1% Weir Escapement Rule

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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 95% of the escapement on average);
2. Estimate % of counts missed if the project was operated past the hard ending date until daily counts equaled less than 1% of 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 required be operated through to capture 95% 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 cumulative count for 3, 4, or 5 days in a row.

All associated files, data, and code are located at https://github.com/commfish/weiRends.

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 preferably 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, the model with the least total variance is chosen for the analysis. A cumulative run is predicted from the selected model, 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 95% of the escapement on average in calculated using the reconstructed cumulative sum.

2 Egegik analysis

As the original workup was for the Egegik River this analysis was repeated here to reflect changes between the current code and the provided spreadsheet.

2.1 Model fits

The Gompertz and logistic models fit similarly, though 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.

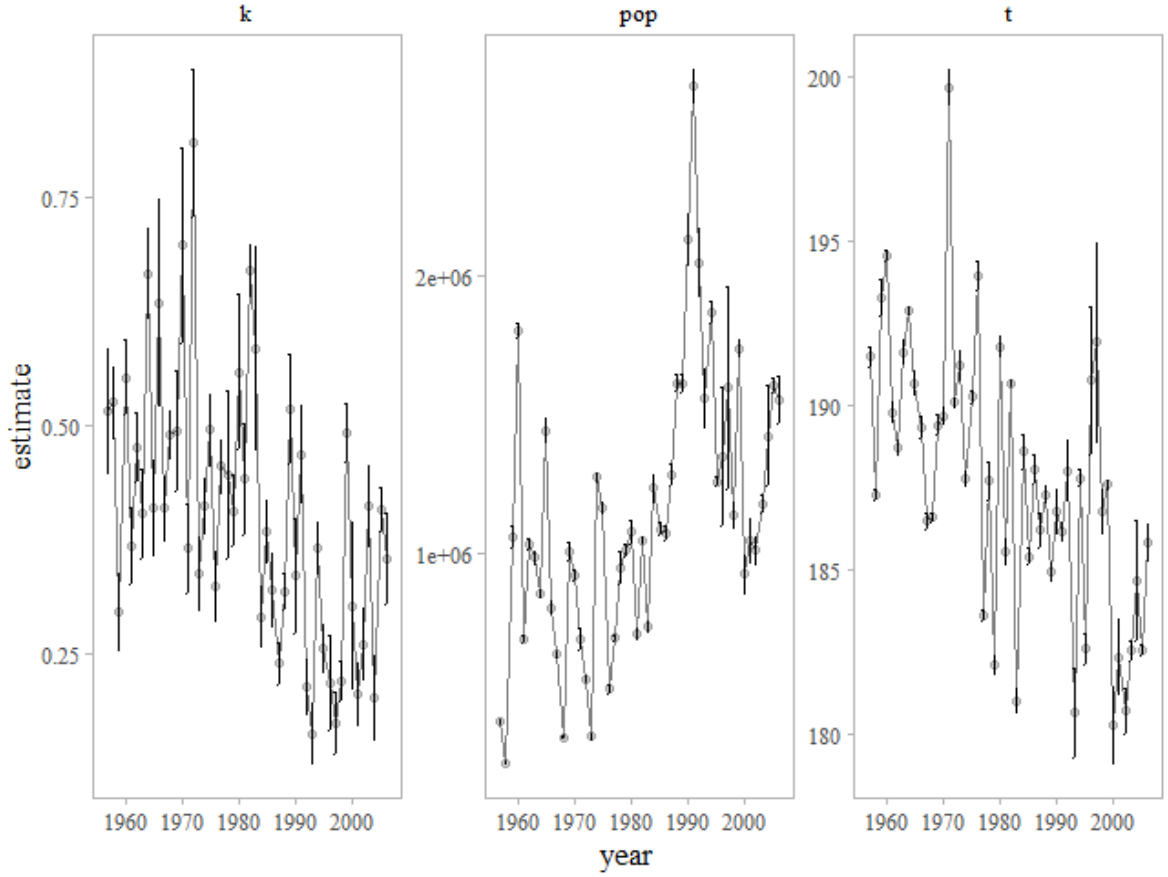

Figure 1: Parameter estimates from the logistic model for the Egegik River.

The predicted data show a reasonable model fit for most years (Figure 2). Based upon all years data the 95% mean passage weir removal date is 2019-07-15. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

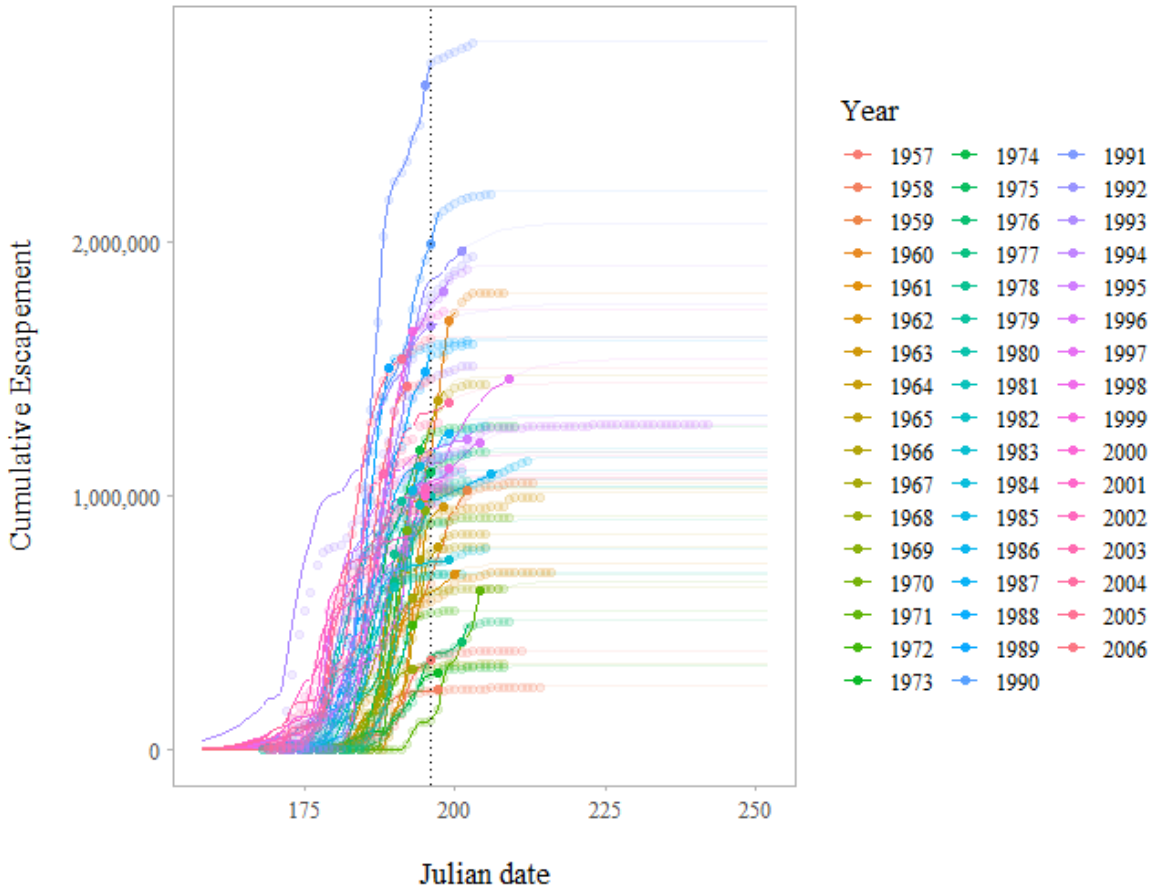

Figure 2: Predicted cumulative escapements by year for the Egegik River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

