Monthly Q Percentile Modeling for WALLY Online Watershed Information Tool

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(Artist's Rendition of the project by Noah Carson)

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Executive Summary

Fathom Scientific Ltd. (FSL) has been contracted by the Province of British Columbia

Ministry of Forests (MoF) to update the underlying hydrological model for Wally – a decision-support tool that will assist water authorization staff in making robust, defensible water allocation decisions. The MoF requested that 180 models be developed (3 Hydrological Zones x 12 months x 5 exceedance values) based the approach developed and described in for the South Coast Stewardship Baseline (SCSB 2016) project as well as for the Regional Strategic Environmental Assessment (RSEA 2020) project. Those projects built on prior work undertaken for the South Coast Drought Response project (Sentlinger 2015).

The SCSB, RSEA, and Drought Response projects utilized traceable and common-sense approaches to determine monthly and seasonal water allocation, paired with transparent and defensible multivariate regression models using Geospatial statistics and Quality Controlled/Quality Assured (QA/QC) hydrometric data. These studies used a modified k-fold approach to ensure the chosen model was robust to different training sets. The resulting algorithm has been dubbed the Modified k-fold Multivariate Geospatial Regression (MkMGR) model. The Wally team was disbanded in 2021, but the work was made Open Source and we have branched and updated the tool.

Wally uses a state-of-the-art Upstream Drainage Area (UDA) delineation algorithm that utilizes the GIS Whitebox Tools to delineate a watershed outlet which is combined with the BC FreshWater Atlas (FWA) to accurately and defensively delineate watershed headwaters. Using this accurate watershed boundary, GeoSpatial stats such as average slope, glacial content, and annual precipitation is derived and used to build multivariate models for various hydrostats, such as Mean Annual unit-Runoff (MAR) and 7Q10.

The resulting models are integrated into the online Wally tool, and is made available to MoF staff, being hosted on Fathom servers for the period of one year. The tool is accurate, faster, and aligns with an ethos of a public good, when compared to the alternatives, as it was in RSEA (2020). For posterity, and to support the triumph of the commons, we hope this important work can be continued beyond the borders of this contract.

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ACRONYMS AND ABBREVIATIONS

GIS	Geographic Information System
HZ	Hydrological Zone
MAD	Mean Annual Discharge
MkMGR	Modified k-fold Multivariate GeoSpatial Regression model
MMD	Mean Monthly Discharge
MOECCS	Ministry of Environment & Climate Change Strategy
P20	20^{th} Percentile, or the 80% Exceedance
POD	Point of Diversion
RISC	Resources Information Standards Committee
SC	South Coast
WSC	Water Survey of Canada

1 INTRODUCTION

Fathom Scientific Ltd has been engaged by the Province of British Columbia, Ministry of Forests: South Coast region to update the Modified k-fold Multivariate Geospatial Regression (MkMGR) model that is implemented in Wally. The Wally project was an ambitious and commendable attempt to bring cutting edge and transparent water modeling to the Province of British Columbia. Gabe Sentlinger of Fathom Scientific was retained as an expert advisor for this project to provide guidance and advice in the modeling of various Hydrological Statistics (hydro-stats), as well as user experience feedback.

1.1 Previous Work

The general approach to the modeling is the same as used in "South Coast Stewardship Baseline (Brem, Fraser Valley South, Toba, Upper Lillooet) REV 1.0" (Sentlinger & Metherall 2016), hereafter referred to as the SCSB. In that study, we built relationships between GeoSpatial Stats (GeoStats) and hydro-stats, and employed a modified k-fold approach to regression modeling which determined the most robust model using limited dataset sizes (from 5-30 training samples). This modeling technique is hereafter referred to as Modified k-fold Geospatial Regression Model (MkMGR). The full details of that study are described in the SCSB report and generally not repeated here. The approach was further refined in "RSEA Hydrology and Allocation Baseline REV 1.0." (Sentlinger & Metherall 2020 hereafter referred to as RSEA). In this later study, we added more hydro-stats to the models, and combined Hydrological Zones (HZ) to increase the training dataset size in data-sparse regions. The approach and results from the Wally project are contained within "Hydrological Modeling for the Wally Project. Version 0.5 (Oct 6, 2021)" (Sentlinger, 2021).

In general, Geo-Spatial Statistics, or "geo-stats", are derived/calculated from GIS layers that previous studies have found to be powerful predictor variables. These predictor variables are derived for long term (usually WSC) stations and used in a Multivariate Regression Model for the dependent Hydrological Statistic (hydro-stat). Because datasets in Hydrological Zones (HZ) are generally sparse (from 6 to 43 according to Table 1 in the Wally Report) which is close to the number of predictor variables (from 6-8), we use a Modified k-Fold approach, which iterates through up to 100 variations on the training dataset (using 70% of the data) to find the most robust model. One the best model is chosen, all available QC'd data is used to retrain the model. This approach, called Modified k-fold Multivariate Geo-Spatial Regression (MkMGR) strikes a balance between robustness and accuracy. Typically, the best model contains 2-4 variables, with a median of 3. The geo-stats used are listed below, in order of prevalence in this study, as calculated by the number of models in which the co-efficient is non-zero.

1. Glacier Coverage (%) 63%
2. Median Elevation (m) 53%
3. Potential EvapoTranspiration (mm/year) 51%

4. Precipitation (mm/year) 42%
5. Solar Exposure (%) 40%
6. Slope (%) 24%
7. Drainage Area (km^2) 7%

In almost all cases, we normalize by Mean Annual Discharge (MAD) in order to focus in on the subtle differences between stations. The one exception is that the MAD is derived by Mean Annual unit Runoff (MAR), which the MAD divided by DA *1000 to get $l/s/km^2$.

There is a multiple regression model for each hydro-stat. For an ungauged basin, or study site, the Wally tool will:

1. Delineate the Upstream Drainage Area (UDA) and calculate the geo-stats for the UDA.
2. Apply the multivariate model for the desired hydrostat, the March P20 for example, using the derived geo-stats.
3. Multiply the result of the model by the normalizing variable, usually MAD, to get the hydro-stat in engineering units, usually m^3/s.

We reviewed the two reports provided by the client, "Estimating Flow-Duration and Low-Flow Frequency Statistics for Unregulated Streams in Oregon" (Risley, Stonewall, and Haluska2009) and "Estimating Annual High-Flow Statistics and Monthly and Seasonal Low-Flow Statistics for Ungaged Sites on Streams in Alaska and Conterminous Basins in Canada" (Wiley & Curran, 2003), collectively referenced hereafter as the "USGS Methods". While they take a technically different approach, the main methods are the same:

1. Break up the region into hydrologically similar zones. Risley et al, takes an interesting approach to refining zone boundaries or breaking up zones (as we did in RSEA 2020).
2. Build multi-variate regression models based on Geo-Spatial statistics. We differ in that we use only publicly available datasets that span the BC, Yukon, AB, and USA border.
3. Use an iterative approach to add and remove independent variables that increase their objective variables, R^2 and Mean Absolute Error

However, we differ in how we approach robustness.

1. They use the step-wise regression, both forward and backwards, and artificially limit the number of variables to 4, although they screen out unused variables based on cross-correlation and significance. We use the modified k-fold method described in Sentlinger (2016, 2017, 2020, 2021), which essentially does the same but perhaps is more robust for smaller datasets that are available in Canada.
2. They use Drainage Area as an independent variable. We chose to build all of our models in drainage area normalized space, thereby eliminating the most significant variable that will skew regression and results in large R^2 values. We also chose to divide all flow hydro-stats by Mean Annual Discharge (MAD) to

again focus on the more subtle details in the regression, much like using a microscope on the variance.

We compare example results to the two methods under Section 2.4. In all cases, our normalized approach outperforms the USGS methods.

2 METHODOLOGY

There are three main components to the estimation of Hydro-stats, they are: 1. the Watershed Delineation and GeoStats, 2. the Water License Allocation and Return coefficients, and 3. the HydroStat modeling. The details of each are outlined in previous reports and not repeated here. We will go over the salient features of 3 as it pertains to the new models.

2.1.1 Geospatial Predictor Variables

Beyond having the flow statistics derived from Hydat using FASSTR, we need GIS-derived statistics to complete the analysis, which required having drainage area polygons. The drainage area polygons were generated using Wally, described in detail in Sentlinger (2021), but basically, the catchment is a hybrid of a Whitebox Tools delineated Catchment outlet (based on CDEM) and BC FWA headwaters.

Note that the Geospatial stats used in the current study are essentially the same as used in SCSB and RSEA, however the base data from which it is derived has changed slightly, namely the DEM and PET.

The spatial data sources used to derive catchment characteristics are as follows:

1. Digital Elevation Model (DEM): In Sentlinger (2016) we used elevation data primarily provided by GeoBase and the 1:50k Canadian Digital Elevation Data (CDED). This data is very good quality in BC: we have found that elevation contours are within 10m of BC Terrain Resource Inventory Mapping (TRIM) contours. For most areas of the Province in the current study, 90m pixels were used to derive DEM stats. However, when delineating drainage lines in more populated areas with more terrain modification, 20m pixels were used. For this study, we chose to use the 90m CDEM to derive DEM-based geospatial stats:

    a. The hillshade image (using an azimuth of 180° and altitude of 45° with shadows, a.k.a. Solar Exposure),

    b. Slope in % (rise/run),

c. Median Elevation, and

d. Drainage Area.

Because this dataset is a higher resolution than the 500m pixels in SCSB and RSEA, the coefficients and intercepts (model parameters) from that study cannot be directly employed to the geospatial stats derived in this study.

2. Glacier coverage: We used the 1:50k NTS glacier coverage database

3. PRISM Annual Precipitation: Produced by the Oregon Climate Center (Daly 2002). This regression model uses data from local long-term meteorological stations along with DEM data to estimate the local ($1km^2$ pixels) precipitation. We only considered annual precipitation since Sentlinger & Metherall (2016) found no significant predictive power was gained going to monthly precipitation estimates.

4. Annual Potential Evapo-Transpiration (PET) (Trabucco 2019): This variable is globally available and takes into account solar radiation and temperature. It's an updated model from PET (Trabucco 2009) used in SCSB and RSEA. In all cases checked, it's a larger value than Trabucco 2009. Therefore, again, the models derived in SCSB and RSEA cannot be directly applied to the estimates of PET in this study.

5. As an experiment, we used %GrossAllocated/MAD as a predictor variable. While we found some predictive power in low flow months in HZ26, namely August and February, it was not easy to employ in the production Wally tool, and did not offer significant advantage, perhaps only 1-2% improvement in R2 over alternative models. It was not therefore included in the production models, but the modeling results are included in the appendix for information.

2.2 Naturalization/Water License Consideration

Naturalization of long-term flow series was not attempted given the difficulty and complexity of the task. The first step undertaken was to derive all the upstream surface water licenses for the WSC stations (see Sentlinger, 2021 Section 2.6), then calculate the total gross allocated water, the return flows, and the net allocated water. Two stats were found to be particularly useful in flagging/excluding WSC records:

1. the Gross Allocation (disregarding return flows) expressed as %MAD
    - The Gross Allocation is the total licensed surface flow on an annual basis
2. the Net Allocation.

- The Net Allocation is the net licensed surface flow in consideration of the estimated return flows, on an annual basis.

We found that by filtering stations by

1. >10 complete years of daily data AND
2. A Wally DA within 20% of the Hydat DA AND
3. <200%MAD Gross Allocation OR Net Allocation = Zero,

we could achieve a balance between keeping stations that have MAR and S-7Q10/MAD close the QA/QC'd values in Obedkoff/Ptolemy/Ahmed, while filtering out stations that did not. Note that Ptolemy included stations with <20 years. To put it another way, if a station had <200%MAD Allocated Gross, it was included regardless of Net Allocated. If a station had a Net Allocation of Zero, it was included regardless of Gross Allocated. Generally, the latter are run-of-river hydropower projects. In RSEA, we note:

> *"Ahmed and Obedkoff used only Non-Regulated WSC data as indicated in the WSC record. Ahmed states:*
>
> *The hydrometric stations (data) included in the analyses met the following criteria:*
>
> - *natural flow (or flow with minor regulation);*
> - *minimum 12 years of substantially complete monthly flow data (with a few exceptions); and*
> - *Measured instantaneous discharge.*
>
> *Dave Hutchinson (2020) provided this definition of regulated: "The record designation Natural (or non-regulated) is applied only if the monthly mean value and/or the maximum instantaneous value is increased or decreased by 10% from that of the natural regime". Based on this definition, we can assume that the flow records used in this report have not been modified by more than 10% of mean monthly flow. If they have been reduced by this much or more, then the model results are conservative (i.e. lower than natural)."*

In the current study, we are not using Ahmed or Obedkoff as training data, and cannot rely on the QA/QC they implied. **We are not considering the WSC designation of Regulated/Natural**. Instead we have used their studies as reference points to try to achieve a balance between sample size and natural conditions. It's impossible to know the true hydro-stat for a watercourse unless it's 100%natural. However, many WSC stations have some form of water license, often insignificant. We do not have an objective measure to use the chosen filter of <200%GrossAllocated/MAD OR NetAllocated/MAD = 0. This filter also resulted in a significantly tighter distribution about a regression line for a hydro-stat and HZ, independent of the reference studies (Obedkoff/Ahmed). This topic is further discussed in Section 2.4 of the Wally report (Sentlinger 2021), with plots, summarized in. We fully acknowledge that more rigorous work and selection criteria could be employed, but point out that our filtered WSC hydro-stats have a high R^2 with those form Obedkoff/Ahmed (>97%), shown in Figure 1.

We acknowledge that there is work to be done on naturalization. However, we believe the foundation is in place to undertake such work. This first pass at the model is simply meant to flag those WSC records which do not pass the Quality Control filters employed in Obedkoff/Ahmed. If anything, un-naturalized flows, especially low flows, will be reflected in the regression models as lower predicted flows (conservative from a water licensing perspective). We also consider the potential impact of surface water licenses on outliers (Anderson, Mahood_Newton, Owl, Coquitlam) in the Validation Section 3.4.

2.3 Derivation of Long-Term Hydro-stats

We used the FASSTR library from the BC Government to derive hydro-stats from the Hydat Database. We normalize all datasets, usually by MAD, but by DA in the case of deriving MAD. We do this in order to get the most information out of the relatively small datasets, which is discussed further below. We use the quantile function in FASSTR to determine the P10, P20, P30, P40, P50 for each month. We only use months from complete years of data. Table 1 shows all WSC stations and their MAD and GeoSpatial Stats used in the study.

2.4 HydroStat Normalization

Since Sentlinger&Metherall (2016) we've used normalized dependent variables, starting with the Mean Annual unit-area Runoff (MAR), which is the MAD/DA. If we don't do this, the regression is dominated by the DA, and it also makes it difficult to see regional trends in a geographical depiction. Seeing how the MAR varies with regions, and how it transitions between Hydrological Zones has been critical for Quality Assurance and Quality Control in previous studies. Likewise, normalizing the low flow hydrostats, for example S-7Q10 or P20, by the estimated site MAD, allows the information in the regression to be maximized to find subtleties between stations. Both of these techniques have resulted in modeling results superior to EcoFish Research (SCSB 2016) and to NEWT (RSEA 2021).

As an example of the problem with performing the regression against absolute P20 values, rather than P20/MAD, take August in HZ27 for example, shown in Figure 2. The regression is skewed towards the larger flows, while lower flows have very large %errors, and negative predicted flows. Taking the log of DA and log of Precipitation, as they did in USGS does not help and results in more negatively skewed predicted flows. However, taking Log(P20), Log(DA) and Log(Ppt) results in reasonable results, shown in Figure 4. An R^2 of 0.90 is still not as strong as the R^2 of 0.96 in the comparable Aug P20/MAD shown in Figure 16. Every regression test we undertook where we did not normalize, chose DA and Ppt as the first two variables, and the final R^2 is not as good as dividing by MAD, then multiplying by SimMAD. We have therefore chosen to divide all monthly hydrostats by MAD before regression, then multiply by the Simulated MAD to arrive at a flow value.

There are further questions to answer regarding the regression:

1. Does the %Allocated affect the low flow statistics
2. Should the low flow values be normalized by Mean Monthly Discharge (MMD) or Mean Annual Discharge.

As described in S&M (2016) and subsequent reports, we normalize monthly flows by MAD as well. One deterrent to normalizing P value statistics by MMD, such as Aug P20/MMD, is that the final P20 values would be based on two regression models: Sim-MMD/MAD and MAD=Sim-MAR*DA. Results in Figure 5 to Figure 16 compare the models for each of the 3 zones for August P20, divided by MMD and also divided by MAD. The latter, /MAD, generally outperforms /MMD, if only marginally. Therefore we've chosen to use /MAD as our normalizing variable. Note that if the measured MAD is used, the R^2 values are very high: HZ25: 0.99, HZ26: 0.97, and HZ27: 0.97. This suggests that the P20/MAD regression is very strong and that both can be improved upon with improved modeling of MAD.

