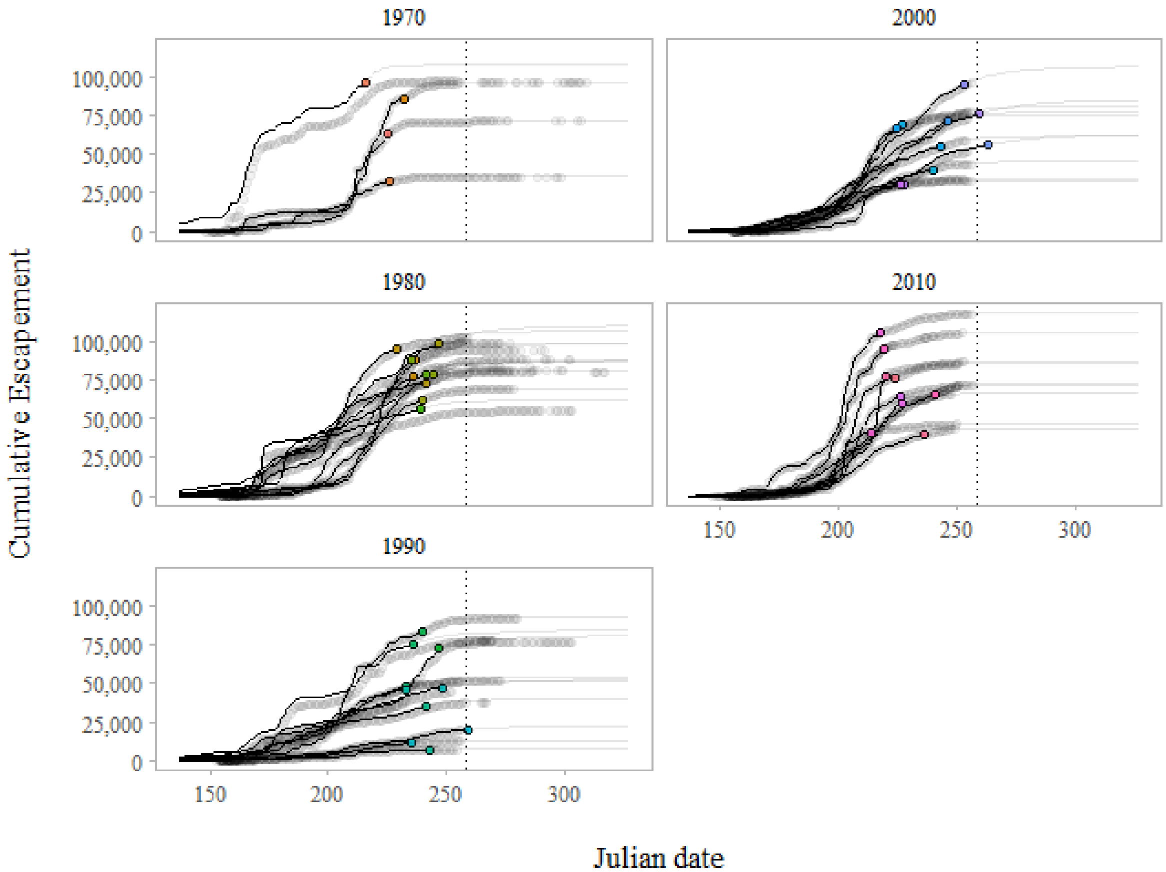

Figure 7: Predicted cumulative escapements by year and decade for the Chilkoot River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the mean date when 90% of the run has passed the weir.

Based upon median removal dates presented in Table 4, there is a 95% chance of capturing 89% of the total run for all weir removal rules (# of days) (Table 5). Note that there is a 50% chance of capturing 99% of the run.

Table 4: Median end dates for weir removal based upon number of days to implement the 1% rule for the Chilkoot River.

days	median	l_25	u_75	date
one	258.4	258	258	2019-09-15
two	258.4	258	258	2019-09-15
three	258.4	258	258	2019-09-15
four	258.4	258	258	2019-09-15
five	258.4	258	258	2019-09-15

Table 5: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 1% rule is implemented for the Chilkoot River.

% Chance	one	two	three	four	five
99	87.9	87.9	87.9	87.9	87.9
95	89.4	89.4	89.4	89.4	89.4
90	93.6	93.6	93.6	93.6	93.6
80	97.0	97.0	97.0	97.0	97.0
70	97.6	97.6	97.6	97.6	97.6
60	98.4	98.4	98.4	98.4	98.4
50	98.8	98.8	98.8	98.8	98.8

The 1% rule does not extend the median end date (Table 4) which is reflected in the percent risk as well (Figure 8).