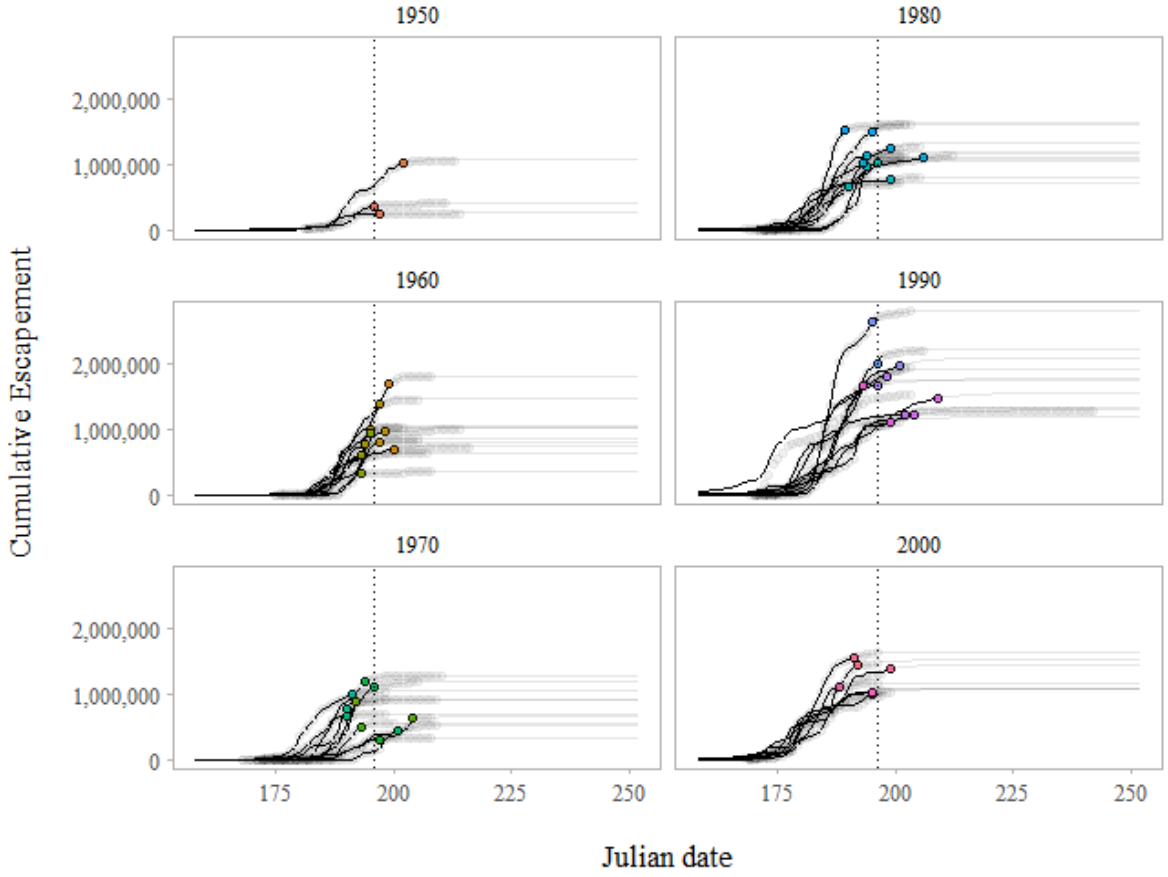

Figure 3: Predicted cumulative escapements by year for the Egegik River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

Based upon median removal dates presented in Table 1 there is a 95% chance of capturing 94-96% 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	197	196	202	2019-07-16
two	198	196	203	2019-07-17
three	199	197	204	2019-07-18
four	200	198	205	2019-07-19
five	201	199	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	92	93	93	93
95	93	94	95	96	96
90	94	95	96	97	97
80	95	97	97	97	98
70	96	97	98	98	98
60	96	98	98	98	99
50	97	98	99	99	99