In regards to the %Allocated, we've pursued several lines of investigation without definitive results. For example, in Figure 14, Anderson Creek is quite high above the regression line (Measured is higher than Predicted for this region) but only has 7%MAD allocated gross and 2%Allocated Net (after return coefficients are applied). This passes our <200%MAD filter. We have investigated all water licenses in the catchment and determined that many are irrigation, but with restrictions against summer (August) withdrawals. So, it may very well be that water is stored in the wet months and released slowly over summer with no withdrawals. However, this not possible to determine automatically from the water license database. This may not even explain the higher than expected August P20. Likewise, the Yorkson Creek shown in Figure 13 is much higher compared to the regression line, and has 0%Allocated, Net or Gross. But it is in a heavily urbanized region. Similarly for the outlier Mahood Creek near Newton and Mackay Creek in North Vancouver. Either these outliers are caused by influences from urban development, or these are naturally occurring statistics that we cannot accurately model. In either case, the regression modeling will capture this uncertainty and the Wally tool will relay it to the user. In future iterations of the tool and modeling, we may be able to either naturalize, or filter objectively, these outliers.

We tried to include the %Allocated Gross as a predictor variables in the modeling algorithm. It did not perform as well as the other predictor variables, but was chosen as one of the significant variables in 11/284 models, primarily in HZ26 in low flow months. These results are included in the Appendix for reference. In general, the R2 did not increase much, maybe 1-2%, over a model based on geo-stats alone. Due to the difficulty in implementing this variable in the production Wally tool, it was not used in the final models, shown in Table 2 to Table 4.

3 RESULTS AND DISCUSSION

3.1 Summary of Results

In this section, we only discuss two key percentile, the P20 and P50 models. Results were similar in the other percentiles. In particular we are trying to understand which WSC stations fall above or below the regression and line and why. We also discuss which predictor variables were chosen as the "best" model and give possible explanations as to why that might be.

Tables showing the geospatial coefficients, R^2, Standard Error in Hydro-Stat units (for example P20/MAD in %) are shown in Table 2 for Zone 25, Table 3 for Zone 26, and Table 4 for Zone 27. In these tables, the coefficient is shown for each geo-stat, along with the intercept. Note that the Slope is %x100, ie a slope of 50% is 50, but %Glacier and %SolExp are both decimal, so 5% glacier is 0.05. This is a strange inconsistency that should be resolved in future models.

In the tables, Avg is the average of all values in the training data. STDEV is the standard deviation of all the training data. STEYX is the regression modeling error and in units of the regression dependent variable. For example MAR (l/s/km2), P20/MAD is in %MAD, not %Error! For example, in HZ26, the STEYX for August is 0.043, meaning 4.3%MAD, not %Error. So if the P20 is 0.015m^3/s at MacKay in August, and our simulated P20 value is 0.009m^3/s, the difference is 0.006m^3/s. If we divide that by the MAD of 0.023m^3/s, it's an error of 0.026 or 2.6%. This is within 1 standard error, and definitely within 2xStandardErrors (95% confidence) therefore is not significantly different, which is shown in **Error! Reference source not found.** for MacKay Creek in the row "FSL 95% SigDiff?" with the answer "False".

A few observations serve as part of the validation exercise:

1. In HZ 25, with higher elevations and larger glacier content, we can see that GLC was the most popular geo-stat, appearing in 61 of the 78 models (78% of the time) followed by PET, Med Elev, and Ppt. DA was not included in many (remember these stats are all divided by MAD).
2. In HZ 26, which has glaciers but is more coastal, Glc was second to Med Elev, followed by PET.
3. In HZ 27, with no glacier and much more low lying delta lands, predominant predictor variables were Precip and SolExp.
4. In all cases, the regression result is better than simply taking the HZ average, as expected. This is shown in the column "Better?" and "By how much".

5. In HZ25 and HZ26, the R2 and the improvement was often the lowest in June.
6. In HZ25 and HZ26, the R2 and the improvement were often highest in late summer, probably due to glacier influence.
7. In HZ27, the greatest improvement and performance were in May-July, and the poorest performance was in Aug – Sep.
8. In HZ25 and HZ26, the Glc coefficient is always negative in the winter and positive in the summer
9. In HZ25 and HZ27, the SolExp slopes are always negative in late summer, ie the more solar exposure, the lower the late summer flows.
10. Similarly for PET in HZ25 and HZ26, the coefficients are negative in late summer.
11. Counterintuitively, the slopes for Precip are negative for the P/MAD values, but often positive for the MMD models. Likely, this is due to the division by MAD of the independent variable.

3.2 P20

P20/MAD and P20 values are shown for Zones 25, 26, and 27 in Figure 17 to Figure 34. Each regression line shows the 95th percentile confidence limits. Please note that each page is a paired model, the top is the regression dataset, i.e. Aug P20/MAD, and the bottom is set back to physical units, i.e. m^3/s. The R^2 is always much higher in the bottom figure. During this exercise, we noticed that P20/MAD model for Coquitlam River above Coquitlam Intake in February resulted in a negative flow, shown in Figure 31. Upon further investigation, the precipitation was found to be much larger than the other stations, 4600mm/year compared to 1500-3600mm/year. Since the P20/MAD coefficient for Precip is negative (shown in Table 4), a negative Q resulted. As a result of this, we added a check within the algorithm for negative flows within each model iteration and did not select a model if negative flows resulted. Therefore, Coquitlam is not negative using the next best model (which now uses Ppt and Slope instead of Ppt and Med.Elev).

We recommend that future iterations of the models show the range of the training data and the error that is inherent when extrapolating instead of interpolating.

3.3 P50

The P50 results are similar in distribution to the P20 results, with Anderson above the regression for HZ27, shown in Figure 35, and Seymour River at Seymour Falls Dam below, along with Mahood Creek near Newton. The Validation exercises below explore these outliers further and offer possible explanations.

3.4 Validation

This section includes validation tables for various stations throughout the South Coast region. Many of the stations are included in the training data, and some are not.

In each figure, we compare the mean monthly discharge to the simulated, along with measured MAD and simulated. This latter result is the fulcrum point for all the other hydro-stats. Because we've normalized by MAD, the accuracy of the estimated MAD will directly impact all other hydro-stat accuracy. In each case, if the measured MAD is input, the resulting hydrostat match is always much better. For this reason, we recommend that the Wally tool feature a method to manually enter the MAD for a study catchment. We also note that the relative difference between two stats, ie P50/P20, will be more accurate than P50-P20, because the former will divide the simulatedMAD out of the equation.

In each table is also the STEYX from the model. It is used to determine if there is a statistically significant difference between the measured and simulated hydro-stat at 95% confidence level. We've also added the metric P50-P20 and compared it to the allocated flows. Along with the P50-P20 is a "worst case" version that takes into account the 95% confidence level in the estimates.

3.4.1 Anderson Creek at the Mouth (08MH104)

From Figure 37, we can see that Anderson Creek is being underestimated in every month but for Nov-Dec. While the HydroStat STEYX values are large, and no significant difference is apparent at 95% confidence in many months, July-Oct are significantly different. Note that if the measured MAD of 0.69 m^3/s is used, shown in Figure 38, instead of the modeled 0.58 m^3/s, the series are much closer. As with most of the regressions described before, Anderson is higher than expected Notice that the estimated gross allocated water is not very close to the difference between measured and simulated, ie. trying the naturalize the measured flow using allocated water would not get us much closer with the synthetic series. This site warrants further investigation.

3.4.2 MacKay Creek near Montroyal Boulevard (08GA061)

Figure 39 shows MacKay Creek at Montroyal Boulevard. The P20 measured and simulated are very close here with no significant differences.

3.4.3 Stawamus Creek (08GA076)

Figure 40 shows Stawamus Creek at Montroyal Boulevard. Again, Sim MAD is over estimated and the resulting P values are overestimated. If the measured MAD, shown in Figure 41 is used, the results are very close.

3.4.4 Mahood Creek near Newton Creek (08MH018)

Figure 42 shows Mahood Creek and but unlike the regression, the simulated Pvalues are larger than measured because the SimMAR is larger. Figure 43 shows the same monthly results if the Measured flow is used and a much closer result is obtained.

3.4.5 Seymour River at Seymour Falls Dam (08GA021)

Figure 44 shows the Seymour River at Seymour Falls Dam. This is listed as Regulated in Hydat, but the Net Allocation figures come out to 0% and the Gross Allocated is 138%MAD, which passes our filter. Wally measures a DA of only 123 km^2, while Hydat uses 148 km^2. MkMGR gives 115 $l/s/km^2$, while the measured is only 90 $l/s/km^2$. Figure 45 shows the same modeling but using the measured MAD.

3.4.6 Squamish River Near Brackendale (08GA022)

Figure 46 shows the Squamish River near Brackendale. FSL 2023 is underestimating Freshet in Jun-Aug, and the same is true for the P50 and P20, which is a conservative results. Figure 47 shows the same modeling but using the measured MAD.

3.4.7 Tyson Creek Intake (Sentlinger 2006)

Figure 46 Tyson Creek Intake, a high elevation transitional catchment on the sunshine coast which the author worked on. This data is publicly available to support the water license application. The data is already synthetic, based on 3 years of measured in situ data. So while this does not meet the 10 year minimum flow record, it is an example of a professionally prepared report with best practices.

While the MAD is very close to that from the report, 1.34 m^3/s vs 1.33 m^3/s, the DA is slightly different 11.9 km^2 vs 10.9km^2. The hydrographs are similar, but FSL 2023 misses the peak in June and October by 1 month.

3.4.8 Skookum Creek Intake (Sentlinger 2010)

Figure 49 shows Skookum Creek Intake, a high elevation transitional catchment on near Squamish which the author worked on. This data is publicly available to support the water license application. The data is already synthetic, based on 6 years of measured in situ data. So while this does not meet the 10 year minimum flow record, it is an example of a professionally prepared report with best practices.

The MAD from FSL 2023 is overestimated by 30%. The hydrographs are similar, with a Nash Sutcliffe of 87% IF the measured MAD is used, shown in Figure 50

3.5 Discussion

The MkMGR results for the South Coast are comparable to previous runs of the algorithm and are very promising. Many of the monthly P-Value results depend on the accuracy of the MAD used to de-normalize them. We are recommending that an entry for MAD be used to fine-tune the MkMGR absolute hydro-stats.

3.5.1 Limitations and Caveats

The MkMGR results are a good first approximation of many hydro-stats, however it must be noted that the regression results have uncertainty and we've done our best to report the 95%confidence limits in each case. We urge the user of these flow estimates to take into account the uncertainty. Furthermore, caution should be exercised when extrapolation outside of the training dataset range.

We have made the training data in the form of pdfs within this report and will be available within Wally in the future. When considering an ungauged basin, consider where it falls within each of the significant predictor variables. For example, WSC does not monitor many catchments smaller than $5km^2$, but many water licenses exist on smaller catchments. We recommend that the user employs these scatter plots and regression lines to extrapolate from the nearest, most similar catchment, to the target catchment, just as is recommended in Obedkoff (2003). Wally will use MkMGR to estimate the HydroStat based on the best fit Multivariate Regression line to the most robust model, but if the user knows of a nearby station, they may make a local regression from the scatterplots.

3.5.2 Recommendations for Future Work

Extrapolation to ungauged basins outside of the training range should result in larger uncertainty than the standard error alone. This should be considered in future iterations. Work was done in EcoFish (Sentlinger 2018) to address this topic.

When determining the best, most robust model, we currently only take that model with the highest minimum R^2 over 100 iterations using 70% of the data. However, it has been noted that often there are 3-5 models of very close performance, within 1-10% in R^2 performance. We recommend considering an ensemble approach similar what was undertaken in the IPCC approach for modeling future climate change. Along these same lines, in order to take into account future climate scenarios, consider models that employ PET, or consider temperature predictor variables. That way, future versions of the geo-stat based on future climate scenarios can be used to estimate the impact to a particular hydro-stat in future climate scenarios. In Sentlinger (2016) we considered various temperature predictor variables, but none performed as well as the PET, and were often correlated.

4 CONCLUSIONS AND RECOMMENDATIONS

We have successfully launched a version of the Wally online Water Allocation tool. We have built the contractual 180 models (5 Percentile/Exceedance values x 12 months x 3 Hydrological Zones). Table 2, Table 3, and Table 4 show the coefficients, intercepts, uncertainty, and other stats for the 180 new models. In addition to the contractual models, we've added 5x Percentile/Exceedance models for annual values, and we've redone the mean monthly discharge and MAR models, resulting in 234 new/updated models. It should be noted that often there are 5-10 models within 5% R^2 values and that choosing one of these alternative, or perhaps creating a maximum likelihood/Bayesian ensemble model may offer more resilience and higher accuracy to new basins. Alternately, many catchments use PET as a predictor variable, especially for lower flows. PET will directly be influenced by climate change and discussions are ongoing with the developer or the PET product to include future ensemble versions. This could then be input to a model using PET to estimate the change to the hydro-stat in future climate scenarios.

The Wally tool/user interface is loaded with functionality from its previous incarnation as a provincial product. However, it requires refinement to make it serve its purpose as a decision making aid, in an efficient manner. Work will be ongoing over the next year of hosting the tool to streamline and improve the user interface, including:

- A monthly P50-P20 estimate, with uncertainty bars, compared to allocated water,
- Plots of regression training data where the selected catchment falls within the cluster
- Climate change estimates to various hydrostats.

We trust this report and the beta online tool meets your needs and we look forward to working with you over the next year to refine the analysis and online tool.

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TABLES

Table 1: WSC Training Data

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\fromAlex\TrainingData\2023-02-11\[AnnualTraining_AllZones_V0.1.csv]AnnualTraining_AllZones_V0.1 2023-03-29 6:14