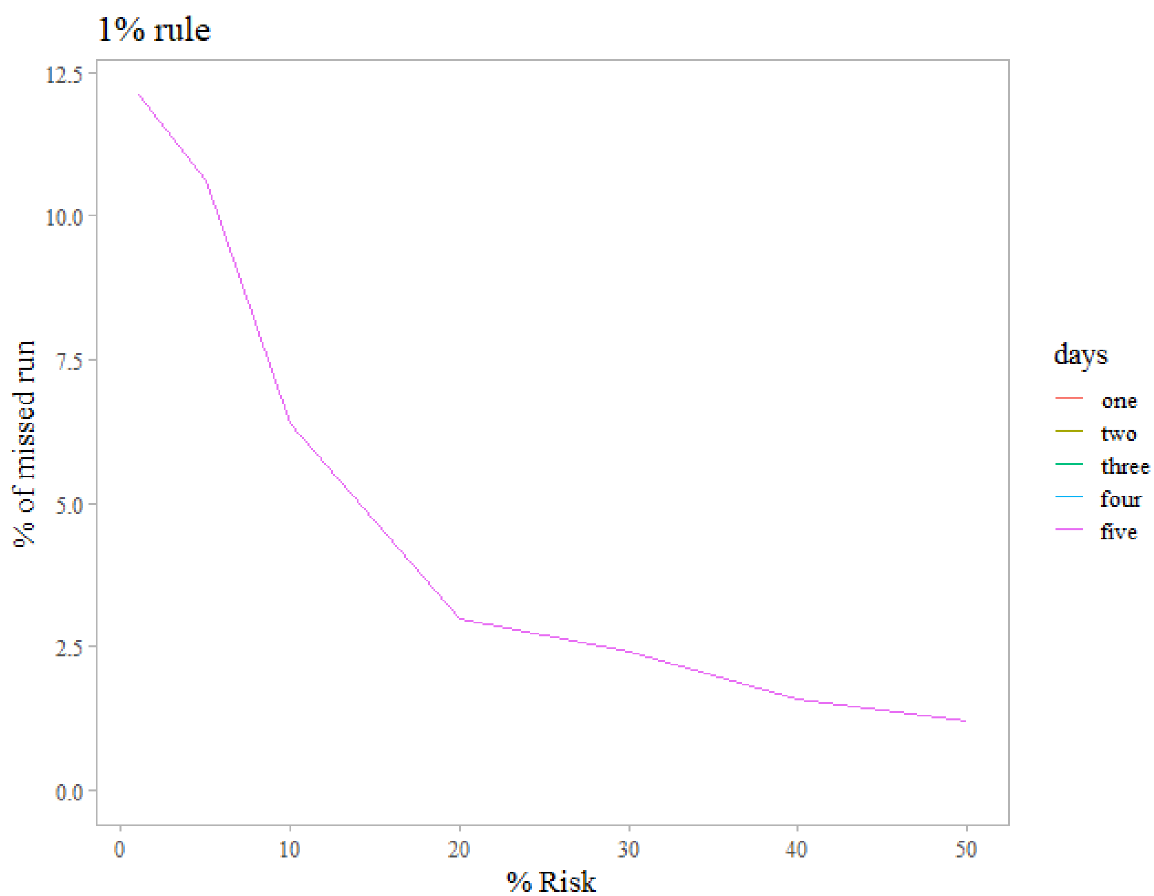

Figure 8: The percent of the run that will be missed at a given risk level, e.g., 11% of the run will be missed 5% of the time using a five day 1% rule for the Chilkoot River.

The percent of the run that would be missed is further examined in Table 6. Overall, this run is not well represented by the 1% rule as the rule would not extend the median removal date. The reason for this is that the run past the 90% removal date occurs in daily numbers that are less than 1% of the cumulative run for those days. Therefore, an additional weir removal rule of 0.05% passage was explored.

Table 6: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 1% rule is implemented for the Chilkoot River.

bins	one	two	three	four	five
1% run missed	52.1	52.1	52.1	52.1	52.1
5% run missed	13.7	13.7	13.7	13.7	13.7
10% run missed	3.4	3.4	3.4	3.4	3.4
20% run missed	0.2	0.2	0.2	0.2	0.2
30% run missed	0.0	0.0	0.0	0.0	0.0
40% run missed	0.0	0.0	0.0	0.0	0.0
50% run missed	0.0	0.0	0.0	0.0	0.0

3.2 0.05% Rule

Using a 0.05% rule did not adjust the median removal date (Table 7), but slighlty improved the chance that the majority of the run was observed (Table 8). The 0.05% rule decreased the percent risk (Figure 9).