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

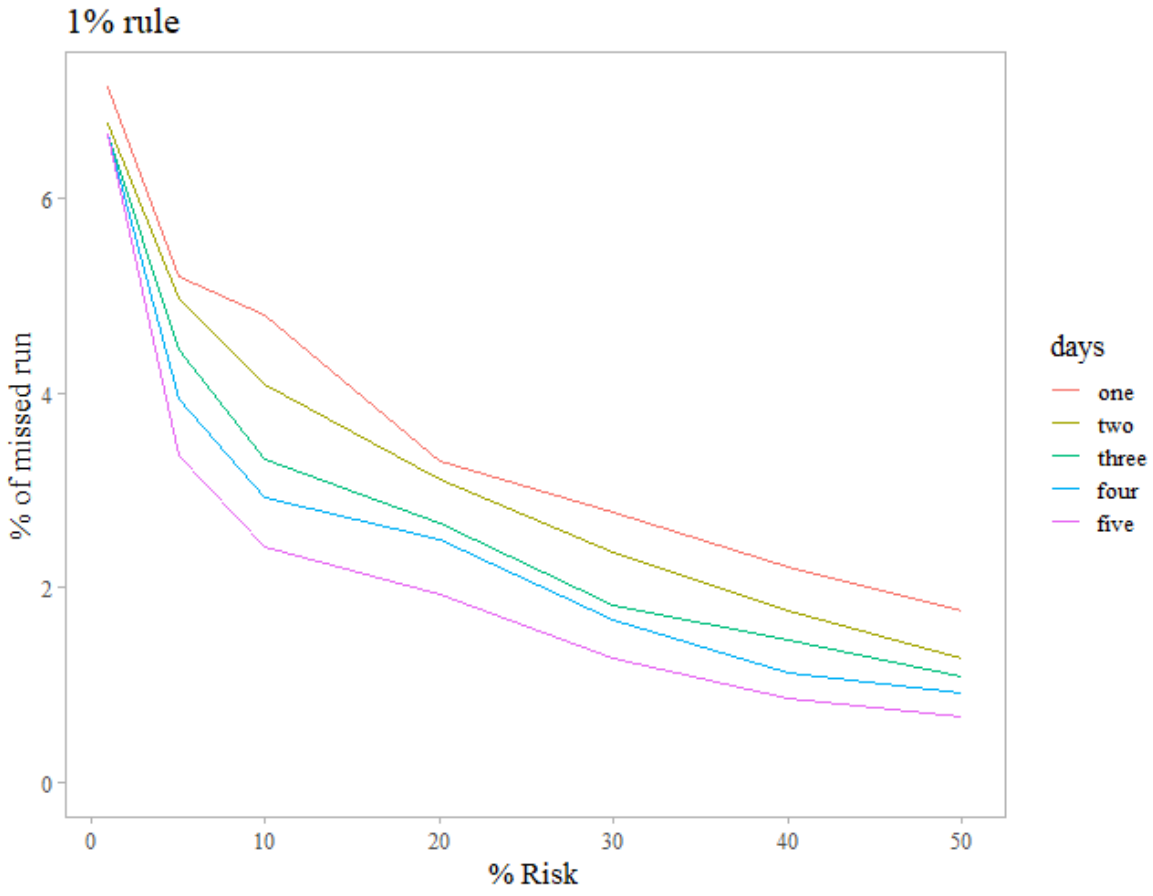

Figure 4: The percent of risk that a given % of the run is missed, e.g., 5% of the run will be missed 4% of the time using a five day 1% rule for the Egegik River.

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	80.6	66.7	54.6	45.7	39.2
5% run missed	6.3	4.8	3.8	3.5	2.2
10% run missed	0.1	0.1	0.1	0.2	0.1
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

The logistic model provided an overall better fit to the data than the Gompertz model. None of the parameter estiminates have substantial error bars (Figure 5) and the models converged for all years. The predicted data show a reasonable model fit for most years (Figures 6 & 7). Based upon all years data the 95% mean passage weir removal date is 2019-09-01. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

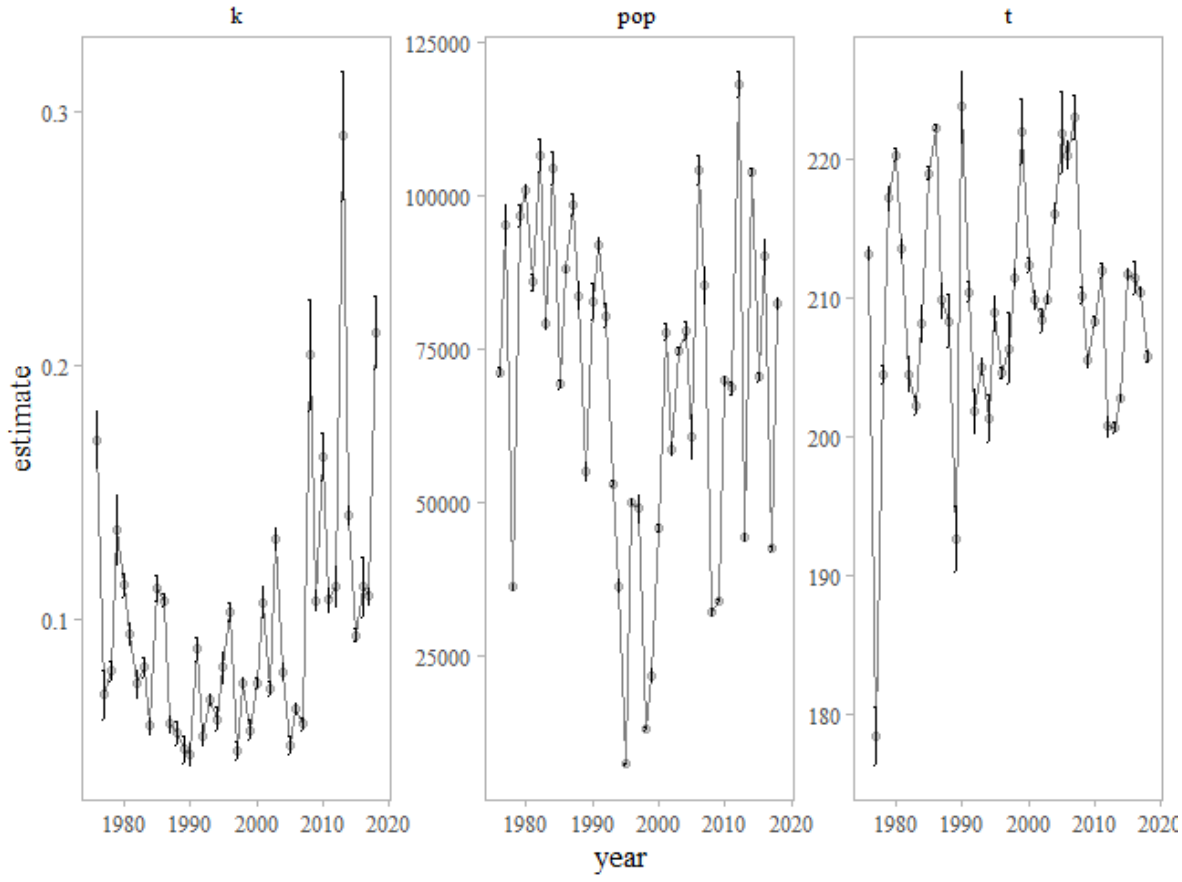

Figure 5: Parameter estimates from the logistic model for the Chilkoot River.