StnNumber	Station Name	HZ	Last Year	Mean Q (m^3/s)	MAR ($l/s/km^2$)	Min Q (m^3/s)	Max Q (m^3/s)	Min Month	Max Month	Years of Data	DA_WSC (km^2)	DA%Diff with FSL	DA_FSL (km^2)	Ppt (mm/year)	Slope (%)	Glc (%)	MedElev (m)	PET (mm/year)	SolExp (%)
08FB006	ATNARKO RIVER NEAR THE MOUTH	25	2020	28.3	11.0	11.0	157.0	3	5	46	2550.0	-1%	2565.7	770	15.0	0%	1416	756	68%
08FB007	BELLA COOLA RIVER ABOVE BURNT BRIDGE CREEK	25	2009	90.0	24.7	13.9	429.0	2	10	39	3720.0	2%	3650.4	1072	20.4	7%	1439	743	67%
08GD004	HOMATHKO RIVER AT THE MOUTH	25	2021	271.0	47.3	38.8	1690.0	12	6	53	5680.0	-1%	5723.7	1367	29.4	21%	1549	737	65%
08GD007	MOSLEY CREEK NEAR DUMBELL LAKE	25	1994	48.9	31.3	6.8	210.0	2	7	13	1550.0	-1%	1561.9	1110	30.8	12%	1747	739	64%
08GE002	KLINAKLINI RIVER EAST CHANNEL (MAIN) NEAR THE MOUTH	25	2020	302.2	51.4	28.4	1520.0	1	6	42	5780.0	-2%	5879.9	1478	25.9	19%	1420	732	66%
08LG008	SPIUS CREEK NEAR CANFORD	25	2020	10.1	13.2	0.5	65.5	1	5	46	775.0	1%	765.4	1166	16.5	0%	1360	865	68%
08LG048	COLDWATER RIVER NEAR BROOKMERE	25	2020	6.8	21.5	0.4	62.4	9	5	53	316.0	0%	314.9	2024	19.3	0%	1437	841	68%
08LG068	SPIUS CREEK BELOW SILVER CREEK	25	2020	3.4	20.4	0.1	26.1	9	2	17	178.0	6%	168.2	1415	17.2	0%	1408	844	70%
08MA002	CHILKO RIVER AT OUTLET OF CHILKO LAKE	25	2021	43.2	20.2	6.2	183.0	4	7	59	2130.0	0%	2139.6	1060	24.2	8%	1914	769	66%
08ME004	BRIDGE RIVER AT LAJOIE FALLS	25	1947	44.3	45.3	3.0	212.0	2	5	21	956.0	-2%	979.2	1493	25.8	21%	1834	770	67%
08ME005	BRIDGE RIVER NEAR GOLD BRIDGE	25	1940	66.8	39.9	13.3	518.0	2	10	16	1650.0	-1%	1674.6	1365	26.8	14%	1762	775	66%
08ME027	HURLEY RIVER BELOW LONE GOAT CREEK	25	2020	13.4	43.1	1.3	63.5	3	6	25	312.0	0%	311.9	1462	28.7	9%	1806	764	66%
08ME028	BRIDGE RIVER ABOVE DOWNTON LAKE	25	2020	36.8	52.2	2.8	159.0	3	6	25	708.0	1%	704.3	1691	22.8	28%	1916	759	67%
08MF062	COQUIHALLA RIVER BELOW NEEDLE CREEK	25	2018	3.4	38.1	0.4	25.2	9	5	46	85.5	-4%	89.3	2848	25.2	0%	1388	831	65%
08MF065	NAHATLATCH RIVER BELOW TACHEWANA CREEK	25	2019	35.9	50.2	2.9	156.0	3	5	38	712.0	0%	714.6	2245	35.5	2%	1491	807	65%
08MG005	LILLOOET RIVER NEAR PEMBERTON	25	2020	124.8	59.6	17.6	474.0	1	6	93	2100.0	0%	2093.3	2118	30.6	19%	1485	771	66%
08MG008	BIRKENHEAD RIVER AT MOUNT CURRIE	25	1970	23.9	37.1	4.2	91.5	12	6	17	596.0	-8%	644.6	1302	30.4	1%	1496	811	67%
08NL007	SIMILKAMEEN RIVER AT PRINCETON	25	2019	23.5	13.2	1.9	137.0	3	5	77	1810.0	2%	1777.9	1219	13.8	0%	1330	870	69%
08NL024	TULAMEEN RIVER AT PRINCETON	25	2020	21.6	12.2	1.4	180.0	9	5	68	1780.0	0%	1777.9	1219	13.8	0%	1330	870	69%
08NL070	SIMILKAMEEN RIVER ABOVE GOODFELLOW CREEK	25	2021	7.8	19.7	1.0	128.0	9	11	46	408.0	3%	397.4	1383	19.8	0%	1617	862	69%
08NL071	TULAMEEN RIVER BELOW VUICH CREEK	25	2021	6.5	25.4	0.3	379.0	9	11	47	253.0	0%	253.8	2024	16.7	0%	1544	827	68%
Count	Average				32.2					42.2				1515.8	23.3	8%	1556.6	797.2	67%
21	Coefficient of Variation				48%					50%				32%	27%	119%	12%	6%	2%
08FB004	SALLOOMT RIVER NEAR HAGENSBORG	26	2020	8.9	55.9	2.0	92.7	3	10	47	159.0	2%	156.1	2369	34.4	3%	1160	695	65%
08FB005	NUSATSUM RIVER NEAR HAGENSBORG	26	1995	16.3	60.4	2.4	47.3	1	5	23	269.0	-1%	271.6	2463	36.4	9%	1347	684	62%
08FB009	CLAYTON FALLS CREEK NEAR THE MOUTH	26	1995	6.3	67.9	1.5	24.1	1	11	16	92.5	0%	92.5	3047	32.7	8%	1226	678	60%
08GA024	CHEAKAMUS RIVER NEAR MONS	26	1947	19.7	68.6	2.3	76.2	1	7	23	287.0	-13%	331.1	2309	29.9	15%	1608	773	64%
08GA054	MAMQUAM RIVER ABOVE MASHITER CREEK	26	1986	25.5	76.4	6.5	100.0	10	3	16	334.0	1%	330.9	3881	25.3	3%	1168	790	69%
08GA071	ELAHO RIVER NEAR THE MOUTH	26	2020	105.2	87.7	9.0	523.0	3	8	39	1200.0	-2%	1221.1	2719	33.2	27%	1460	734	65%
08GA072	CHEAKAMUS RIVER ABOVE MILLAR CREEK	26	2019	19.5	65.6	2.2	53.1	3	6	37	297.0	0%	296.4	2381	30.8	17%	1653	768	64%
08GA075	MAMQUAM RIVER ABOVE RING CREEK	26	2020	23.8	83.7	5.7	114.0	3	2	25	284.0	3%	275.6	3952	26.1	3%	1182	784	67%
08GB013	CLOWHOM RIVER NEAR CLOWHOM LAKE	26	2021	15.5	105.6	2.5	133.0	2	12	28	147.0	1%	146.0	4181	36.7	5%	1234	763	65%
08GE003	ICY CREEK NEAR THE MOUTH	26	2020	2.9	124.8	0.2	24.1	3	8	18	23.0	-1%	23.2	2150	36.5	41%	1477	679	54%
08MF003	COQUIHALLA RIVER NEAR HOPE	26	1982	33.0	44.5	8.4	137.0	1	6	32	741.0	1%	733.3	2566	32.5	0%	1179	837	64%
08MF068	COQUIHALLA RIVER ABOVE ALEXANDER CREEK	26	2019	29.9	41.5	4.0	119.0	9	4	28	720.0	0%	721.9	2577	32.4	0%	1186	836	64%
08MG003	GREEN RIVER NEAR PEMBERTON	26	1950	48.0	56.1	7.9	209.0	1	10	34	855.0	3%	829.9	2124	28.2	10%	1468	782	67%
08MG004	GREEN RIVER NEAR RAINBOW	26	1947	8.3	42.4	1.7	28.6	3	5	26	195.0	3%	189.1	1947	24.5	4%	1441	788	66%
08MG006	RUTHERFORD CREEK NEAR PEMBERTON	26	1947	11.6	64.6	1.3	58.3	12	5	23	179.0	-1%	180.3	2174	30.4	12%	1542	775	68%
08MG007	SOO RIVER NEAR PEMBERTON	26	1947	19.0	67.1	1.9	79.3	1	5	23	283.0	-1%	284.7	2178	27.8	15%	1436	773	68%
08MG026	FITZSIMMONS CREEK BELOW BLACKCOMB CREEK	26	2019	3.9	43.0	0.9	33.6	3	5	20	89.7	-1%	90.5	2199	28.1	9%	1695	770	63%
08MH103	CHILLIWACK RIVER ABOVE SLESSE CREEK	26	2020	35.5	54.7	6.7	150.0	9	2	57	650.0	2%	636.2	2163	35.9	0%	1259	829	66%
08MH147	STAVE RIVER ABOVE STAVE LAKE	26	2020	35.2	121.5	5.4	272.0	3	2	28	290.0	0%	289.7	3492	29.0	9%	1279	786	66%
08PA001	SKAGIT RIVER NEAR HOPE	26	1954	28.3	31.2	11.7	189.0	2	5	25	907.0	-1%	917.7	1578	31.8	0%	1358	840	65%
Count	Average				68.2					28.4				2622.5	31.1	10%	1367.8	768.3	65%
20	Coefficient of Variation				38%					36%				27%	12%	106%	13%	7%	5%
08GA047	ROBERTS CREEK AT ROBERTS CREEK	27	2020	1.0	34.7	0.1	11.8	9	2	57	32.6	11%	29.4	2795	10.9	0%	623	851	75%
08GA060	CHAPMAN CREEK ABOVE SECHELT DIVERSION	27	1987	4.4	70.1	0.2	47.3	10	3	16	64.5	3%	62.3	3457	20.1	0%	976	803	71%
08GA061	MACKAY CREEK AT MONTROYAL BOULEVARD	27	2020	0.2	78.2	0.0	3.2	9	1	45	3.6	20%	3.0	2529	26.2	0%	453	865	80%
08GA077	SEYMOUR RIVER BELOW ORCHID CREEK	27	2021	6.6	110.0	0.5	96.7	12	11	28	63.0	5%	60.1	3641	29.7	0%	988	797	67%
08GA079	SEYMOUR RIVER ABOVE LAKEHEAD	27	2021	8.9	108.5	0.4	112.0	8	11	25	82.9	1%	82.5	3623	31.0	0%	929	802	66%
08GB014	HORSESHOE RIVER ABOVE LOIS LAKE	27	2021	6.1	45.6	0.6	26.9	9	12	14	135.0	1%	133.4	1827	17.3	0%	479	878	69%
08GF006	MCALISTER CREEK AT THOMPSON SOUND	27	2011	3.7	98.7	0.1	18.7	11	11	13	36.9	-2%	37.5	3617	35.1	0%	810	728	65%
08MG001	CHEHALIS RIVER NEAR HARRISON MILLS	27	2020	39.1	102.0	3.2	472.0	9	2	39	383.0	0%	383.1	2876	30.3	0%	847	849	67%
08MH006	NORTH ALOUETTE RIVER AT 232ND STREET, MAPLE RIDGE	27	2020	2.8	87.0	0.2	62.4	9	1	60	37.3	14%	32.7	2847	14.7	0%	537	871	72%
08MH018	MAHOOD CREEK NEAR NEWTON	27	1985	0.5	30.8	0.0	8.6	8	11	19	18.4	4%	17.7	1596	1.4	0%	81	958	71%
08MH020	MAHOOD CREEK NEAR SULLIVAN	27	1974	1.2	33.6	0.1	16.4	11	2	22	34.4	-1%	34.8	1595	2.0	0%	74	956	71%
08MH076	KANAKA CREEK NEAR WEBSTER CORNERS	27	2020	2.7	58.6	0.1	72.5	9	1	55	47.7	2%	46.9	2384	8.5	0%	271	902	74%
08MH097	YORKSON CREEK NEAR WALNUT GROVE	27	1977	0.1	24.2	0.0	2.2	7	1	13	6.0	-1%	6.0	1592	1.9	0%	63	941	69%
08MH104	ANDERSON CREEK AT THE MOUTH	27	1986	0.7	26.1	0.2	13.2	9	2	21	27.2	2%	26.7	1482	1.3	0%	81	936	71%
08MH105	NICOMEKL RIVER BELOW MURRAY CREEK	27	1983	1.8	28.0	0.1	21.2	8	1	18	64.5	-1%	65.4	1523	1.6	0%	65	945	70%
08MH108	JACOBS CREEK ABOVE JACOBS LAKE	27	1978	1.0	80.7	0.0	9.1	8	11	11	12.2	2%	11.9	2915	13.3	0%	533	872	71%
08MH141	COQUITLAM RIVER ABOVE COQUITLAM LAKE	27	2021	6.7	136.6	0.3	107.0	9	11	39	52.5	6%	49.3	4625	31.7	0%	1035	789	66%
08MH155	NICOMEKL RIVER AT 203 STREET, LANGLEY	27	2020	2.0	28.8	0.2	36.4	9	2	35	70.0	-1%	71.1	1520	1.5	0%	64	945	70%
Count	Average				65.7					29.4				2580.1	15.5	0%	494.8	871.6	70%
18	Coefficient of Variation				55%					55%				37%	81%	424%	75%	8%	5%