Table 7: Median end dates for weir removal based upon number of days to implement the 0.05% rule for the Chilkoot River.

days	median	l_25	u_75	date
one	258.4	258	258	2019-09-15
two	258.4	258	258	2019-09-15
three	258.4	258	258	2019-09-15
four	258.4	258	258	2019-09-15
five	258.4	258	258	2019-09-15

Table 8: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 0.05% rule is implemented for the Chilkoot River.

% Chance	one	two	three	four	five
99	90.4	90.9	91.0	91.5	91.9
95	91.2	91.7	92.1	92.5	92.9
90	93.6	93.6	93.6	93.6	94.0
80	97.0	97.0	97.0	97.0	97.0
70	97.6	97.6	97.6	97.6	97.6
60	98.4	98.4	98.4	98.4	98.4
50	98.8	98.8	98.8	98.8	98.8

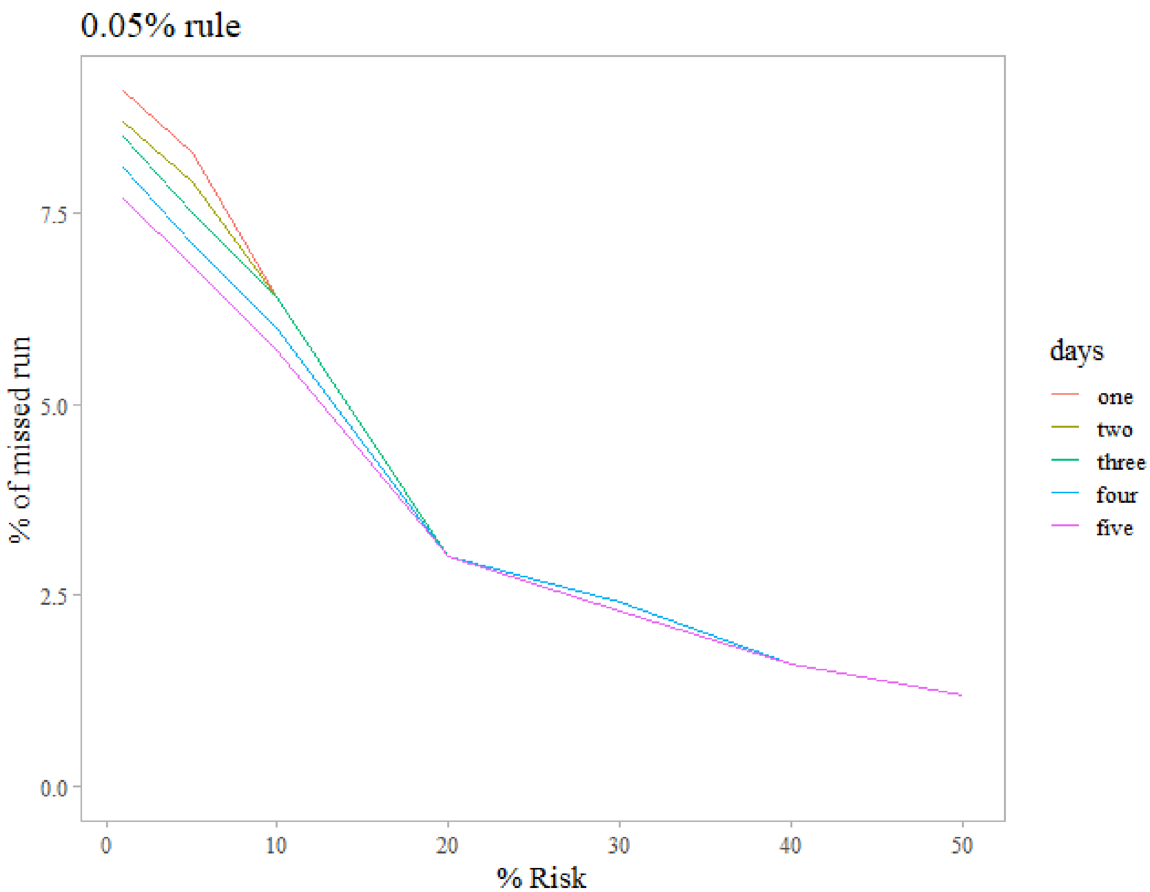

Figure 9: The percent of the run that will be missed at a given risk level, e.g., 7% of the run will be missed 5% of the time using a five day 0.05% rule for the Chilkoot River.