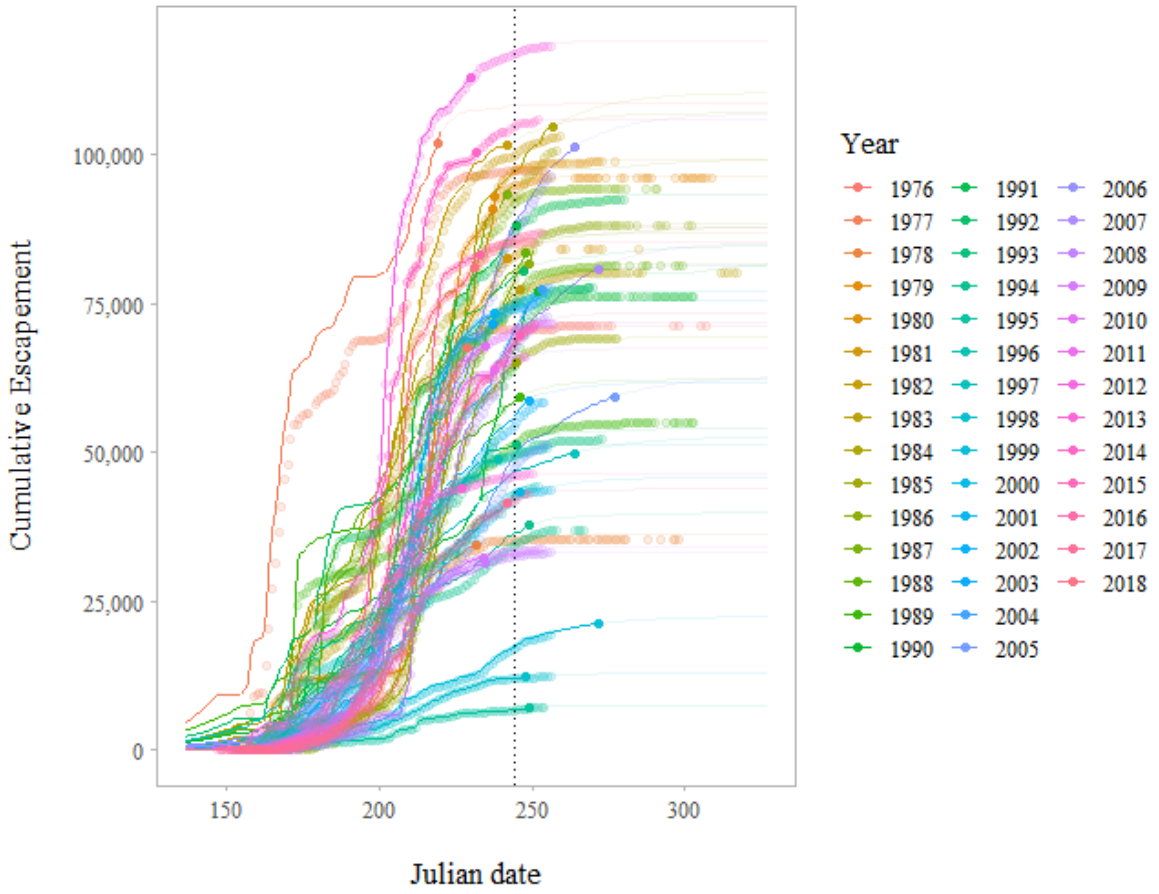

Figure 6: Predicted cumulative escapements by year for the Chilkoot River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

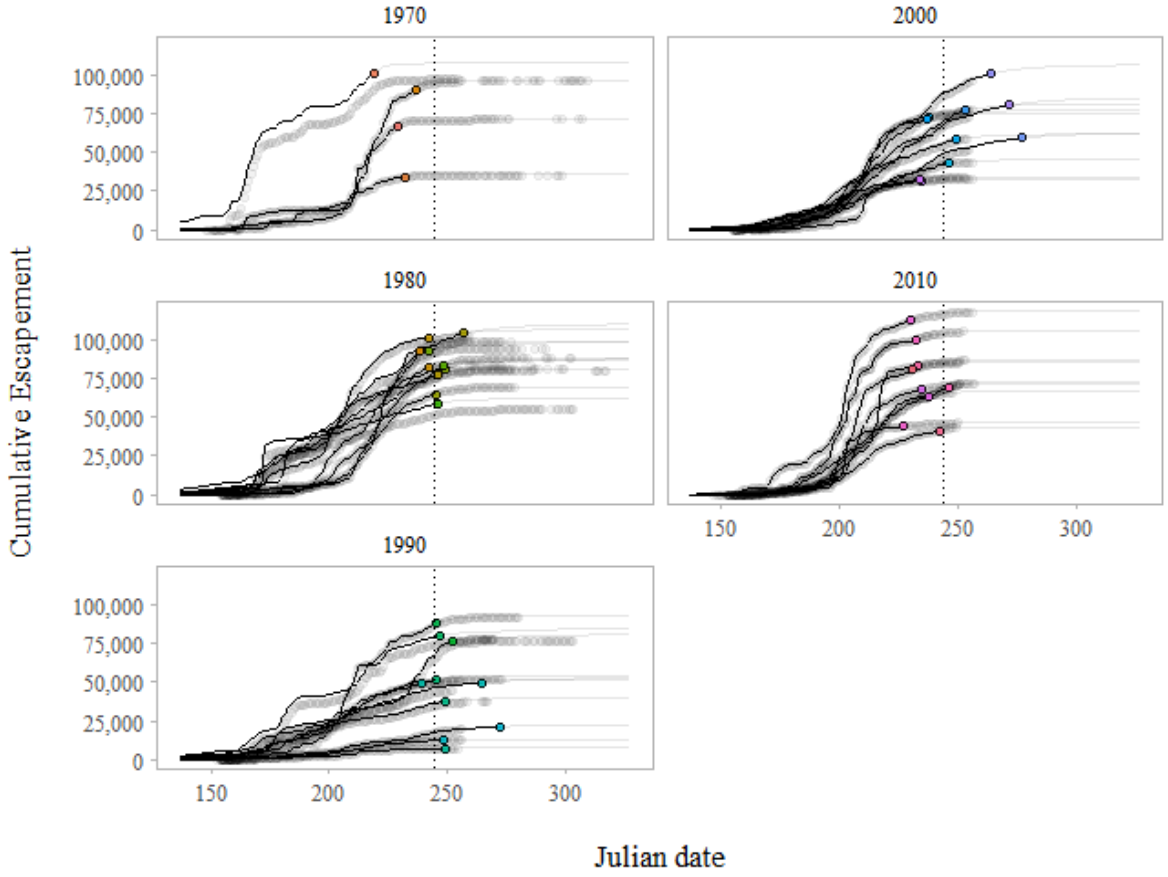

Figure 7: Predicted cumulative escapements by year for the Chilkoot River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

Based upon median removal dates presented in Table 4 there is a 95% chance of capturing 83-85% of the total run, depending on which weir removal rule (# of days) is implemented (Table 5). Note that there is a 50% chance of capturing 95% of the run, e.g., the average 95% mean passage date stated previously.

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	244	244	246	2019-09-01
two	244	244	248	2019-09-01
three	244	244	248	2019-09-01
four	244	244	250	2019-09-01
five	244	244	250	2019-09-01

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	81	82	83	83	84
95	83	84	84	85	85
90	89	90	91	91	92
80	93	93	93	94	94
70	93	94	94	95	95
60	94	95	95	96	96
50	95	96	96	96	96