Table 2: HZ 25 Monthly Model Results

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HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	N	numVars	R2	ADJ R2	MIN R2	R2*MAD	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Better?	By how much?
25	MAR	0	-193.499	0	1.7051292	0.010764	107.2967	0	-0.01224	269.261	23	5	0.97	0.96	0.94	0.99	30.04	16.37	3.02	10%	54%	TRUE	44%
25	P10/MAD	0	1.00022	0	0	0	-0.43845	-0.00103	0	0	23	2	0.46	0.41	0.26	0.96	0.14	0.05	0.04	29%	38%	TRUE	10%
25	P20/MAD	0	1.495916	0	0	0	-0.49871	-0.00139	-9.8E-05	0	23	3	0.54	0.47	0.26	0.97	0.19	0.07	0.05	24%	35%	TRUE	11%
25	P30/MAD	0	1.432343	0	0.005991477	0	-0.646	-0.00132	-0.00013	-0.01208	23	5	0.74	0.67	0.49	0.99	0.25	0.08	0.04	16%	31%	TRUE	15%
25	P40/MAD	0	3.538968	0	0	0	-0.85416	-0.00153	0	-2.85992	23	3	0.73	0.69	0.55	0.99	0.33	0.10	0.05	16%	30%	TRUE	14%
25	P50/MAD	0	5.996476	0	0	-0.00011	0	0	0	-8.00461	23	2	0.71	0.68	0.61	0.99	0.46	0.14	0.08	17%	30%	TRUE	14%
25	M_MMD/MAD	1	0.208463	2.5E-05	0	8.87E-05	-1.0741	0	0	0	23	3	0.76	0.72	0.60	0.99	0.30	0.10	0.05	17%	33%	TRUE	17%
25	M_MMD/MAD	2	0.556005	0	0	5.94E-05	-0.70803	0	-0.0002	0	23	3	0.73	0.68	0.62	0.97	0.29	0.11	0.06	21%	39%	TRUE	18%
25	M_MMD/MAD	3	0.822575	0	0	5.45E-05	-0.80451	0	-0.00034	0	23	3	0.79	0.76	0.71	0.96	0.33	0.14	0.07	20%	44%	TRUE	23%
25	M_MMD/MAD	4	-3.23865	0	0	0	0	0.006552	-0.00081	0	23	2	0.86	0.84	0.81	0.96	0.81	0.51	0.20	24%	63%	TRUE	39%
25	M_MMD/MAD	5	-11.2178	0	-0.04091611	0	0	0.014564	-0.00145	7.495876	23	4	0.90	0.88	0.84	0.94	2.41	1.38	0.44	18%	57%	TRUE	39%
25	M_MMD/MAD	6	-13.6249	0	0.022658088	0.000233	-2.94475	0	0	23.34697	23	4	0.65	0.57	0.44	0.99	2.70	0.53	0.32	12%	20%	TRUE	8%
25	M_MMD/MAD	7	4.519338	0	0.054031551	-0.00042	3.641262	-0.00442	0	0	23	4	0.91	0.89	0.83	0.97	1.81	0.83	0.25	14%	46%	TRUE	32%
25	M_MMD/MAD	8	17.83413	0	-0.004291785	-0.0006	6.274971	0	0.000995	-26.2407	23	5	0.95	0.94	0.90	0.99	1.20	0.99	0.22	18%	82%	TRUE	64%
25	M_MMD/MAD	9	10.82477	0	0	-0.00031	3.428023	-0.00296	0	-11.154	23	4	0.93	0.91	0.87	0.99	0.74	0.59	0.16	22%	79%	TRUE	57%
25	M_MMD/MAD	10	2.698704	0	0.011935792	-6.8E-05	0	-0.00288	0	0	23	3	0.88	0.86	0.82	0.99	0.55	0.23	0.08	15%	42%	TRUE	27%
25	M_MMD/MAD	11	-1.68272	7.77E-05	0	0.000277	-2.38366	0	0.000475	1.694741	23	5	0.76	0.69	0.58	1.00	0.54	0.18	0.09	17%	33%	TRUE	17%
25	M_MMD/MAD	12	0.998006	0	0	8.06E-05	-1.34333	-0.00081	0	0	23	3	0.71	0.66	0.58	0.94	0.37	0.12	0.06	18%	32%	TRUE	14%
25	M_P10/MAD	1	0.944198	0	0	0	-0.43175	-0.00089	-4.2E-05	0	23	3	0.53	0.46	0.26	0.97	0.13	0.04	0.03	25%	35%	TRUE	10%
25	M_P10/MAD	2	0.57465	0	0	0	-0.37182	-0.00053	0.00E+00	0	23	2	0.44	0.39	0.24	0.96	0.12	0.03	0.03	20%	28%	TRUE	8%
25	M_P10/MAD	3	0.260564	0	0.00303706	-5.4E-06	-0.17931	0	-0.00011	0	23	4	0.69	0.62	0.40	0.99	0.14	0.03	0.02	14%	25%	TRUE	10%
25	M_P10/MAD	4	-0.0295	0	0.004093375	2.37E-06	0	0.000801	-0.00031	0	23	4	0.81	0.77	0.72	0.99	0.24	0.09	0.04	16%	38%	TRUE	22%
25	M_P10/MAD	5	-1.75099	0.00E+00	-0.03403664	0.000295	-1.61485	0.003836	0	0	23	4	0.90	0.88	0.83	0.71	0.90	0.53	0.17	22%	59%	TRUE	37%
25	M_P10/MAD	6	4.298084	0	0	0	0	-0.00392	0	0	23	1	0.40	0.37	0.26	0.96	1.14	0.34	0.27	23%	29%	TRUE	7%
25	M_P10/MAD	7	13.09759	0	0	-0.00039	3.558954	-0.00378	0.000749	-14.6748	23	5	0.96	0.95	0.90	0.98	1.02	0.78	0.16	18%	77%	TRUE	59%
25	M_P10/MAD	8	10.27764	0	0	-0.00038	3.801363	-0.0024	0.00071	-12.4595	23	5	0.94	0.92	0.86	0.99	0.77	0.71	0.18	30%	92%	TRUE	62%
25	M_P10/MAD	9	6.302111	0	0	-0.0002	0.795753	-0.0021	0.000259	-6.53588	23	5	0.84	0.80	0.67	0.97	0.38	0.32	0.13	32%	84%	TRUE	52%
25	M_P10/MAD	10	4.223904	0	0	-0.00011	0	-0.00137	0	-4.06961	23	3	0.74	0.70	0.63	0.98	0.22	0.15	0.08	36%	67%	TRUE	31%
25	M_P10/MAD	11	1.561328	0	0	0	-0.57694	-0.00166	0	0	23	2	0.55	0.51	0.38	0.97	0.19	0.08	0.06	30%	45%	TRUE	14%
25	M_P10/MAD	12	1.072706	0	0	0	-0.49817	-0.00108	-1.3E-05	0	23	3	0.50	0.42	0.25	0.97	0.15	0.05	0.04	27%	37%	TRUE	10%
25	M_P20/MAD	1	1.501661	0.00E+00	0	0	-0.35053	0	0	-1.96808	23	2	0.41	0.35	0.25	0.97	0.15	0.05	0.04	22%	31%	TRUE	9%
25	M_P20/MAD	2	0.564673	0	0	0	-0.43422	-0.00048	0.00E+00	0	23	2	0.46	0.40	0.27	0.95	0.14	0.04	0.03	19%	27%	TRUE	8%
25	M_P20/MAD	3	0.345238	0	0.002506875	0	-0.22921	0	-0.00014	0	23	3	0.75	0.71	0.61	0.99	0.17	0.04	0.02	14%	27%	TRUE	13%
25	M_P20/MAD	4	-0.06974	0	0	0	-0.20931	0.001117	-0.00033	0	23	3	0.78	0.75	0.69	0.98	0.32	0.15	0.07	21%	46%	TRUE	25%
25	M_P20/MAD	5	-2.21125	0	-0.04223768	0.000317	-2.24199	0.005008	0	0	23	4	0.90	0.88	0.83	0.74	1.19	0.69	0.22	20%	58%	TRUE	38%
25	M_P20/MAD	6	0.957496	0	0.023132529	0	0	0	0	0	23	1	0.23	0.20	-0.02	0.97	1.47	0.33	0.30	20%	22%	TRUE	3%
25	M_P20/MAD	7	3.630436	0	0.038151835	-0.00042	3.625032	-0.00488	0.000647	0	23	5	0.96	0.95	0.88	0.98	1.18	0.85	0.18	15%	72%	TRUE	57%
25	M_P20/MAD	8	12.86585	0	0	-0.0005	5.000329	0	0.000863	-19.2386	23	4	0.94	0.93	0.86	0.98	0.88	0.80	0.20	21%	91%	TRUE	69%
25	M_P20/MAD	9	8.995825	0	0	-0.00029	2.362102	0	0	-12.3276	23	3	0.84	0.81	0.72	0.98	0.46	0.38	0.16	36%	83%	TRUE	47%
25	M_P20/MAD	10	2.420425	0	0	-6.3E-05	0	-0.00256	0	0	23	2	0.69	0.66	0.60	0.99	0.27	0.17	0.10	38%	63%	TRUE	25%
25	M_P20/MAD	11	1.48353	0	0.002915301	0	-0.7472	-0.00156	0	0	23	3	0.58	0.51	0.42	0.98	0.24	0.09	0.06	25%	37%	TRUE	12%
25	M_P20/MAD	12	1.109733	3.99E-06	0	0	-0.62616	-0.00111	0	0	23	3	0.49	0.41	0.22	0.97	0.18	0.06	0.05	25%	34%	TRUE	9%
25	M_P30/MAD	1	2.110072	0	-0.002066737	0	-0.421	0	0	-2.76507	23	3	0.47	0.39	0.27	0.96	0.18	0.05	0.04	22%	29%	TRUE	7%
25	M_P30/MAD	2	1.03425	0	0	0	-0.42317	0	0	-1.24872	23	2	0.52	0.47	0.35	0.95	0.17	0.04	0.03	20%	27%	TRUE	8%
25	M_P30/MAD	3	0.426258	0	0	0	-0.23426	0	-0.00014	0	23	2	0.74	0.71	0.63	0.98	0.19	0.05	0.03	14%	28%	TRUE	15%
25	M_P30/MAD	4	-0.41759	0	0	0	-0.25742	0.001816	-0.00041	0	23	3	0.79	0.75	0.70	0.98	0.40	0.21	0.10	24%	51%	TRUE	27%
25	M_P30/MAD	5	-2.46475	0	-0.047980132	0.000307	0	0.007584	-0.00102	0	23	4	0.90	0.88	0.83	0.91	1.47	0.85	0.27	18%	58%	TRUE	40%
25	M_P30/MAD	6	1.362107	0	0	0	0	0	0.00029	0	23	1	0.04	-0.01	-0.20	0.97	1.81	0.31	0.31	17%	17%	TRUE	1%
25	M_P30/MAD	7	12.15967	0	0.023700148	-0.00059	4.621353	0	0.000962	-18.3277	23	5	0.95	0.93	0.89	0.98	1.31	0.89	0.21	15%	68%	TRUE	53%
25	M_P30/MAD	8	14.16373	0	0	-0.00054	5.571941	0	0.000879	-21.0368	23	4	0.94	0.93	0.90	0.98	0.98	0.88	0.22	21%	90%	TRUE	69%
25	M_P30/MAD	9	8.80561	0	0	-0.00031	2.489166	0	0.000363	-12.7283	23	4	0.89	0.86	0.80	0.97	0.53	0.44	0.15	26%	83%	TRUE	57%
25	M_P30/MAD	10	4.847091	0	0.002446516	-0.00014	0	-0.00165	0	-4.55794	23	4	0.79	0.74	0.67	0.98	0.31	0.18	0.09	28%	59%	TRUE	31%
25	M_P30/MAD	11	1.924145	0	0	0	-0.90037	-0.00196	0	0	23	2	0.57	0.52	0.43	0.98	0.28	0.10	0.06	22%	34%	TRUE	12%
25	M_P30/MAD	12	1.21305	0	0	0	-0.70517	-0.00118	0	0	23	2	0.44	0.39	0.19	0.96	0.21	0.07	0.05	25%	33%	TRUE	8%
25	M_P40/MAD	1	0.629608	1.37E-05	0	3.81E-05	-0.71358	-0.00057	0	0	23	4	0.61	0.53	0.22	0.98	0.20	0.06	0.04	21%	29%	TRUE	9%
25	M_P40/MAD	2	1.29274	0	0	0	-0.37896	0	-0.0001	-1.37553	23	3	0.64	0.59	0.43	0.98	0.19	0.05	0.03	18%	28%	TRUE	10%
25	M_P40/MAD	3	0.495113	0	0	0	-0.30253	0	-0.00017	0	23	2	0.76	0.73	0.68	0.98	0.21	0.06	0.03	15%	30%	TRUE	16%
25	M_P40/MAD	4	-1.24583	0	0	0	0	0.003164	-0.00053	0	23	2	0.83	0.81	0.75	0.98	0.49	0.28	0.12	24%	56%	TRUE	32%
25	M_P40/MAD	5	-15.0326	0	0	0	0	0.009702	-0.00146	16.70024	23	3	0.89	0.87	0.84	0.92	1.76	1.01	0.35	18%	58%	TRUE	39%
25	M_P40/MAD	6	2.286118	-6.3E-05	0	0	-0.90287	0	0	0	23	2	0.20	0.12	-0.09	1.00	2.12	0.35	0.32	16%	17%	TRUE	1%
25	M_P40/MAD	7	18.35438	0	0	-0.00056	4.699038	0	0.001189	-27.155	23	4	0.94	0.92	0.87	0.98	1.44	0.93	0.23	16%	64%	TRUE	48%
25	M_P40/MAD	8	15.09868	0	0	-0.00058	6.073022	0	0.000913	-22.3644	23	4	0.94	0.93	0.90	0.99	1.06	0.94	0.23	20%	89%	TRUE	69%
25	M_P40/MAD	9	10.68797	0.00E+00	0	-0.00035	3.561916	0	0	-14.6239	23	3	0.89	0.87	0.82	0.98	0.60	0.51	0.17	22%	84%	TRUE	62%
25	M_P40/MAD	10	5.822617	0	0	-0.00014	0	-0.00189	0	-5.56494	23	3	0.79	0.76	0.69	0.99	0.36	0.20	0.09	26%	55%	TRUE	30%
25	M_P40/MAD	11	2.099733	0	0	0	-1.07991	-0.00211	0	0	23	2	0.55	0.51	0.39	0.98	0.33	0.11	0.07	20%	32%	TRUE	12%
25	M_P40/MAD	12	1.258527	0	0.00E+00	0	-0.79586	-0.0012	0	0	23	2	0.43	0.38	0.23	0.96	0.24	0.08	0.06	25%	32%	TRUE	7%
25	M_P50/MAD	1	1.071225	0	0	0	-0.6787	-0.00082	-8.87E-05	0	23	3	0.57	0.50	0.33	0.96	0.23	0.07	0.04	18%	29%	TRUE	11%
25	M_P50/MAD	2	1.239515	0	0	0	-0.44104	0	-0.00013	-1.1881	23	3	0.67	0.62	0.47	0.98	0.21	0.06	0.04	18%	30%	TRUE	12%
25	M_P50/MAD	3	0.528771	0	0	2.67E-05	-0.41491	0	-0.00019	0	23	3	0.79	0.75	0.69	0.98	0.24	0.08	0.04	16%	33%	TRUE	17%
25	M_P50/MAD	4	-2.05198	0	0	5.14E-05	0	0.004446	-0.00065	0	23	3	0.84	0.82	0.79	0.96	0.61	0.37	0.15	25%	61%	TRUE	36%
25	M_P50/MAD	5	-17.0243	0	0	0	-2.74537	0.008924	-0.00136	21.16677	23	4	0.91	0.89	0.84	0.95	2.11	1.21	0.37	19%	57%	TRUE	38%
25	M_P50/MAD	6	2.617289	0	0	0	-2.57569	0	0	0	23	1	0.29	0.26	0.10	0.97	2.44	0.43	0.37	15%	18%	TRUE	2%
25	M_P50/MAD	7	4.898296	0	0.059367346	-0.00052	4.36429	-0.00518	0	0	23	4	0.93	0.91	0.86	0.96	1.59	0.95	0.26	14%	60%	TRUE	46%
25	M_P50/MAD	8	16.01017	0	0	-0.0006	6.559826	0	0.000942	-23.6497	23	4	0.95	0.94	0.89	0.99	1.14	1.00	0.23	20%	87%	TRUE	67%
25	M_P50/MAD	9	9.888623	0	0	-0.00037	3.509153	0	0.000502	-14.4304	23	4	0.91	0.89	0.83	0.98	0.68	0.57	0.17	26%	84%	TRUE	58%
25	M_P50/MAD	10	6.162334	0	0	-0.00013	0	-0.00209	0	-5.76853	23	3	0.81	0.78	0.72	0.99	0.41	0.21	0.09	23%	51%	TRUE	28%
25	M_P50/MAD	11	1.2044	3.48E-05	0	0.00011	-1.60951	-0.00155	0.000207	0	23	5	0.71	0.62	0.44	0.99	0.38	0.12	0.07	19%	31%	TRUE	13%
25	M_P50/MAD	12	1.342814	0	0	0	-0.91514	-0.00125	0	0	23	2	0.44	0.39	0.24	0.96	0.27	0.08	0.06	24%	32%	TRUE	7%
			Count	6	20	41	61	46	41	33													
			Total	78	78	78	78	78	78	78													
			%Time	8%	26%	0.525641	78%	59%	53%	42%													

Table 3: HZ 26 Monthly Model Results

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\fromAlex\2023-03-26\[Monthly_model_outputs_V0.5.xlsx]Zone 26 — 2023-03-29 20:45

HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	N	numVars	R2	ADJ R2	MIN R2	R2*MAD	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Model Better?	By how much?
26	MAR	0	-13.3183	0	0	0.025003	162.9385	0	0	0	20	2	0.78	0.76	0.62	0.96	68.32	26.76	12.84	19%	39%	TRUE	20%
26	P10/MAD	0	0.66081	0	0	0	-0.51171	-0.00049	0	0	20	2	0.40	0.33	0.15	0.84	0.23	0.07	0.06	24%	31%	TRUE	6%
26	P20/MAD	0	0.751846	0	0	0	-0.58904	-0.0005	0	0	20	2	0.41	0.34	0.19	0.87	0.30	0.08	0.06	21%	26%	TRUE	6%
26	P30/MAD	0	0.447236	0	0	0	-0.46275	0	0	0	20	1	0.31	0.27	0.10	0.92	0.40	0.09	0.07	18%	22%	TRUE	3%
26	P40/MAD	0	1.33646	0	-0.00466	0	0	-0.00021	-0.00038	0	20	3	0.39	0.27	0.03	0.96	0.51	0.09	0.07	14%	17%	TRUE	3%
26	P50/MAD	0	1.024763	0	0	0	0	0	-0.00025	0	20	1	0.22	0.18	0.02	0.98	0.68	0.09	0.08	12%	13%	TRUE	1%
26	M_MMD/MAD	1	1.195159	0	0.008534	0	-0.82815	0	-0.00064	0	20	3	0.79	0.75	0.60	1.00	0.50	0.19	0.09	18%	38%	TRUE	20%
26	M_MMD/MAD	2	0.719603	0	0	0	-0.51786	0.000712	-0.00057	0	20	3	0.83	0.80	0.61	0.99	0.42	0.15	0.07	16%	37%	TRUE	21%
26	M_MMD/MAD	3	0.277877	0	0	0	0	0.001386	-0.00067	0	20	2	0.77	0.74	0.62	0.99	0.42	0.15	0.08	18%	36%	TRUE	18%
26	M_MMD/MAD	4	-0.44011	0	0	0	0	0.002945	-0.00081	0	20	2	0.75	0.72	0.60	0.81	0.70	0.24	0.13	18%	35%	TRUE	17%
26	M_MMD/MAD	5	-1.68486	0	0	0	0	0.005723	-0.00083	0	20	2	0.62	0.57	0.46	0.75	1.57	0.44	0.28	18%	28%	TRUE	10%
26	M_MMD/MAD	6	0.152939	0	0	-0.00023	-1.24221	0	0.000599	2.858619	20	4	0.67	0.58	0.32	0.99	2.09	0.31	0.19	9%	15%	TRUE	6%
26	M_MMD/MAD	7	0.232348	0	0	0	1.156948	-0.00187	0.002133	0	20	3	0.86	0.83	0.73	0.97	1.85	0.48	0.19	10%	26%	TRUE	16%
26	M_MMD/MAD	8	1.310746	0	0	-3.3E-05	2.738573	-0.00308	0.001533	0	20	4	0.92	0.90	0.75	0.95	1.27	0.56	0.17	13%	44%	TRUE	31%
26	M_MMD/MAD	9	2.696144	0	0	0	1.448298	-0.0036	0.000594	0	20	3	0.93	0.92	0.78	0.97	0.91	0.35	0.10	11%	39%	TRUE	28%
26	M_MMD/MAD	10	2.240853	0	0	0	0	-0.00429	-0.0002	3.46481	20	3	0.84	0.81	0.74	1.00	0.89	0.22	0.09	10%	25%	TRUE	14%
26	M_MMD/MAD	11	1.367232	0	0	0.000156	-0.61404	0	-0.00064	0	20	3	0.75	0.70	0.52	0.99	0.82	0.23	0.12	14%	28%	TRUE	13%
26	M_MMD/MAD	12	2.172362	0	0	0	-1.09856	0.000737	-0.00064	-1.84406	20	4	0.86	0.83	0.73	0.99	0.56	0.19	0.07	13%	35%	TRUE	22%
26	M_P10/MAD	1	0.031722	0	0.006729	0	-0.50848	0	0	0	20	2	0.53	0.47	0.34	0.91	0.19	0.07	0.05	27%	39%	TRUE	11%
26	M_P10/MAD	2	0.22991	0	0	0	-0.48389	0	0.00E+00	0	20	1	0.41	0.38	0.20	0.90	0.18	0.08	0.06	35%	44%	TRUE	9%
26	M_P10/MAD	3	0.026474	0	0.006936	0	-0.53625	0	0	0	20	2	0.57	0.52	0.33	0.94	0.19	0.08	0.05	27%	40%	TRUE	13%
26	M_P10/MAD	4	-0.08533	0	0.002715	0	0	0.00118	-0.00045	0	20	3	0.73	0.68	0.50	1.00	0.29	0.12	0.06	22%	40%	TRUE	19%
26	M_P10/MAD	5	-0.46343	0.00E+00	0	0	0	0.002705	-0.00067	0	20	2	0.76	0.74	0.59	0.91	0.68	0.21	0.11	16%	31%	TRUE	16%
26	M_P10/MAD	6	-1.32176	0	0	0	-0.31475	-0.00134	0.000744	3.968331	20	4	0.62	0.52	0.21	0.96	1.18	0.18	0.11	10%	15%	TRUE	6%
26	M_P10/MAD	7	-0.08872	8E-05	0	0	0	-0.00446	0.002186	2.402521	20	4	0.89	0.87	0.68	0.99	1.11	0.43	0.14	13%	39%	TRUE	26%
26	M_P10/MAD	8	1.269833	0	0	0	0	-0.00349	0.001598	0	20	2	0.73	0.69	0.60	0.83	0.79	0.38	0.21	26%	49%	TRUE	22%
26	M_P10/MAD	9	1.379896	4.82E-05	0	1.98E-05	0	-0.00192	0.00065	-0.71827	20	5	0.91	0.88	0.72	0.99	0.44	0.17	0.05	12%	39%	TRUE	27%
26	M_P10/MAD	10	1.448344	3.29E-05	0	0	-0.44844	-0.00194	0.000255	0	20	4	0.92	0.89	0.41	0.99	0.30	0.10	0.03	10%	34%	TRUE	24%
26	M_P10/MAD	11	1.668598	2.56E-05	0	0	-0.66805	-0.00075	-4.8E-05	-1.11115	20	5	0.69	0.58	0.13	1.00	0.27	0.08	0.05	18%	32%	TRUE	13%
26	M_P10/MAD	12	1.260624	2.05E-05	0	0	-0.76377	0	0	-1.51836	20	3	0.70	0.64	0.47	1.00	0.23	0.08	0.05	20%	36%	TRUE	16%
26	M_P20/MAD	1	0.041027	0.00E+00	0.008148	0	-0.63829	0	0	0	20	2	0.58	0.53	0.32	0.92	0.23	0.09	0.06	26%	38%	TRUE	13%
26	M_P20/MAD	2	0.942566	0	0	0	-0.76791	0	0.00E+00	-1.00423	20	2	0.55	0.50	0.30	0.88	0.22	0.09	0.06	29%	41%	TRUE	13%
26	M_P20/MAD	3	0.47347	0	0.002473	0	-0.50359	0	-0.0002	0	20	3	0.64	0.58	0.37	0.96	0.23	0.09	0.06	25%	40%	TRUE	15%
26	M_P20/MAD	4	-0.02176	0	-0.00022	0	0	0.001487	-0.00054	0	20	3	0.74	0.69	0.56	0.98	0.37	0.14	0.07	20%	39%	TRUE	18%
26	M_P20/MAD	5	0.043701	0	0	-8.5E-05	0	0.002917	-0.00086	0	20	3	0.78	0.74	0.63	0.85	0.88	0.25	0.12	14%	29%	TRUE	15%
26	M_P20/MAD	6	0.187316	0	0	0	-1.11419	0	0.000984	0	20	2	0.55	0.50	0.28	0.98	1.41	0.20	0.14	10%	14%	TRUE	4%
26	M_P20/MAD	7	1.082187	8.74E-05	0	0	0	-0.00408	0.002357	0	20	3	0.89	0.87	0.69	0.99	1.28	0.46	0.16	12%	36%	TRUE	24%
26	M_P20/MAD	8	1.546927	0	0	0	0	-0.00405	0.001787	0	20	2	0.75	0.72	0.64	0.85	0.90	0.43	0.22	24%	48%	TRUE	23%
26	M_P20/MAD	9	1.537438	0	0	0	0	-0.00255	0.00069	0	20	2	0.70	0.67	0.55	0.85	0.53	0.22	0.12	23%	41%	TRUE	18%
26	M_P20/MAD	10	1.809239	3.34E-05	-0.00417	0	0	-0.0019	8.19E-05	0	20	4	0.82	0.77	0.38	0.99	0.37	0.12	0.05	14%	33%	TRUE	19%
26	M_P20/MAD	11	0.212855	0	0.013559	0	-0.58897	-0.00032	0	0	20	3	0.41	0.30	0.05	0.89	0.34	0.11	0.09	25%	32%	TRUE	7%
26	M_P20/MAD	12	1.151724	2.36E-05	0.003691	0	-0.89631	0	-7.3E-06	-1.42414	20	5	0.76	0.67	0.30	1.00	0.27	0.10	0.05	18%	36%	TRUE	18%
26	M_P30/MAD	1	0.231322	0	0.007991	0	-0.69981	0	-0.0001	0	20	3	0.63	0.56	0.42	0.92	0.27	0.11	0.07	24%	39%	TRUE	15%
26	M_P30/MAD	2	0.623188	0	0	0	-0.51121	0	-0.00024	0	20	2	0.63	0.58	0.38	0.94	0.25	0.10	0.06	25%	40%	TRUE	15%
26	M_P30/MAD	3	0.374844	0	0	0	-0.40395	0.000417	-0.00028	0	20	3	0.71	0.65	0.51	0.98	0.26	0.10	0.06	22%	39%	TRUE	17%
26	M_P30/MAD	4	0.031471	0	0	0	-0.32513	0.001514	-0.00053	0	20	3	0.77	0.73	0.62	0.97	0.44	0.17	0.08	19%	38%	TRUE	19%
26	M_P30/MAD	5	-0.74026	0	0	0	0	0.003753	-0.00079	0	20	2	0.70	0.66	0.50	0.84	1.05	0.30	0.17	16%	28%	TRUE	12%
26	M_P30/MAD	6	-2.205	0	0	0	0	0	0.000688	4.472116	20	2	0.54	0.48	0.30	0.99	1.60	0.22	0.16	10%	14%	TRUE	4%
26	M_P30/MAD	7	0.717656	0	0	0	0.95153	-0.00282	0.002015	0	20	3	0.82	0.78	0.64	0.92	1.42	0.48	0.21	15%	34%	TRUE	19%
26	M_P30/MAD	8	1.777004	0	0	0	0	-0.0045	0.001943	0	20	2	0.76	0.74	0.67	0.86	0.99	0.46	0.23	23%	47%	TRUE	23%
26	M_P30/MAD	9	1.70268	0	0	0	0	-0.00296	0.000856	0	20	2	0.74	0.71	0.60	0.87	0.61	0.25	0.13	22%	41%	TRUE	20%
26	M_P30/MAD	10	1.909958	0	0	0	0	-0.00193	0	0	20	1	0.60	0.57	0.44	0.89	0.44	0.14	0.09	21%	31%	TRUE	11%
26	M_P30/MAD	11	-0.11657	0	0.018753	0	-0.67636	0	0	0	20	2	0.46	0.40	0.24	0.92	0.41	0.13	0.10	23%	31%	TRUE	8%
26	M_P30/MAD	12	0.038868	0	0.01145	0	-0.82707	0	0	0	20	2	0.60	0.55	0.39	0.90	0.31	0.11	0.07	23%	36%	TRUE	13%
26	M_P40/MAD	1	-0.02454	0.00E+00	0.013761	0	-0.94599	0	0	0	20	2	0.65	0.61	0.52	0.93	0.31	0.13	0.08	24%	40%	TRUE	16%
26	M_P40/MAD	2	-0.00056	0	0.011425	0	-0.80714	0	0	0	20	2	0.64	0.60	0.47	0.91	0.28	0.11	0.07	24%	39%	TRUE	15%
26	M_P40/MAD	3	0.757163	0	0	0	-0.54061	0.000683	-0.00029	-0.82226	20	4	0.76	0.69	0.51	0.98	0.29	0.11	0.06	19%	38%	TRUE	19%
26	M_P40/MAD	4	-0.33283	0	0	0	0	0.002304	-0.00067	0	20	2	0.76	0.73	0.60	0.92	0.51	0.20	0.10	19%	38%	TRUE	19%
26	M_P40/MAD	5	0.251301	0	0	-0.0001	-0.77901	0.003179	-0.00081	0	20	4	0.71	0.64	0.35	0.81	1.22	0.35	0.19	16%	28%	TRUE	13%
26	M_P40/MAD	6	-0.87582	0	0	-0.00017	-0.71656	0.00014	0.000624	3.430086	20	5	0.72	0.62	0.27	1.00	1.78	0.26	0.14	8%	14%	TRUE	7%
26	M_P40/MAD	7	-1.42007	0	0	-0.00011	1.912931	-0.0042	0.001764	5.998334	20	5	0.90	0.86	0.76	0.96	1.55	0.49	0.16	10%	32%	TRUE	21%
26	M_P40/MAD	8	0.851948	0	0	0	2.327089	-0.00265	0.001463	0	20	3	0.88	0.86	0.72	0.93	1.08	0.51	0.18	17%	47%	TRUE	30%
26	M_P40/MAD	9	1.342864	4.53E-05	0	0	0.888009	-0.00262	0.00088	0	20	4	0.93	0.91	0.79	1.00	0.69	0.29	0.08	11%	42%	TRUE	30%
26	M_P40/MAD	10	2.15898	0	0.000292	0	0	-0.00216	0	0	20	2	0.63	0.58	0.48	0.92	0.52	0.15	0.09	18%	29%	TRUE	11%
26	M_P40/MAD	11	-0.12412	0	0.021877	0	-0.85159	0	0	0	20	2	0.52	0.47	0.28	0.93	0.48	0.15	0.10	22%	30%	TRUE	9%
26	M_P40/MAD	12	0.849277	0	0.00E+00	0	-0.71314	0	-0.0003	0	20	2	0.61	0.56	0.46	0.91	0.36	0.13	0.09	24%	38%	TRUE	13%
26	M_P50/MAD	1	0.465058	0	0.010583	0	-0.88537	0	-2.54E-04	0	20	3	0.72	0.67	0.50	0.95	0.36	0.14	0.08	22%	40%	TRUE	18%
26	M_P50/MAD	2	-0.01979	0	0.013504	0	-0.91024	0	0	0	20	2	0.66	0.62	0.49	0.91	0.31	0.12	0.07	23%	39%	TRUE	15%
26	M_P50/MAD	3	0.316638	0	0	0	-0.41696	0.000753	-0.00038	0	20	3	0.77	0.73	0.54	0.99	0.33	0.12	0.06	18%	37%	TRUE	19%
26	M_P50/MAD	4	-0.43442	0	0	0	0	0.002674	-0.00075	0	20	2	0.75	0.72	0.61	0.88	0.59	0.22	0.11	19%	38%	TRUE	18%
26	M_P50/MAD	5	-0.17919	0	-0.01537	0	0	0.004595	-0.00106	0	20	3	0.65	0.58	0.39	0.81	1.40	0.40	0.24	17%	28%	TRUE	11%
26	M_P50/MAD	6	-0.74953	0	0	-0.00028	0	0	0	5.367285	20	2	0.57	0.52	0.18	0.99	1.96	0.31	0.21	11%	16%	TRUE	5%
26	M_P50/MAD	7	-1.34193	0	-0.00595	0	1.724894	-0.00356	0.002063	4.599903	20	5	0.89	0.85	0.73	0.96	1.70	0.51	0.18	10%	30%	TRUE	20%
26	M_P50/MAD	8	1.093717	6.27E-05	0	0	2.182123	-0.00355	0.001821	0	20	4	0.94	0.92	0.77	1.00	1.18	0.55	0.14	12%	46%	TRUE	35%
26	M_P50/MAD	9	1.080345	4.36E-05	0	0	1.240552	-0.00288	0.000916	0.714122	20	5	0.93	0.91	0.67	1.00	0.77	0.32	0.08	11%	42%	TRUE	31%
26	M_P50/MAD	10	2.257021	0	0	5.06E-05	0	-0.00232	0	0	20	2	0.71	0.67	0.51	0.95	0.61	0.17	0.09	15%	27%	TRUE	12%
26	M_P50/MAD	11	-0.12886	0	0.025298	0	-1.02403	0	0	0	20	2	0.56	0.51	0.28	0.94	0.57	0.17	0.11	20%	29%	TRUE	9%
26	M_P50/MAD	12	0.529283	0	0.00926	0	-0.95808	0	-0.00023	0	20	3	0.68	0.62	0.41	0.92	0.41	0.15	0.09	22%	37%	TRUE	15%
			Count	11	24	11	50	49	56	17													
			Total	78	78	78	78	78	78	78													
			%Time	14%	31%	0.141026	64%	63%	72%	22%													

Table 4: HZ 27 Monthly Model Results

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\fromAlex\2023-03-26\[Monthly_model_outputs_V0.5.xlsx]Zone 27 2023-03-29 20:45

HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	N	numVars	R2	ADJ R2	MIN R2	R2*MAD	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Better?	By how much?
27	MAR	0	-429.353	0	2.67065	0.03123	0	0.428891	0	0	27	3	0.94	0.93	0.91	0.99	70.74	36.65	9.09	13%	52%	TRUE	39%
27	P10/MAD	0	0.42007	0	0.000606	0	65.47445	0	0	-0.45302	27	3	0.26	0.16	0.08	0.97	0.12	0.05	0.04	37%	42%	TRUE	5%
27	P20/MAD	0	0.214563	0	0	-7.3E-05	48.5543	0	0.000286	0	27	3	0.55	0.49	0.37	0.98	0.18	0.07	0.05	26%	38%	TRUE	12%
27	P30/MAD	0	0.385431	0	0	-0.0001	54.61889	0	0.000411	-0.10949	27	4	0.67	0.61	0.49	0.99	0.26	0.09	0.05	21%	35%	TRUE	14%
27	P40/MAD	0	0.464436	0	0	-0.00015	25.62369	0	0.000582	0	27	3	0.68	0.64	0.52	0.99	0.38	0.12	0.07	18%	31%	TRUE	13%
27	P50/MAD	0	0.662697	0	0.004765	-0.0002	0	0	0.000546	0	27	3	0.66	0.61	0.48	0.99	0.53	0.14	0.08	15%	26%	TRUE	10%
27	M_MMD/MAD	1	-0.71592	0	0	0	0	0.003168	-0.00076	0	27	2	0.93	0.92	0.90	0.99	1.61	0.49	0.13	8%	30%	TRUE	22%
27	M_MMD/MAD	2	-0.86088	0	0	-0.00022	0	0.003162	0	0	27	2	0.88	0.87	0.86	0.97	1.29	0.42	0.15	11%	33%	TRUE	21%
27	M_MMD/MAD	3	0.158624	0	0	-0.00017	-74.5446	0	0	2.094649	27	3	0.77	0.74	0.72	0.99	1.16	0.23	0.11	10%	20%	TRUE	10%
27	M_MMD/MAD	4	1.089032	0	0	-0.00015	-61.3862	0	0.000656	0	27	3	0.55	0.50	0.38	1.00	1.04	0.16	0.11	10%	15%	TRUE	5%
27	M_MMD/MAD	5	1.28238	0	0	0	-168.745	0	0.001223	-1.38969	27	3	0.91	0.90	0.88	1.00	0.98	0.49	0.15	15%	50%	TRUE	35%
27	M_MMD/MAD	6	6.789533	0	-0.00062	0.000119	65.53256	-0.00473	0	-3.23397	27	5	0.91	0.89	0.85	1.00	0.76	0.49	0.15	19%	65%	TRUE	45%
27	M_MMD/MAD	7	3.295391	0	0	5.61E-05	0	-0.00228	0	-1.51652	27	3	0.89	0.87	0.83	0.99	0.41	0.24	0.08	20%	58%	TRUE	38%
27	M_MMD/MAD	8	1.740901	0	0	0	0	-0.00125	0	-0.62154	27	2	0.77	0.75	0.68	0.97	0.23	0.11	0.05	23%	47%	TRUE	24%
27	M_MMD/MAD	9	0.789145	0	0	8.64E-05	0	-0.00077	0	0	27	2	0.77	0.75	0.67	0.98	0.35	0.14	0.07	20%	40%	TRUE	21%
27	M_MMD/MAD	10	0.256805	0	0	0.000243	-60.2453	0	0	0	27	2	0.81	0.80	0.77	0.99	0.89	0.24	0.11	12%	27%	TRUE	15%
27	M_MMD/MAD	11	0.253986	0	0	0	240.843	0	-0.00031	2.176272	27	3	0.54	0.48	0.38	1.00	1.60	0.23	0.16	10%	14%	TRUE	4%
27	M_MMD/MAD	12	-2.22974	0	0	-0.0002	-451.59	0.004187	0	1.124847	27	4	0.91	0.90	0.87	1.00	1.65	0.49	0.15	9%	29%	TRUE	20%
27	M_P10/MAD	1	0.770124	0	0	-0.00013	3.369434	0	0	-0.18109	27	3	0.40	0.32	0.28	0.86	0.31	0.18	0.14	45%	57%	TRUE	12%
27	M_P10/MAD	2	0.688471	0	0	-0.00014	12.16406	0	0	0	27	2	0.48	0.44	0.39	0.88	0.32	0.18	0.13	42%	58%	TRUE	15%
27	M_P10/MAD	3	0.829813	0	0	-0.00031	-164.232	0	0.000592	0	27	3	0.58	0.53	0.31	0.94	0.33	0.14	0.09	29%	43%	TRUE	15%
27	M_P10/MAD	4	0.637914	0	0	-0.00026	-38.4123	0	0.000768	0	27	3	0.59	0.54	0.43	0.98	0.37	0.13	0.09	23%	35%	TRUE	12%
27	M_P10/MAD	5	1.125271	0.00E+00	0	0	35.49079	0	0.000543	-1.4792	27	3	0.88	0.86	0.83	0.99	0.40	0.25	0.09	22%	63%	TRUE	40%
27	M_P10/MAD	6	3.271518	0	0	0	0	-0.0021	0	-1.71581	27	2	0.79	0.78	0.71	0.93	0.27	0.20	0.09	34%	74%	TRUE	39%
27	M_P10/MAD	7	0.863854	0	0	0	110.2027	-0.00027	0	-0.73867	27	3	0.41	0.33	0.26	0.96	0.12	0.07	0.05	46%	59%	TRUE	13%
27	M_P10/MAD	8	0.311909	0	0	0	0	0	0	-0.34474	27	1	0.09	0.05	-0.04	0.87	0.07	0.04	0.04	59%	61%	TRUE	2%
27	M_P10/MAD	9	0.185821	0	0	0	0	0.000148	0	-0.34749	27	2	0.09	0.01	-0.07	0.87	0.07	0.04	0.04	53%	55%	TRUE	1%
27	M_P10/MAD	10	0.401449	0	0	-9.26E-06	0	0	0	-0.39315	27	2	0.14	0.07	-0.10	0.97	0.10	0.03	0.03	31%	33%	TRUE	2%
27	M_P10/MAD	11	0.091072	0	0	-0.00018	2.251598	0	0.000434	0.584504	27	4	0.41	0.30	0.00	0.96	0.26	0.09	0.07	28%	35%	TRUE	7%
27	M_P10/MAD	12	0.693192	0	0	-0.00013	4.574369	0	0	0	27	2	0.47	0.42	0.38	0.91	0.34	0.18	0.13	39%	52%	TRUE	13%
27	M_P20/MAD	1	1.078234	0.00E+00	0	-0.00017	0	0	0	-0.27017	27	2	0.48	0.44	0.40	0.91	0.43	0.22	0.16	38%	51%	TRUE	14%
27	M_P20/MAD	2	0.977092	0	0.006149	-0.00025	0	0	0	0	27	2	0.59	0.56	0.46	0.88	0.42	0.21	0.14	33%	50%	TRUE	17%
27	M_P20/MAD	3	1.151426	0	0	-0.00035	-176.259	-0.00015	0.000599	0	27	4	0.60	0.53	0.33	0.95	0.43	0.16	0.11	24%	38%	TRUE	13%
27	M_P20/MAD	4	0.719396	0	0	-2.66E-04	0	0	0.000853	0	27	2	0.61	0.58	0.44	0.98	0.48	0.15	0.10	20%	32%	TRUE	12%
27	M_P20/MAD	5	1.31903	0	0	0	18.11461	0	0.000708	-1.73628	27	3	0.91	0.89	0.88	0.99	0.50	0.31	0.10	20%	63%	TRUE	43%
27	M_P20/MAD	6	4.635822	0	0	0	0	-0.00308	0	-2.32549	27	2	0.87	0.86	0.83	0.96	0.36	0.27	0.10	27%	75%	TRUE	48%
27	M_P20/MAD	7	0.776288	0	0.002632	0	88.68884	0	0	-0.97087	27	3	0.55	0.49	0.46	0.97	0.15	0.09	0.06	39%	57%	TRUE	18%
27	M_P20/MAD	8	0.404573	0	0	0	45.57419	0	0	-0.45541	27	2	0.17	0.10	-0.01	0.96	0.09	0.05	0.04	48%	52%	TRUE	4%
27	M_P20/MAD	9	0.363171	0	0	0	0	0	0	-0.38874	27	1	0.13	0.10	-0.02	0.93	0.09	0.04	0.04	41%	43%	TRUE	2%
27	M_P20/MAD	10	0.745726	0	0	-2.5E-05	0	-0.00062	0	0	27	2	0.26	0.20	0.09	0.97	0.14	0.04	0.03	25%	28%	TRUE	3%
27	M_P20/MAD	11	0.726321	0	0	-0.00021	0	0	0.000413	0	27	2	0.42	0.38	0.19	0.97	0.40	0.11	0.09	22%	28%	TRUE	6%
27	M_P20/MAD	12	0.96394	0	0	-0.00019	0	0	0	0	27	1	0.60	0.58	0.52	0.93	0.47	0.22	0.14	31%	47%	TRUE	17%
27	M_P30/MAD	1	1.175154	0	0	-0.00022	0	0	0	-0.04313	27	2	0.60	0.57	0.52	0.94	0.56	0.26	0.17	30%	46%	TRUE	17%
27	M_P30/MAD	2	1.082046	0	0	-0.00021	6.650721	0	0	0	27	2	0.64	0.61	0.56	0.94	0.53	0.24	0.15	28%	45%	TRUE	17%
27	M_P30/MAD	3	1.224479	0	0	-0.00037	-191.581	-6.6E-05	0.000632	0	27	4	0.60	0.53	0.32	0.96	0.53	0.18	0.12	22%	35%	TRUE	12%
27	M_P30/MAD	4	0.284771	0	0	-0.00029	0	0	0.00101	0.746882	27	3	0.61	0.56	0.39	0.98	0.58	0.18	0.12	20%	31%	TRUE	11%
27	M_P30/MAD	5	3.070701	0	0	0	0	-0.00173	0.000575	-1.85789	27	3	0.93	0.92	0.89	0.99	0.60	0.37	0.10	17%	62%	TRUE	45%
27	M_P30/MAD	6	5.696793	0	0	0	161.5623	-0.00403	0	-2.55679	27	3	0.90	0.89	0.84	0.99	0.44	0.33	0.11	24%	76%	TRUE	52%
27	M_P30/MAD	7	1.698013	0	0	0	126.302	-0.0009	0	-1.06585	27	3	0.68	0.64	0.59	0.97	0.18	0.11	0.06	33%	58%	TRUE	25%
27	M_P30/MAD	8	0.512438	0	0	0	52.66896	0	0	-0.58976	27	2	0.23	0.16	0.11	0.96	0.10	0.05	0.05	43%	49%	TRUE	5%
27	M_P30/MAD	9	0.393627	0	0	0	0	0	1.99E-05	-0.41768	27	2	0.18	0.11	0.01	0.94	0.11	0.05	0.04	39%	42%	TRUE	3%
27	M_P30/MAD	10	0.400569	0	0.002811	0	0	0	0	-0.36207	27	2	0.48	0.44	0.37	0.97	0.20	0.06	0.05	24%	32%	TRUE	9%
27	M_P30/MAD	11	0.891299	0	0.007882	-0.00018	0	0	0	0	27	2	0.39	0.34	0.24	0.97	0.55	0.14	0.11	20%	26%	TRUE	5%
27	M_P30/MAD	12	1.049056	0	0	-0.00024	0	0	0	0.246648	27	2	0.67	0.64	0.61	0.95	0.60	0.27	0.16	26%	45%	TRUE	18%
27	M_P40/MAD	1	1.432485	0.00E+00	0	-0.00027	-33.485	0	0	0	27	2	0.71	0.69	0.64	0.95	0.71	0.29	0.16	22%	41%	TRUE	19%
27	M_P40/MAD	2	1.312437	0	0	-0.00025	-5.27105	0	0	0	27	2	0.72	0.69	0.65	0.96	0.65	0.27	0.15	23%	42%	TRUE	19%
27	M_P40/MAD	3	1.314205	0	0	-3.83E-04	-205.61	0	0.000612	0	27	3	0.61	0.56	0.39	0.96	0.63	0.20	0.13	20%	32%	TRUE	12%
27	M_P40/MAD	4	0.909351	0	0	-0.00029	0	0	0.001013	0	27	2	0.58	0.55	0.40	0.98	0.69	0.20	0.13	19%	29%	TRUE	10%
27	M_P40/MAD	5	0.097732	0	0	0	0	0	0.001108	0	27	1	0.90	0.89	0.88	0.99	0.70	0.43	0.14	20%	61%	TRUE	41%
27	M_P40/MAD	6	6.759852	0	0	0	0	-0.00488	0	-2.90491	27	2	0.90	0.89	0.86	0.98	0.52	0.40	0.13	25%	76%	TRUE	51%
27	M_P40/MAD	7	2.254155	0	0	0	0	-0.00131	0	-1.299	27	2	0.76	0.74	0.70	0.94	0.22	0.13	0.07	30%	60%	TRUE	30%
27	M_P40/MAD	8	0.531544	0	0.001165	0	0	0	0	-0.61972	27	2	0.34	0.29	0.16	0.95	0.12	0.06	0.05	39%	47%	TRUE	8%
27	M_P40/MAD	9	0.143048	0.00E+00	0	-3.4E-05	0	0	0.000151	0	27	2	0.24	0.18	0.10	0.95	0.14	0.06	0.05	38%	42%	TRUE	5%
27	M_P40/MAD	10	0.174142	0	0.005769	0	0	0	0	0	27	1	0.62	0.60	0.53	0.98	0.27	0.09	0.06	22%	34%	TRUE	13%
27	M_P40/MAD	11	0.121588	0	0	-2.97E-04	0	0	0.000554	1.564926	27	3	0.53	0.47	0.31	0.98	0.73	0.18	0.13	17%	25%	TRUE	7%
27	M_P40/MAD	12	1.066254	0	0.00E+00	-0.00028	0	0	0	0.631105	27	2	0.76	0.74	0.71	0.96	0.75	0.31	0.15	20%	41%	TRUE	21%
27	M_P50/MAD	1	1.797977	0	0	-3.36E-04	0	0	0	0	27	1	0.80	0.79	0.76	0.97	0.91	0.34	0.15	17%	37%	TRUE	20%
27	M_P50/MAD	2	0.606673	0	0	-0.00028	-0.41289	0	0	1.340377	27	3	0.79	0.76	0.75	0.97	0.80	0.32	0.15	19%	40%	TRUE	21%
27	M_P50/MAD	3	1.218393	0	0	-0.00017	0	0	0	0	27	1	0.53	0.51	0.41	0.97	0.77	0.21	0.15	20%	28%	TRUE	8%
27	M_P50/MAD	4	0.970887	0	0	-0.00028	0	0	0.00102	0	27	2	0.62	0.59	0.43	0.99	0.80	0.21	0.13	16%	26%	TRUE	10%
27	M_P50/MAD	5	3.652475	0	0	0	0	-0.00227	0.000784	-1.87723	27	3	0.94	0.93	0.91	1.00	0.81	0.48	0.12	15%	59%	TRUE	44%
27	M_P50/MAD	6	7.733524	0	0	0	0	-0.00573	0	-3.12004	27	2	0.89	0.88	0.84	0.99	0.61	0.46	0.15	25%	75%	TRUE	50%
27	M_P50/MAD	7	2.745945	0	0	0	128.4345	-0.00177	0	-1.37137	27	3	0.82	0.80	0.74	0.99	0.26	0.16	0.07	26%	61%	TRUE	35%
27	M_P50/MAD	8	0.99898	0	0	0	0	-0.0004	0	-0.73705	27	2	0.45	0.40	0.30	0.95	0.14	0.07	0.05	36%	48%	TRUE	12%
27	M_P50/MAD	9	0.140288	0	0	-2.5E-05	0	0	0.000164	0	27	2	0.33	0.27	0.22	0.95	0.16	0.07	0.06	35%	42%	TRUE	7%
27	M_P50/MAD	10	0.223486	0	0.009655	0	-48.3411	0	0	0	27	2	0.70	0.68	0.64	0.99	0.39	0.15	0.08	21%	37%	TRUE	17%
27	M_P50/MAD	11	-0.08439	0	0	-1.02E-04	244.7104	0	0	1.873021	27	3	0.47	0.40	0.30	0.99	0.95	0.21	0.15	16%	22%	TRUE	6%
27	M_P50/MAD	12	0.917995	0	0	-0.00034	-117.324	0	0	1.323923	27	3	0.83	0.81	0.79	0.98	0.95	0.36	0.15	16%	38%	TRUE	22%
			Count	0	11	47	36	24	28	44													
			Total	78	78	78	78	78	78	78													
			%Time	0%	14%	60%	46%	31%	36%	56%													

FIGURES

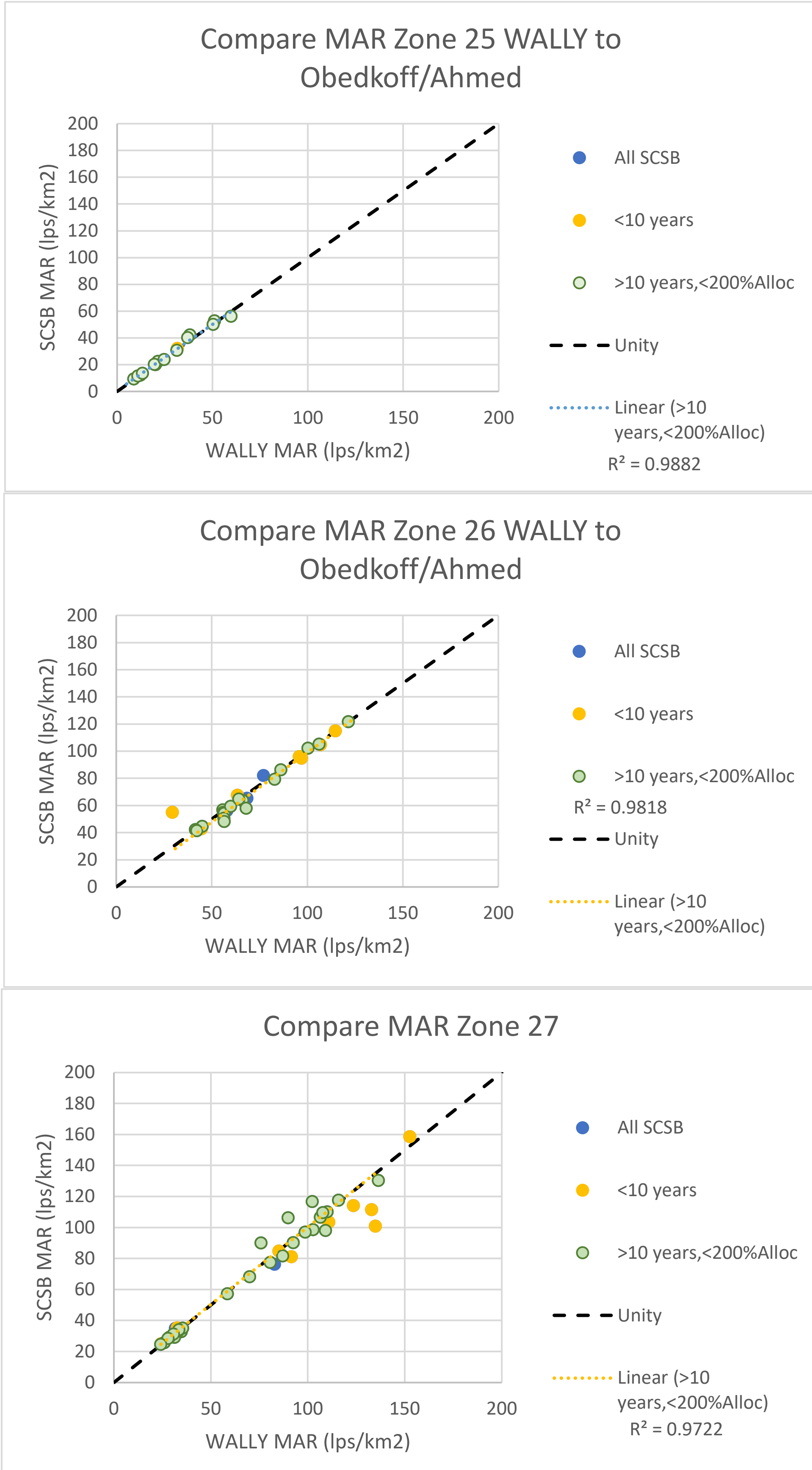


Figure 1: Results of Filtering for the 3 HZ

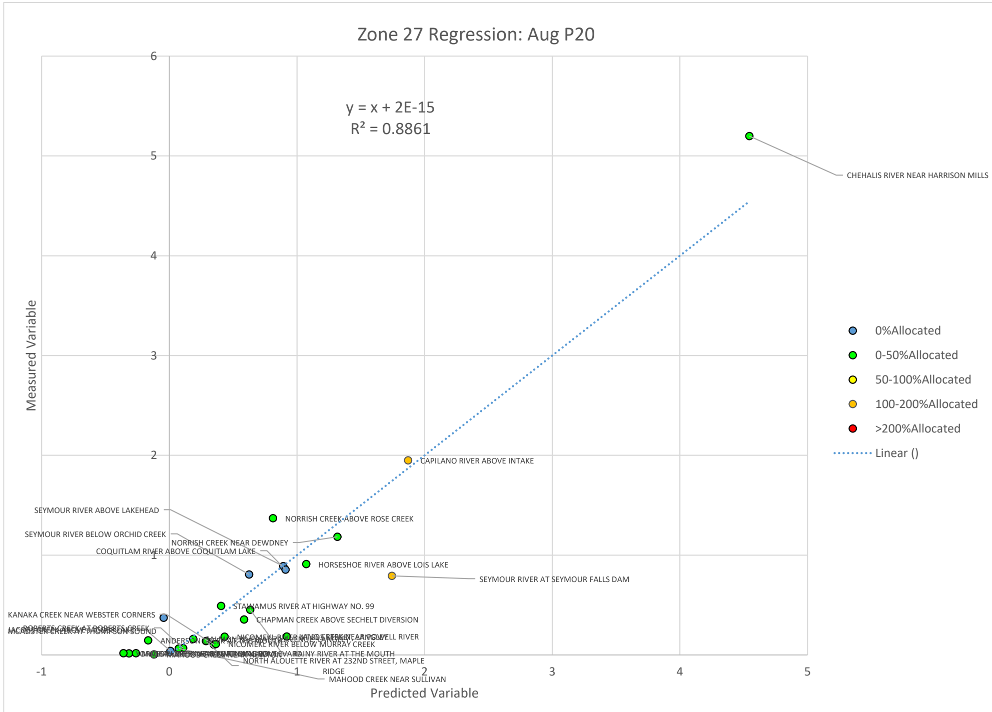


Figure 2: Regression results of August P20

This figure shows the problem associated with regression without normalization by MAD. The large influence of large flows, due to large drainage area, skews the regression to try to minimize the error between the large flow and the modeled large flow, sacrificing the accuracy at the smaller flows.