The percent of the run that would be missed is further examined in Table 9. Overall, this run is not well represented by the 0.05% rule as the rule would not extend the median removal date. The reason for this is that the run past the 90% removal date occurs in daily numbers that are less than 0.05% of the cumulative run for those days.

Table 9: The percent of risk that a given % of the run is missed for the Chilkoot River.

bins	one	two	three	four	five
1% run missed	50.7	50.4	50.2	50.0	49.6
5% run missed	11.8	11.3	11.0	10.6	10.2
10% run missed	2.5	2.3	2.1	2.0	1.8
20% run missed	0.1	0.1	0.1	0.1	0.1
30% run missed	0.0	0.0	0.0	0.0	0.0
40% run missed	0.0	0.0	0.0	0.0	0.0
50% run missed	0.0	0.0	0.0	0.0	0.0

4 Situk River

4.1 1% Rule

The Gompertz model provided an overall better fit to the data than the logistic model for the Situk River. None of the parameter estimates had substantial error bars (Figure 10) and the models converged for all years. The predicted data showed a reasonable model fit for most years (Figures 11 & 12). Based upon all years of data, the 90% mean passage weir removal date is 2019-08-19. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

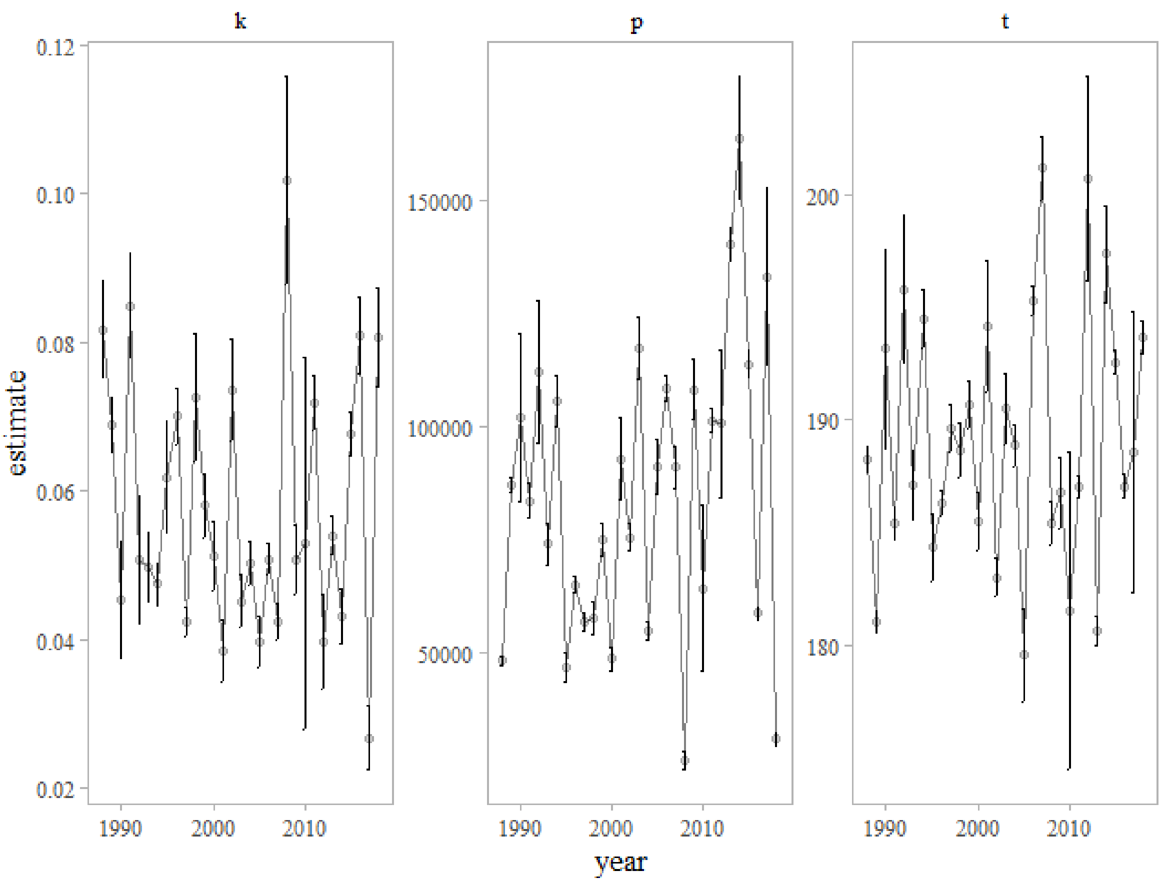

Figure 10: Parameter estimates from the Gompertz model for the Situk River.