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

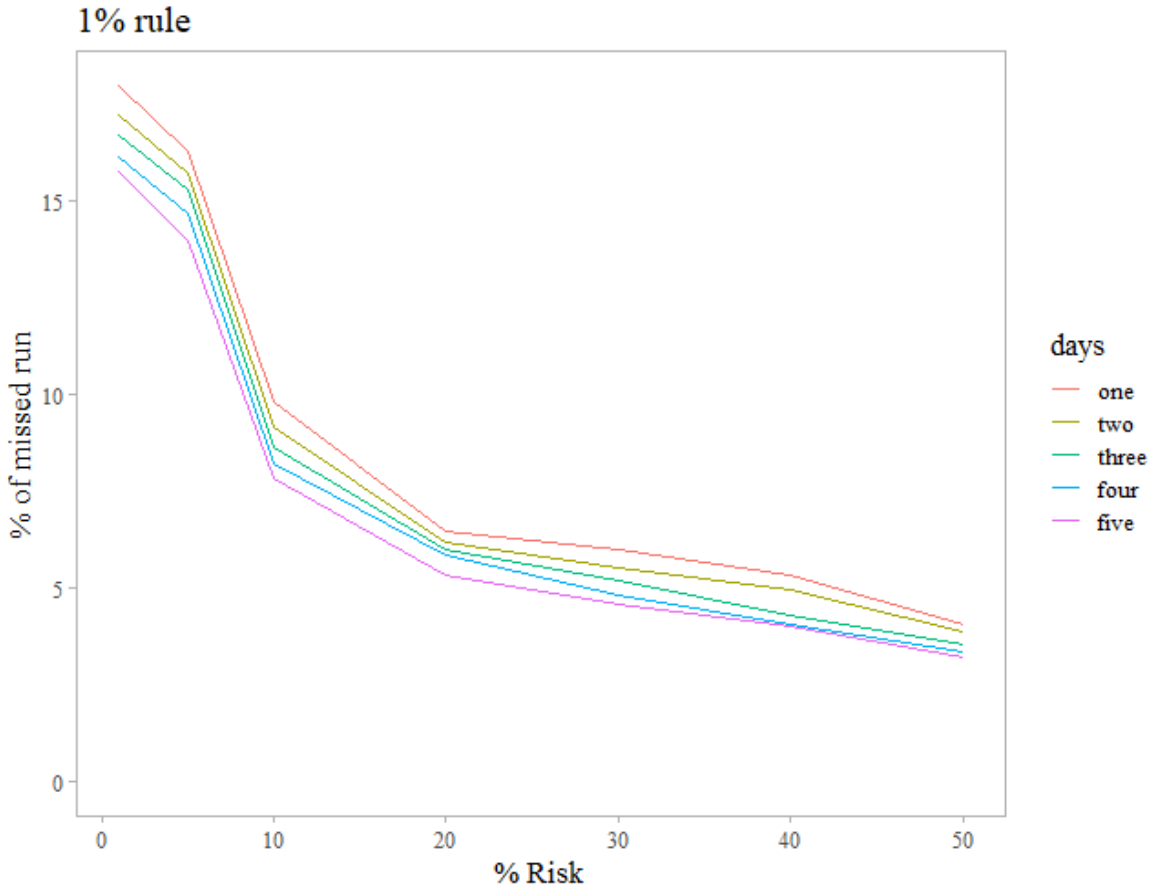

Figure 8: The percent of risk that a given % of the run is missed, e.g., 5% of the run will be missed 14% of the time using a five day 1% rule for the Chilkoot River.

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 would not extend the median removal date. The reason for this is that the run past the 95% removal rate 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	90.5	90.1	89.6	89.2	88.8
5% run missed	39.2	36.8	34.5	32.6	30.6
10% run missed	10.6	9.0	7.7	6.7	5.7
20% run missed	0.6	0.4	0.3	0.2	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

3.1 0.05% Rule

Using a 0.05% rule proved to adjust the median removal date (Table 7) and substantially improve the chance that the majority of the run was observed (Table 8). The 0.05% rule decreases 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	247	244	252	2019-09-04
two	248	244	253	2019-09-05
three	249	244	254	2019-09-06
four	250	244	255	2019-09-07
five	251	245	256	2019-09-08

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	89	90	90	90	91
95	91	91	92	92	92
90	92	93	93	94	94
80	95	96	96	96	96
70	96	96	96	97	97
60	96	97	97	97	97
50	97	97	98	98	98

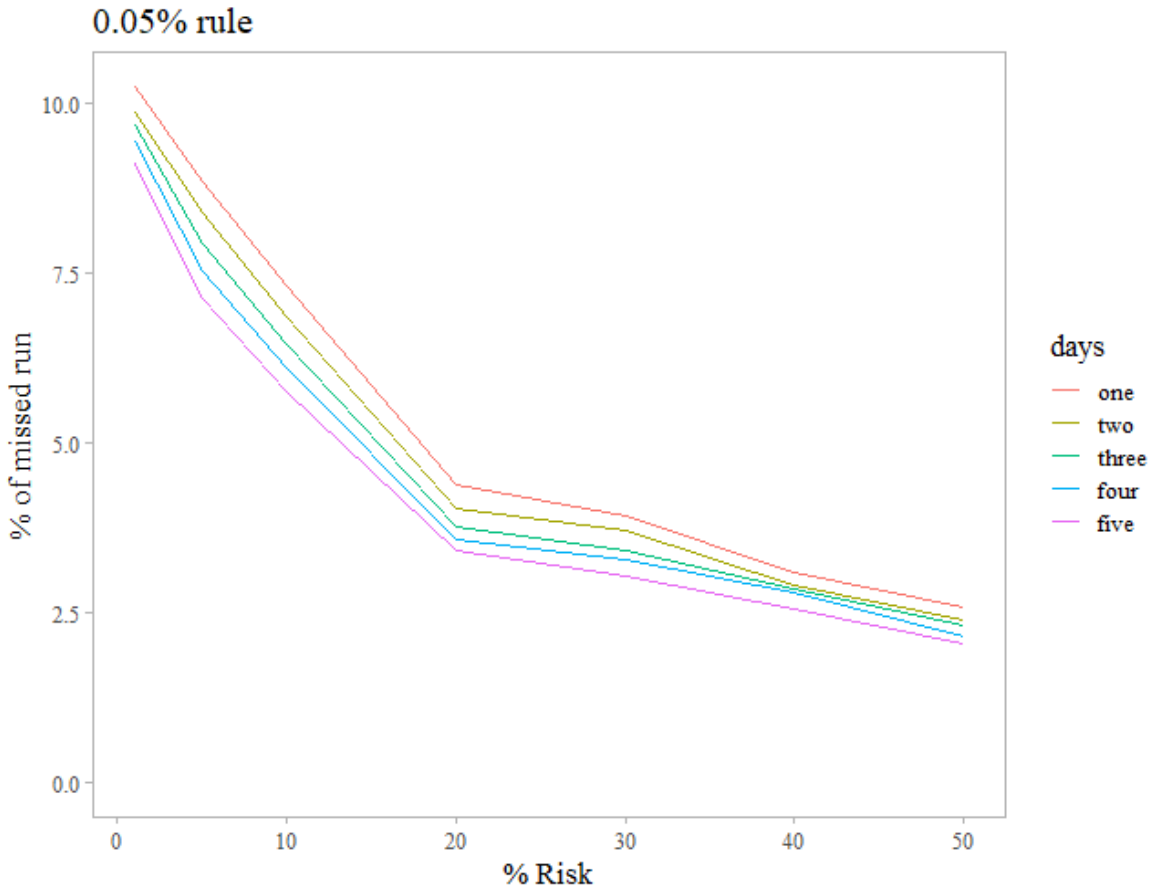

Figure 9: The percent of risk that a given % of the run is missed, e.g., 5% of the run will be missed 7% of the time using a five day 0.05% rule for the Chilkoot River.