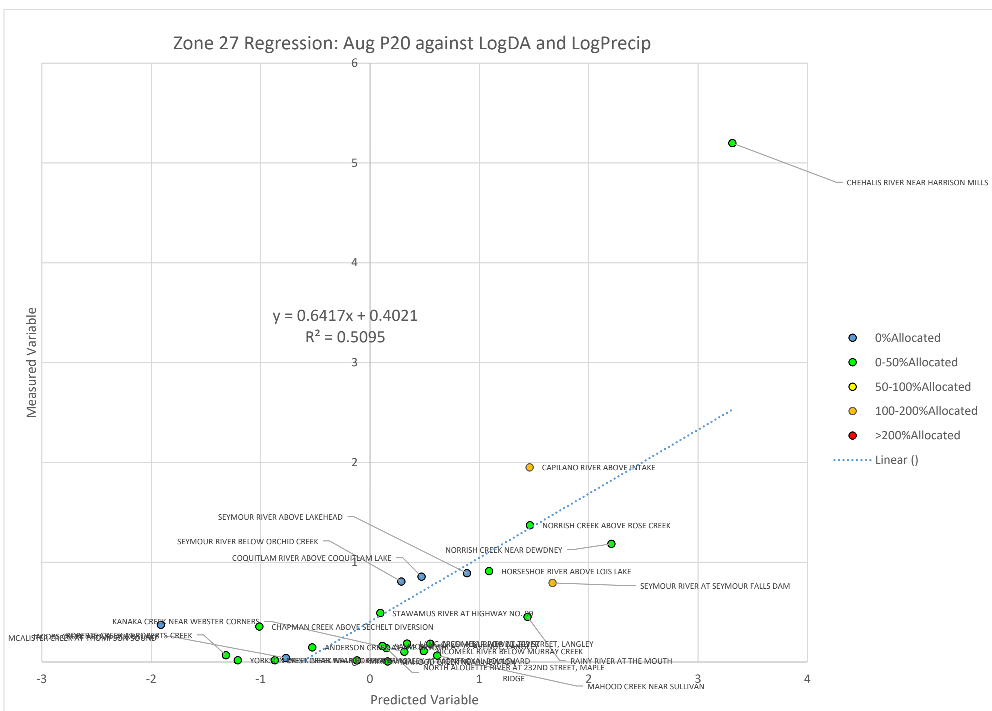
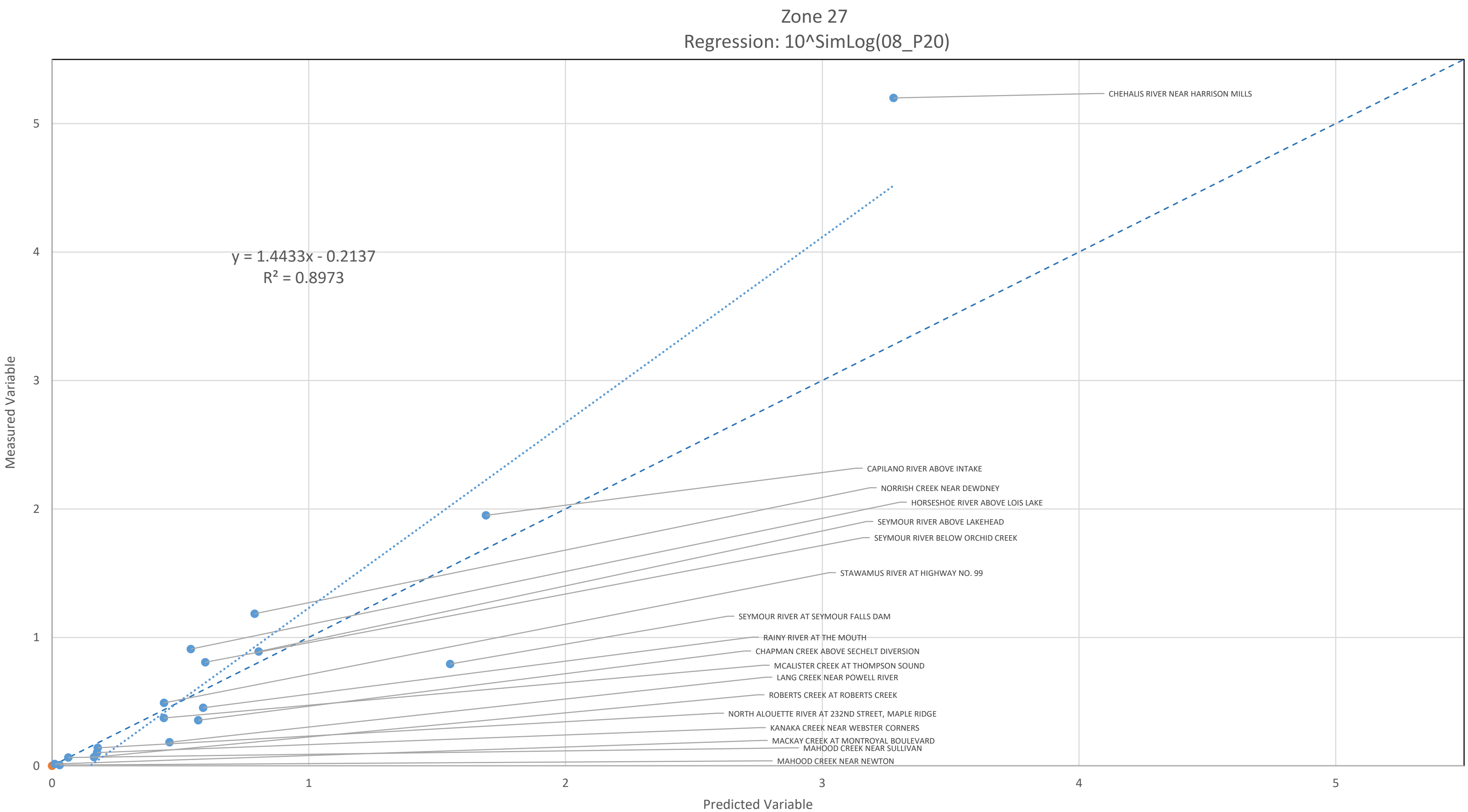


Figure 3: Regression results of August P20 against LogDA and LogPpt

The USGS papers use LogDA and LogPpt to reduce the effect of DA on the regression, however this result is worse than using the unmodified DA and Ppt.

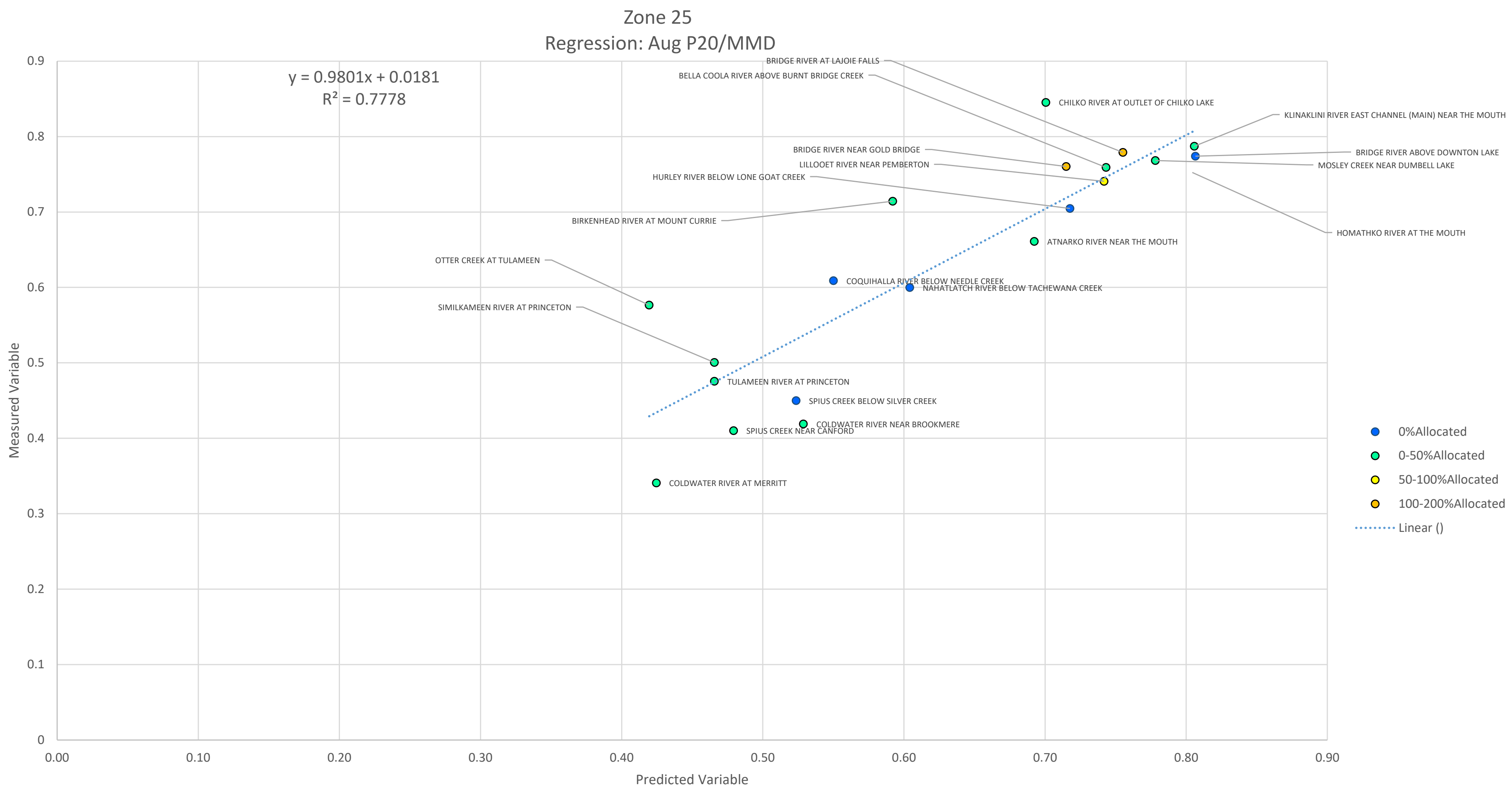


Notes:
1) In the USGS studies, the logarithm of Q is the dependent variable, log(DA) and log(Prerip) are the usual most siginificant indepndent variables. Even following this regime, the R2 is not as good as the MAD or MMD normalized results.

BC MINISTRY OF FORESTS	
WALLY MODEL UPDATE	
ZONE 27: AUGUST 10^SIM_LogP20	
Fathom Scientific Ltd. V0.3 Mar 16, 2023	Figure 4

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCS8\MonthlyP20\08\[Zone27_ARM_08_P20_DivMAD_usingWALLY_V3_Datav0.3.xlsm]Data

Figure 4: Zone 25: August 10^SIM_LogP20



Notes:
1) Otter Creek is an outlier

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 25: AUGUST SIM_P20/MMD
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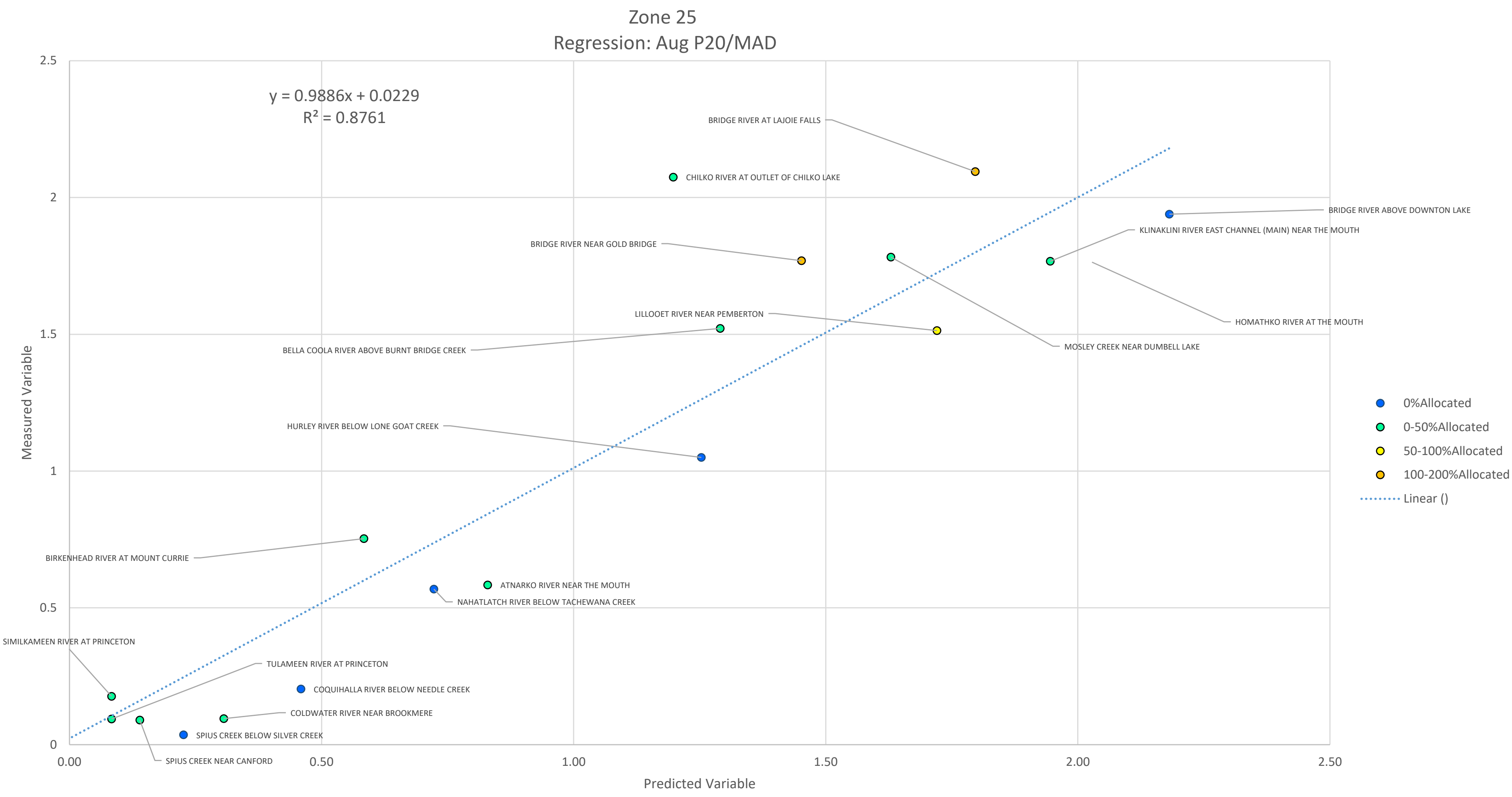
Figure 5

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCSB\MonthlyP20\08\[Zone25_ARM_08_P20_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 5: Zone 25: August SIMP20/MMD



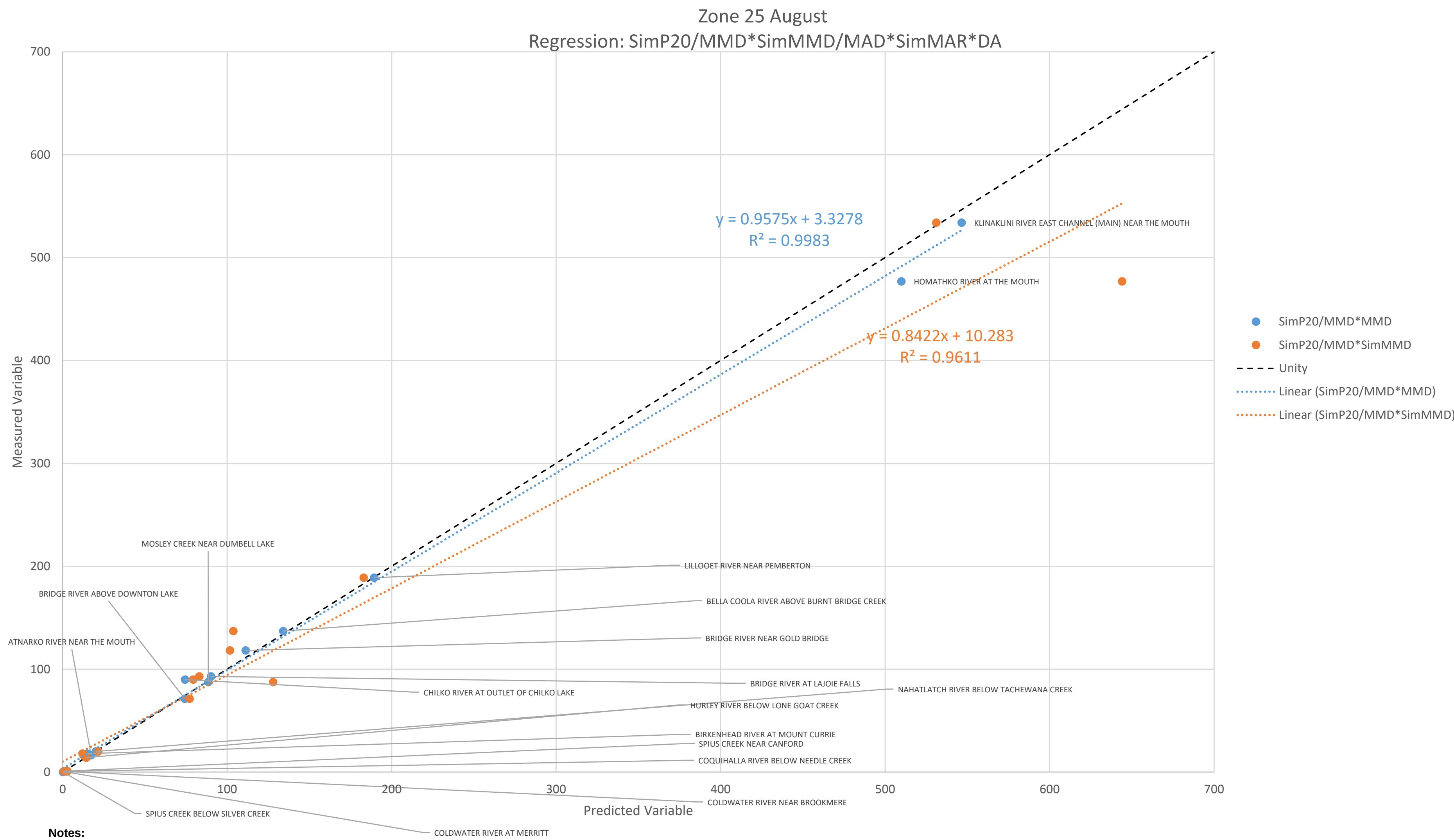
Notes:
1) Dividing by MAD instead of MMD creates a larger spread of values than dividing by MMD.