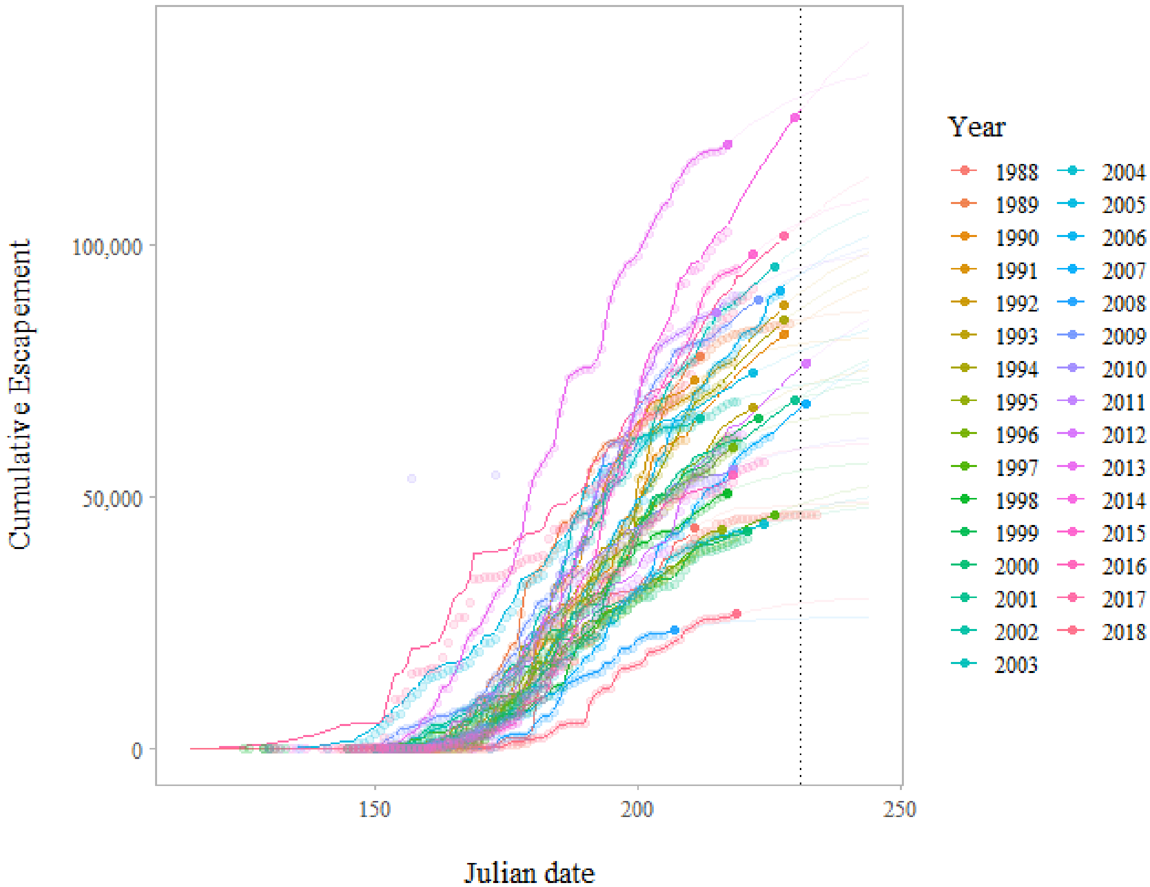

Figure 11: Predicted cumulative escapements by year for the Situk River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the date where 90% of escapement has occurred 95% of the time. The circles are the cumulative escapement data and the lines are the predicted cumulative escapements.