The percent of the run that would be missed is further examined in Table 9. Overall, this run is 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 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	88.7	88.0	86.7	85.4	83.7
5% run missed	20.7	18.0	15.7	13.7	11.7
10% run missed	1.8	1.3	0.9	0.7	0.5
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 Situk River

The Gompertz model provided an overall better fit to the data than the logistic model for the Situk River. None of the parameter estiminates have substantial error bars (Figure 10) and the models converged for all years. The predicted data show a reasonable model fit for most years (Figures 11 & 12). Based upon all years data the 95% mean passage weir removal date is 2019-08-16. This is the date that the weir must be operated through, i.e., removal could occur on the following day.

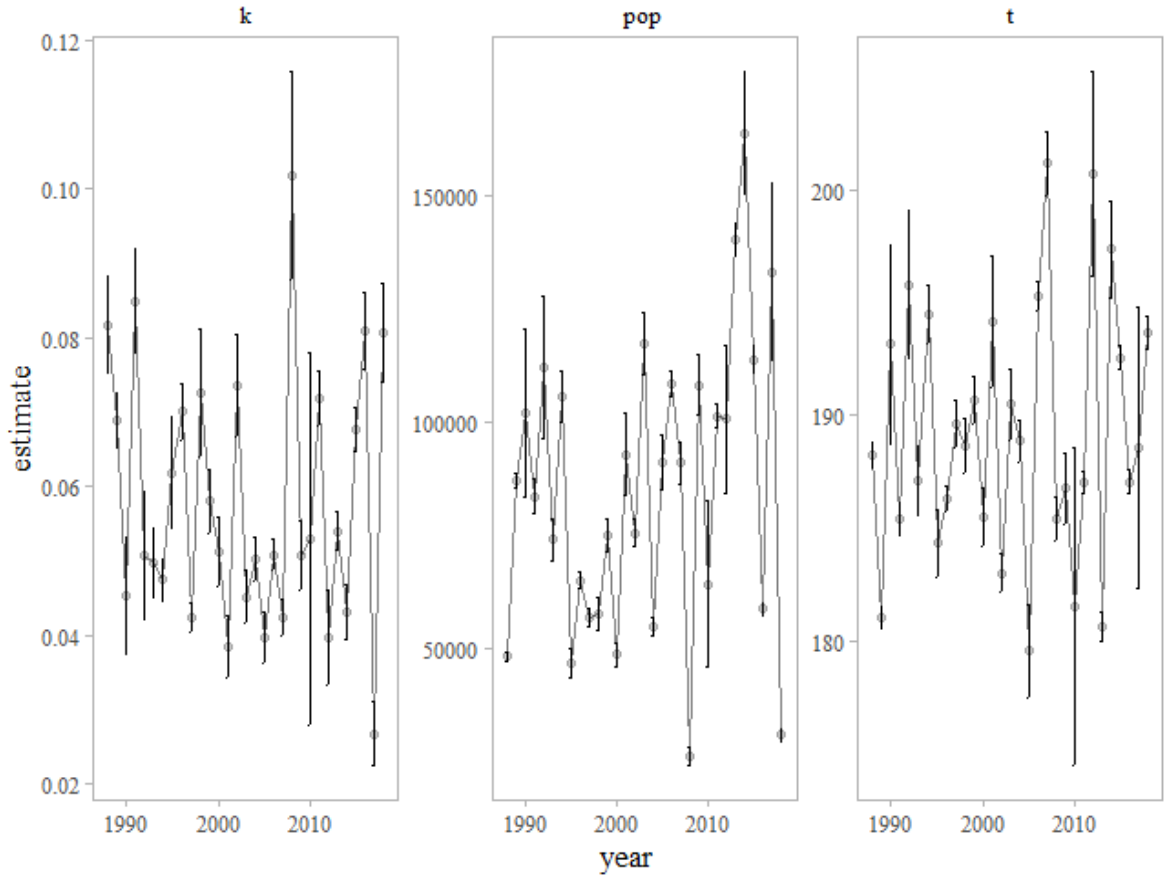

Figure 10: Parameter estimates from the Gompertz model for the Situk River.