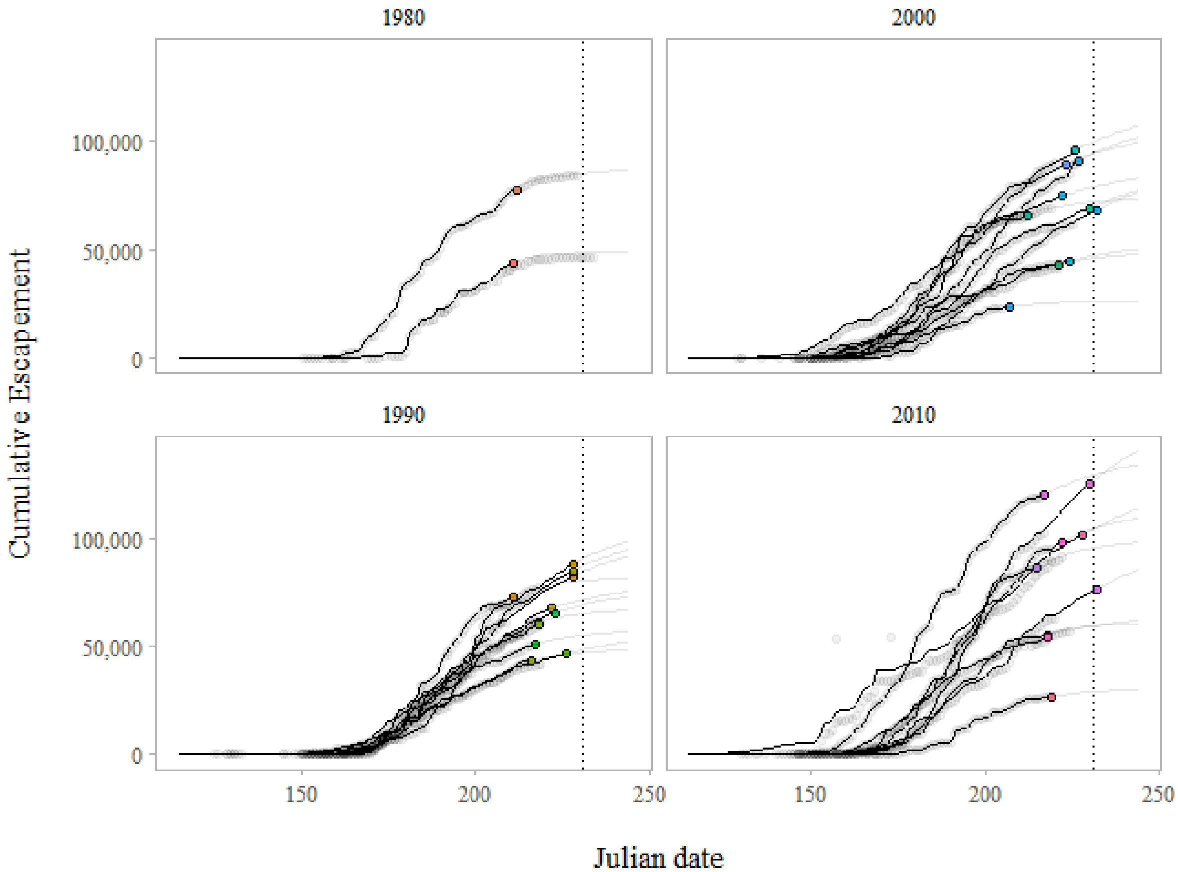

Figure 12: Predicted cumulative escapements by year and decade for the Situk River. Filled circles indicate 90% of the run has passed the weir. The vertical line is the date where 90% of escapement has occurred 95% of the time. The circles are the cumulative escapement data and the lines are the predicted cumulative escapements.

Based upon median removal dates presented in Table 10, there is a 95% chance of capturing 91% of the total run for all weir removal rules (# of days) (Table 11). Note that there is a 50% chance of capturing 95% of the run.

Table 10: Median end dates for weir removal based upon number of days to implement the 1% rule for the Situk River.

days	median	l_25	u_75	date
one	231	231	231	2019-08-19
two	231	231	231	2019-08-19
three	231	231	231	2019-08-19
four	231	231	231	2019-08-19
five	231	231	231	2019-08-19

Table 11: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 1% rule is implemented for the Situk River.

% Chance	one	two	three	four	five
99	89.8	89.8	90.6	90.6	91.0
95	90.5	90.5	91.0	91.0	91.4
90	91.0	91.0	91.1	91.3	91.5
80	91.7	91.8	91.8	92.0	92.3
70	92.3	92.6	92.7	93.6	93.6
60	94.3	94.3	94.3	94.3	94.5
50	94.7	94.7	94.7	94.7	95.1

The 1% rule does not extend the median end date (Table 10) which is reflected in the percent risk as well (Figure 13).

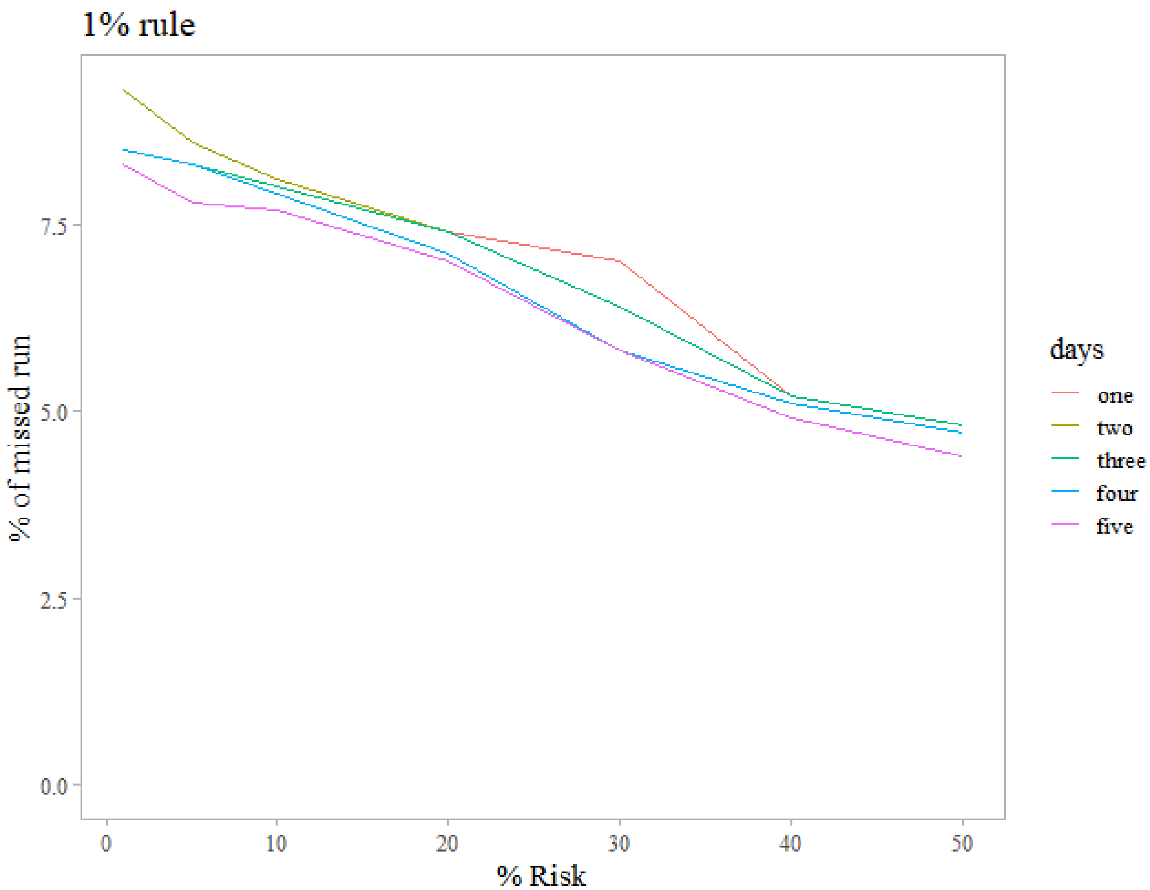

Figure 13: The percent of risk that a given % of the run is missed, e.g., 8% of the run will be missed 5% of the time using a five day 1% rule for the Situk River.

The percent of the run that would be missed is further examined in Table 12. Overall, this run is not well represented by the 1% rule and would not extend the median removal date. The reason for this is that the run past the 90% removal date occurs in daily numbers that are less than 1% of the cumulative run for those days. Therefore, an additional weir removal rule of 0.05% passage was explored.

Table 12: The percent of risk that a given % of the run is missed for the Situk River.

bins	one	two	three	four	five
1% run missed	97.3	97.4	97.5	97.6	97.7
5% run missed	40.3	39.6	38.4	37.2	35.2
10% run missed	5.6	5.2	4.6	4.0	3.2
20% run missed	0.0	0.0	0.0	0.0	0.0
30% run missed	0.0	0.0	0.0	0.0	0.0
40% run missed	0.0	0.0	0.0	0.0	0.0
50% run missed	0.0	0.0	0.0	0.0	0.0

4.2 0.05% Rule

Using a 0.05% rule proved to adjust the median removal date (Table 13) and substantially improved the chance that the majority of the run was observed (Table 14). The 0.05% rule decreased the percent risk (Figure 14).

Table 13: Median end dates for weir removal based upon number of days to implement the 0.05% rule for the Situk River.

days	median	l_25	u_75	date
one	232	231	241	2019-08-20
two	233	231	242	2019-08-21
three	233	231	243	2019-08-21
four	234	231	244	2019-08-22
five	235	231	244	2019-08-23

Table 14: The percent of the run that is caught at a given risk level (% Chance) based upon the number of days the 0.05% rule is implemented for the Situk River.