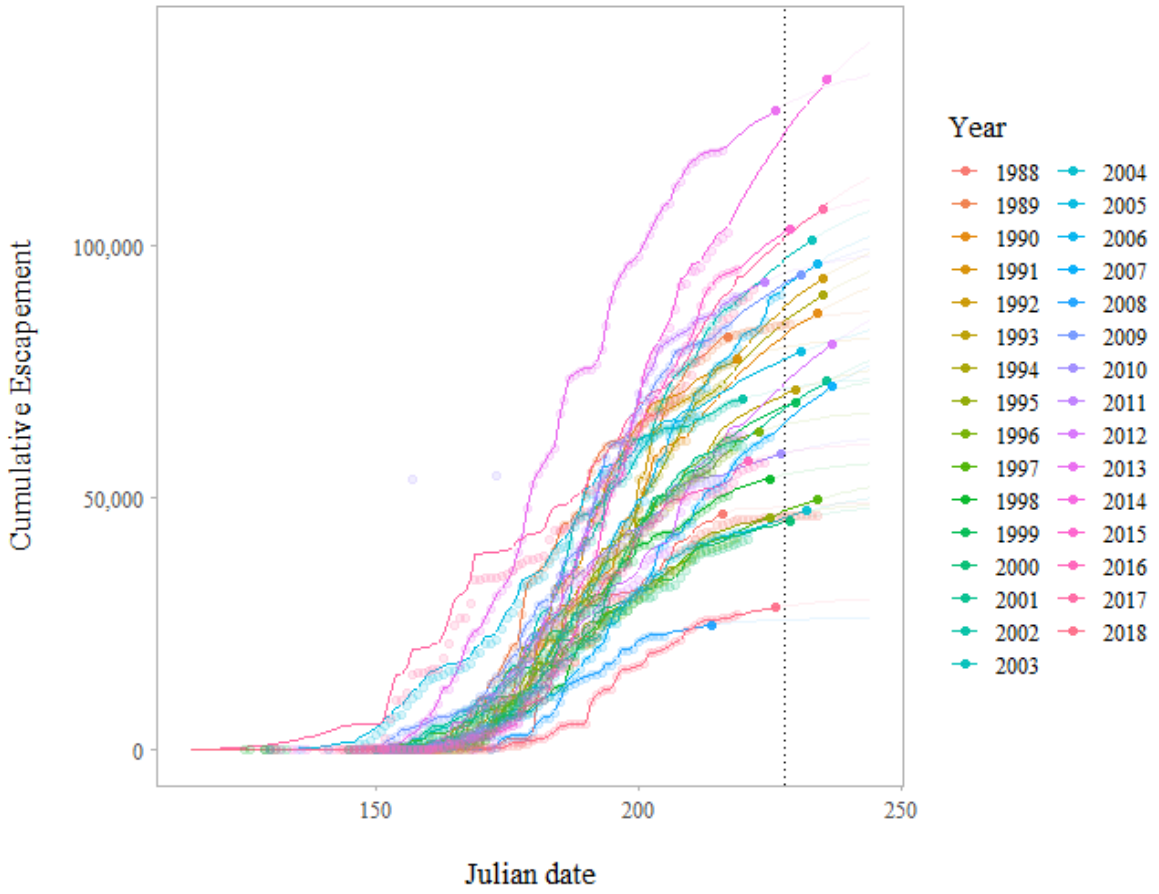

Figure 11: Predicted cumulative escapements by year for the Situk River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

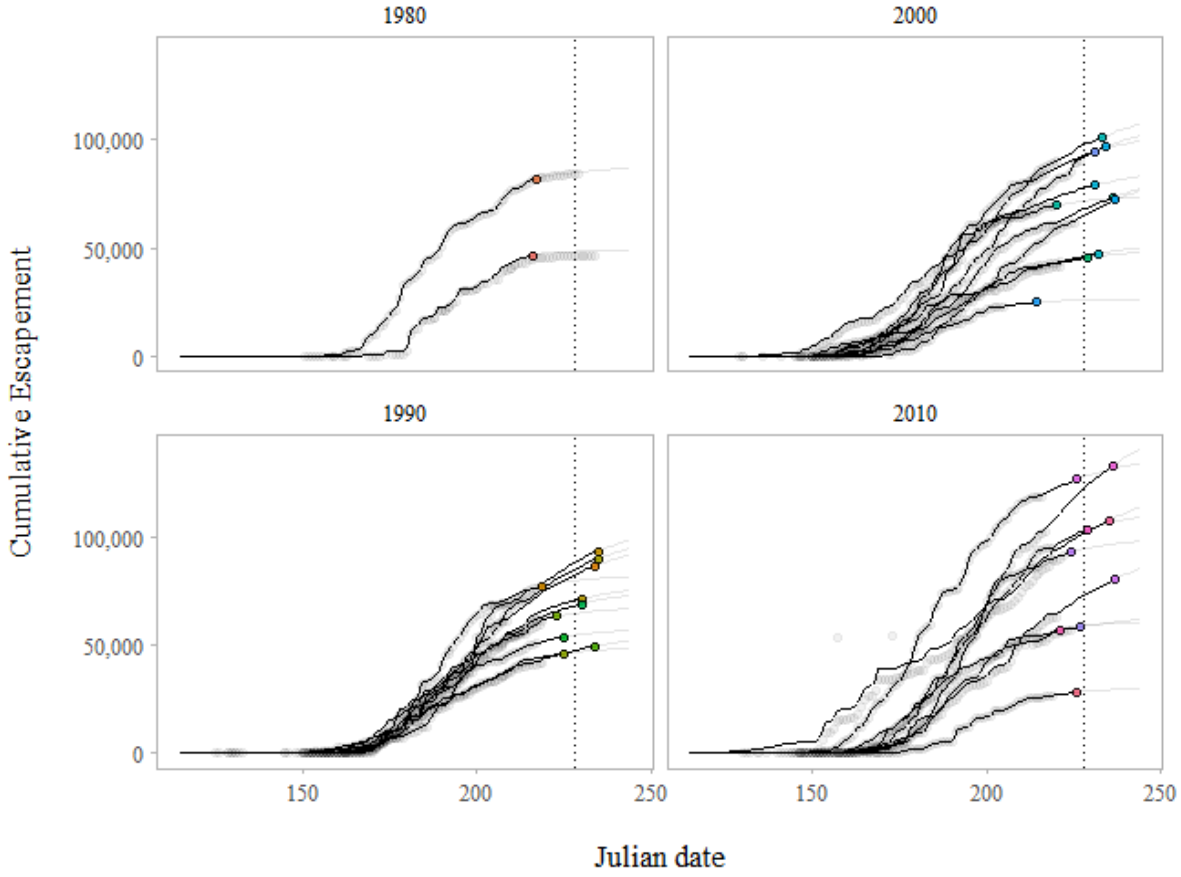

Figure 12: Predicted cumulative escapements by year for the Situk River. Filled circles indicate 95% of the run has passed the weir. The vertical line is the mean date that 95% of the run has passed the weir.

Based upon median removal dates presented in Table 10 there is a 95% chance of capturing 89-90% of the total run, depending on which weir removal rule (# of days) is implemented (Table 11). Note that there is a 50% chance of capturing 95% of the run, e.g., the average 95% mean passage date stated previously.

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	228	228	228	2019-08-16
two	228	228	228	2019-08-16
three	228	228	228	2019-08-16
four	228	228	228	2019-08-16
five	228	228	228	2019-08-16

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	89	89	89	89
95	89	89	89	90	90
90	89	89	90	90	90
80	90	90	90	91	91
70	92	92	92	92	93
60	93	93	93	93	93
50	93	93	94	94	94