% Chance	one	two	three	four	five
99	94.9	95.2	95.6	96.0	96.1
95	95.1	95.5	95.7	96.1	96.4
90	95.2	95.6	96.0	96.2	96.5
80	95.9	96.0	96.3	96.6	96.8
70	96.4	96.4	96.8	96.8	97.0
60	97.1	97.1	97.1	97.2	97.2
50	97.6	97.9	98.0	98.0	98.0

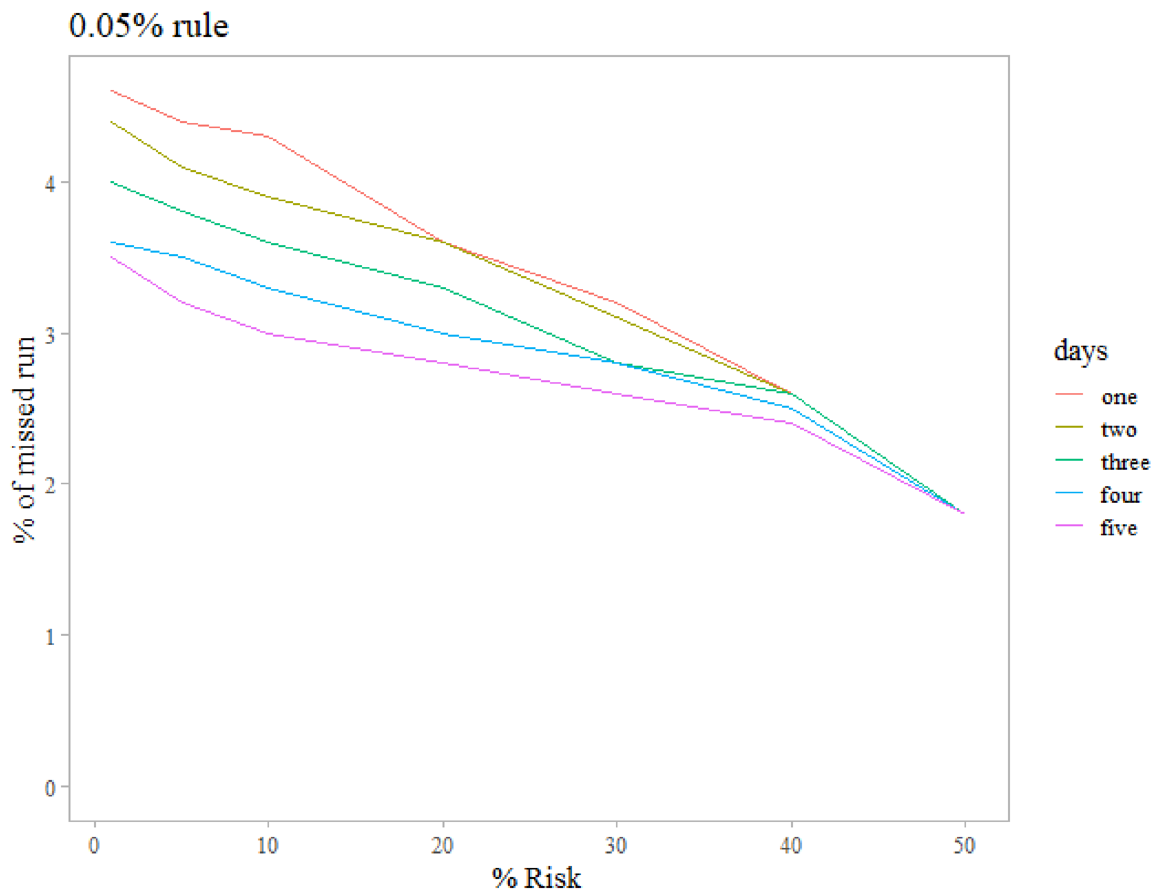

Figure 14: The percent of the run that will be missed at a given risk level, e.g., 3% of the run will be missed 5% of the time using a five day 0.05% rule for the Situk River.

The percent of the run that would be missed is further examined in Table 15. Overall, this run is well represented by the 0.05% rule with a low potential for missing 5% or more of the run, and a reasonable risk of missing only 1% of the total run.

Table 15: The percent of risk that a given % of the run is missed for the Situk River.

bins	one	two	three	four	five
1% run missed	50.8	48.6	41.3	39.8	36.8
5% run missed	12.9	11.5	10.9	9.7	8.7
10% run missed	3.1	2.5	3.0	2.4	2.1
20% run missed	0.2	0.2	0.3	0.2	0.2
30% run missed	0.0	0.0	0.0	0.0	0.0
40% run missed	0.0	0.0	0.0	0.0	0.0
50% run missed	0.0	0.0	0.0	0.0	0.0