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

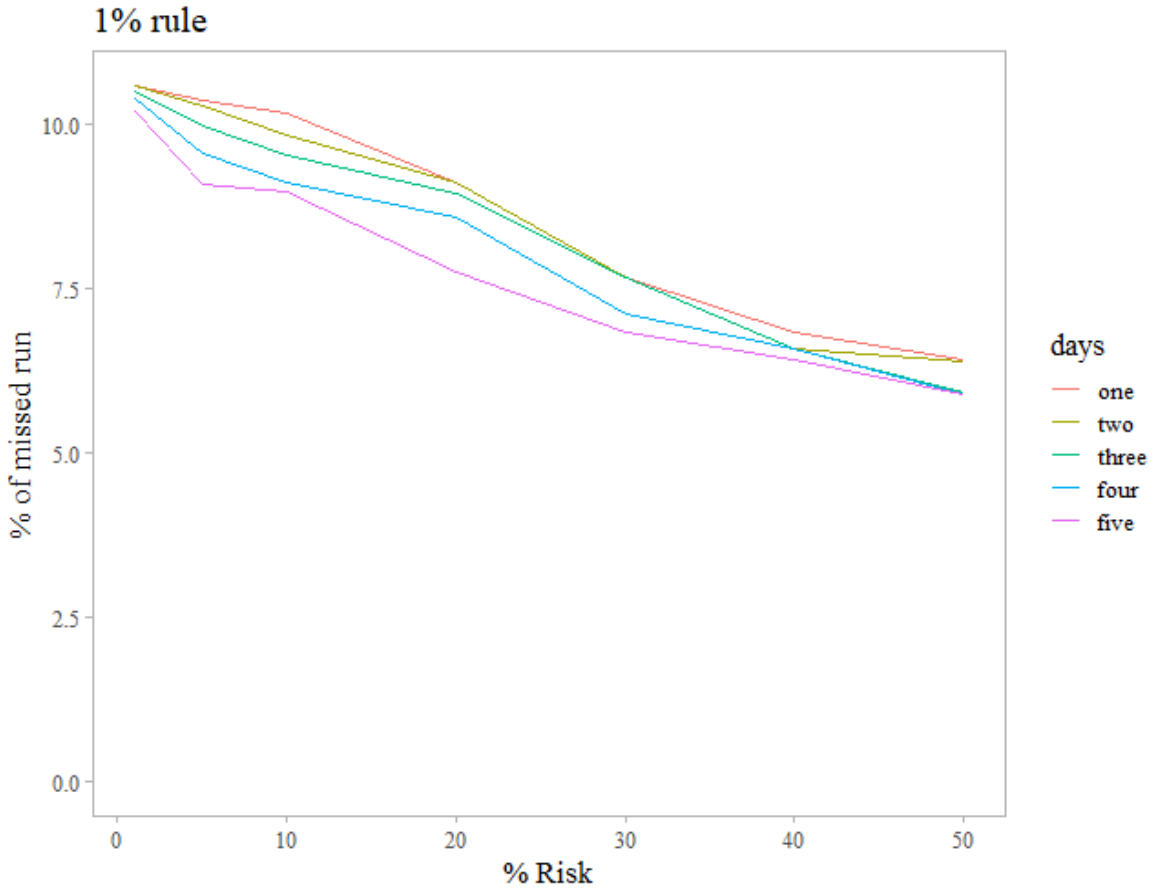

Figure 13: The percent of risk that a given % of the run is missed, e.g., 5% of the run will be missed 10% of the time using a five day 1% rule for the Situk River.

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 as the would not extend the median removal date. The reason for this is that the run past the 95% removal rate 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	99.1	99.2	99.2	99.3	99.3
5% run missed	56.9	56.1	54.9	53.2	50.7
10% run missed	12.2	11.4	10.0	8.6	6.9
20% run missed	0.2	0.2	0.1	0.1	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

4.1 0.05% Rule

Using a 0.05% rule proved to adjust the median removal date (Table 13) and substantially improve the chance that the majority of the run was observed (Table 14). The 0.05% rule decreases 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	228	241	2019-08-20
two	233	228	242	2019-08-21
three	233	228	243	2019-08-21
four	234	228	244	2019-08-22
five	235	228	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	95	95	95	95	96
95	95	95	95	95	96
90	95	95	96	96	96
80	95	96	96	96	96
70	96	96	96	96	97
60	96	96	96	97	97
50	97	97	97	97	97

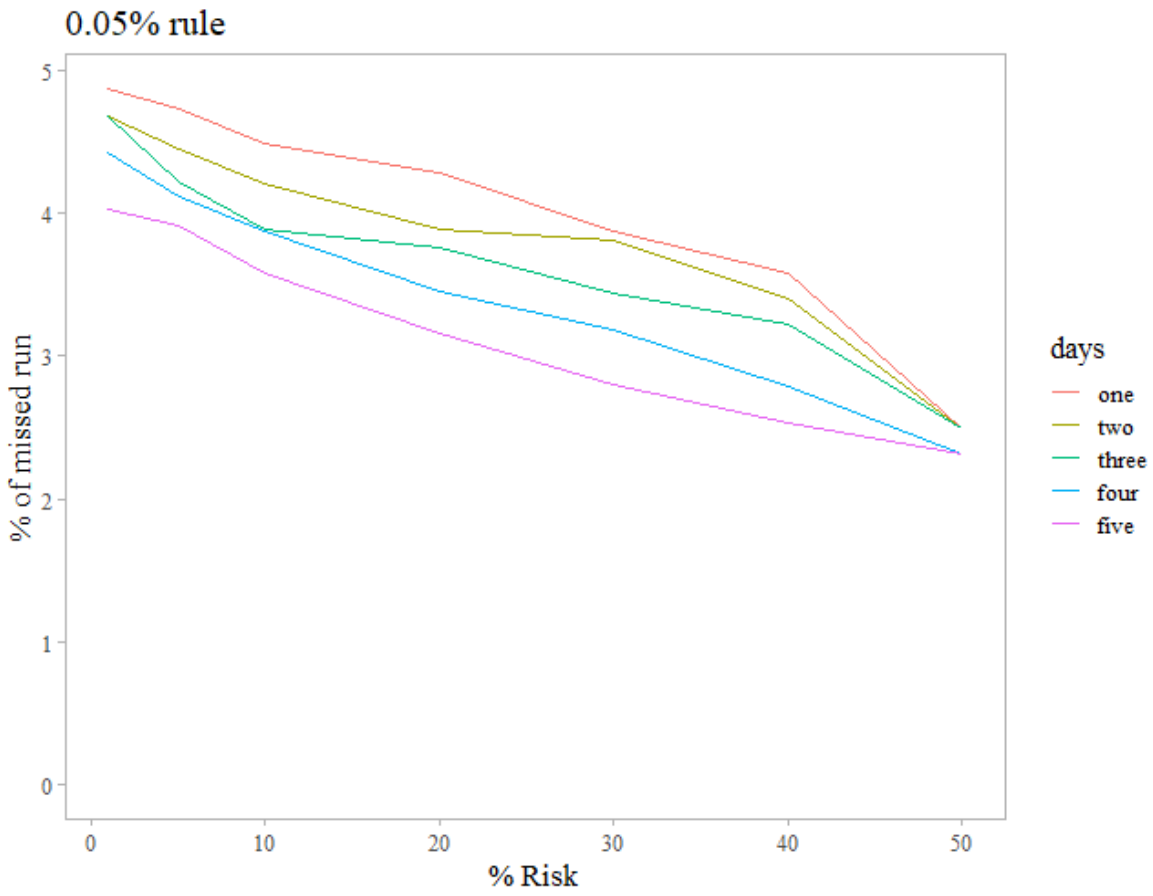

Figure 14: The percent of risk that a given % of the run is missed, e.g., 5% of the run will be missed 7% of the time using a five day 0.05% rule for the Chilsituk River.

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	53.8	51.5	43.9	42.4	39.2
5% run missed	16.1	14.5	13.5	12.2	10.8
10% run missed	4.6	3.9	4.3	3.6	3.2
20% run missed	0.5	0.4	0.6	0.4	0.4
30% run missed	0.1	0.0	0.1	0.1	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