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 25: AUGUST SIM_P20/MAD

Fathom Scientific Ltd. | VER 1.5 | Mar 16, 2023 | Figure 6

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCSB\MonthlyP20\08\[Zone25_ARM_08_P20_DivMAD_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 6: Zone 25: August P20/MAD

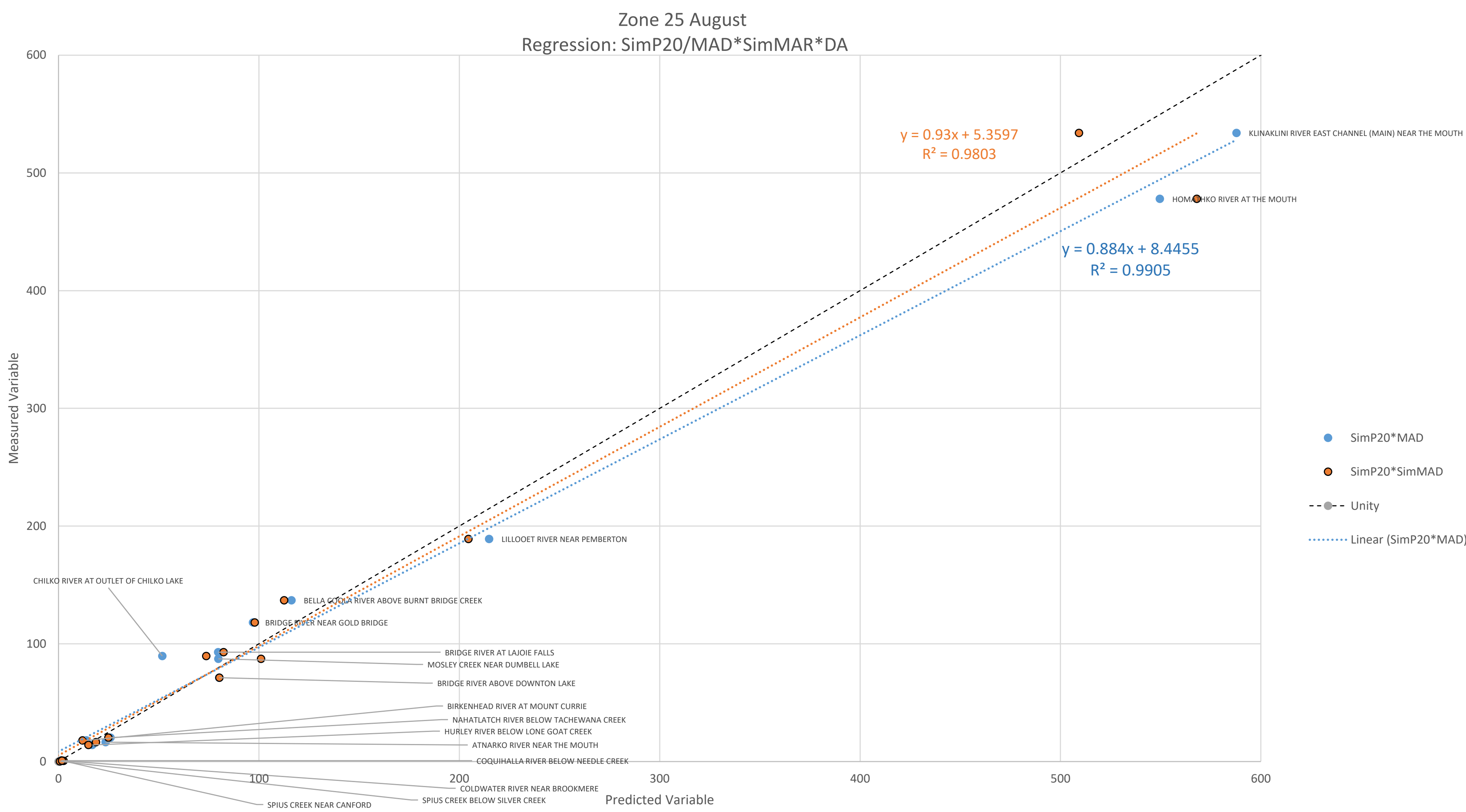


Notes:
1) The match is closer when multiplied by the true MMD as opposed to the Simulated MMD.

BC MINISTRY OF FORESTS	
WALLY MODEL UPDATE	
ZONE 25: AUGUST SIM_P20/MMD*MMD	
Fathom Scientific Ltd. VER 1.5 Mar 16, 2023	Figure 7

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCSB\MonthlyP20\08\[Zone25_ARM_08_P20_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 7: Zone 25: August SimP20/MMD*MMD



Notes:
1) After multiplying by the MAD, the R^2 is much higher than the straight P20 model and no negative values are obtained

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 25: AUGUST SIM_P20/MAD*MAD
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Figure 8

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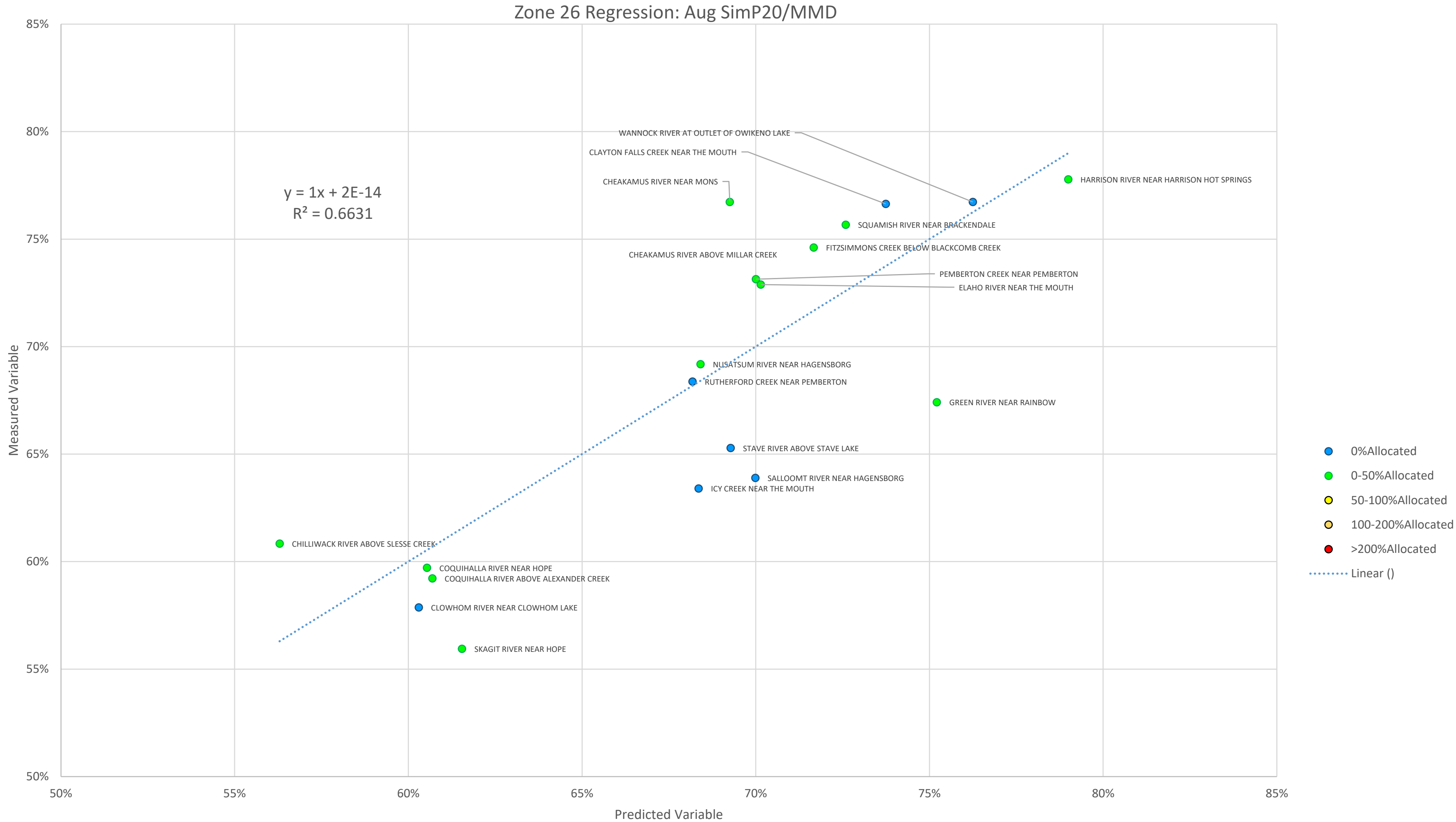
Figure 8: Zone 25: August Sim P20/MAD*MAD

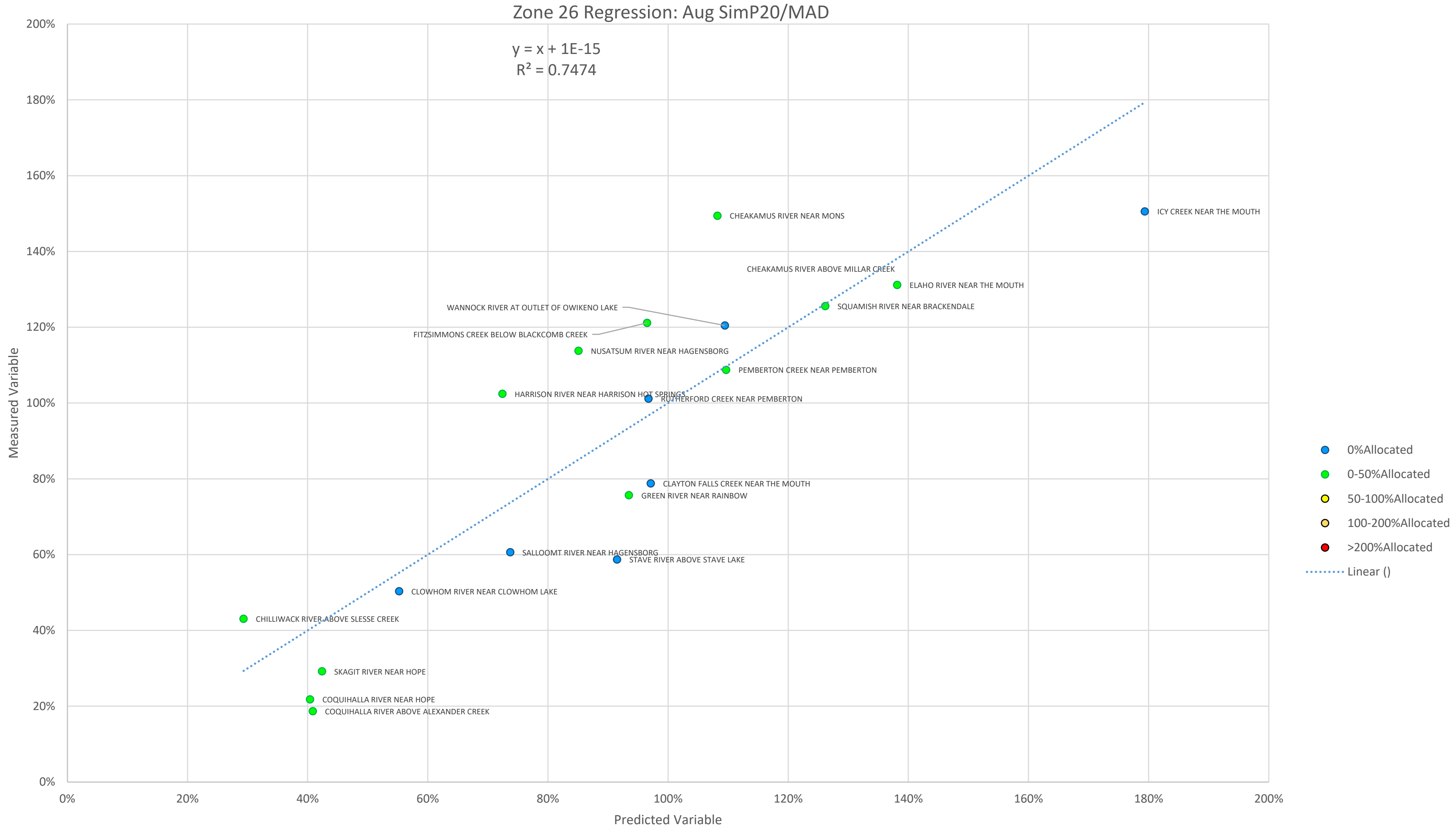


Notes:
1) No comment

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 26: AUGUST SIM_P20/MMD*MMD
Fathom Scientific Ltd. VER 1.5 Mar 16, 2023 — Figure 9

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCSB\MonthlyP20\08\[Zone25_ARM_08_P20_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 9: Zone 26: August SIMP20/MMD

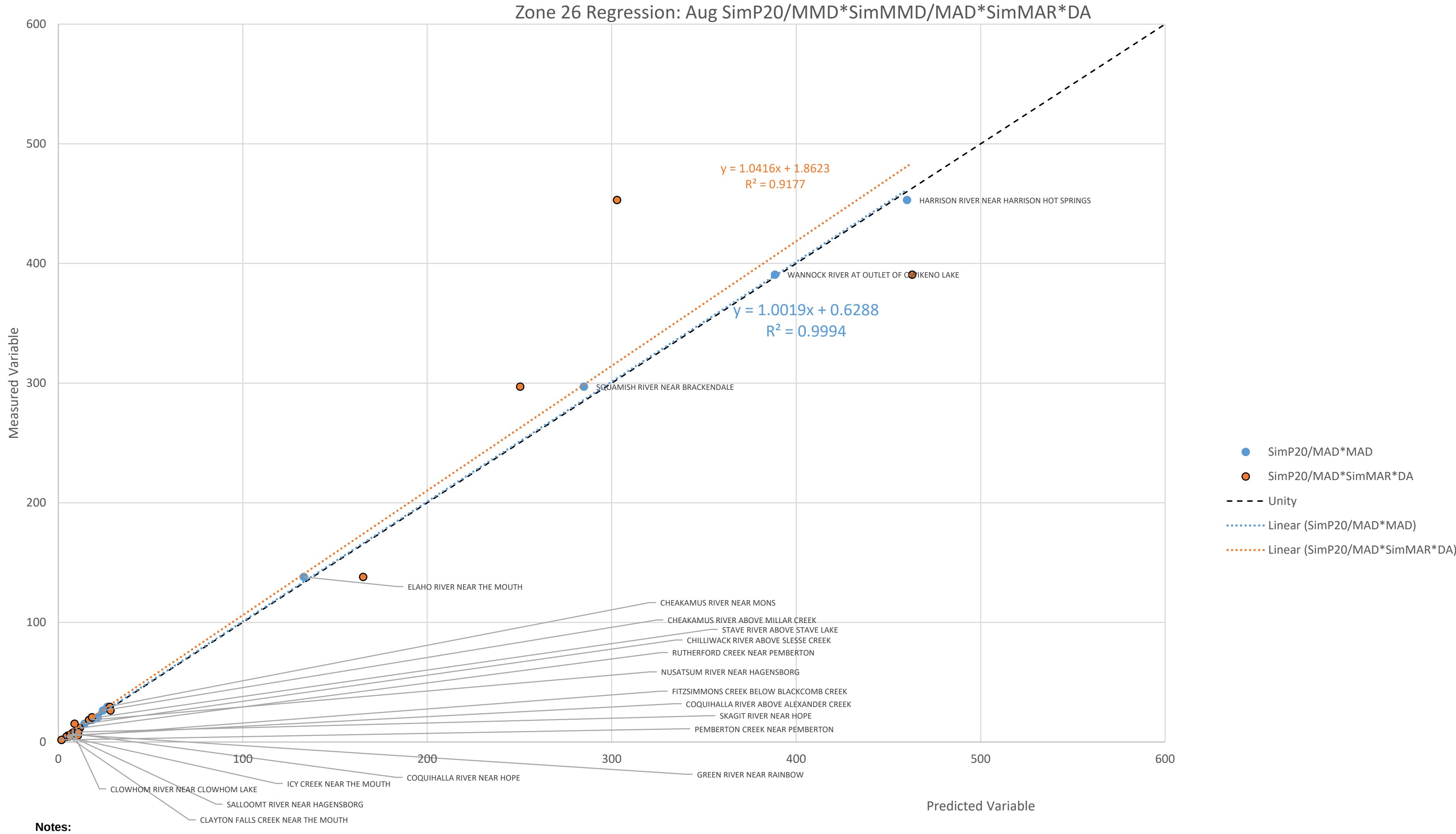


Notes:
1) No comment

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 26: AUGUST SIM_P20/MMD*MMD
Fathom Scientific Ltd. V0.3 Mar 16, 2023 — Figure 10

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCS8\MonthlyP20\08\[Zone26_ARM_08_P20divMAD_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 10: Zone 26: August P20/MAD



Notes:
1) The match is closer when multiplied by the true MMD as opposed to the Simulated MMD.

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 26: AUGUST SIM_P20/MMD*MMD
Fathom Scientific Ltd.
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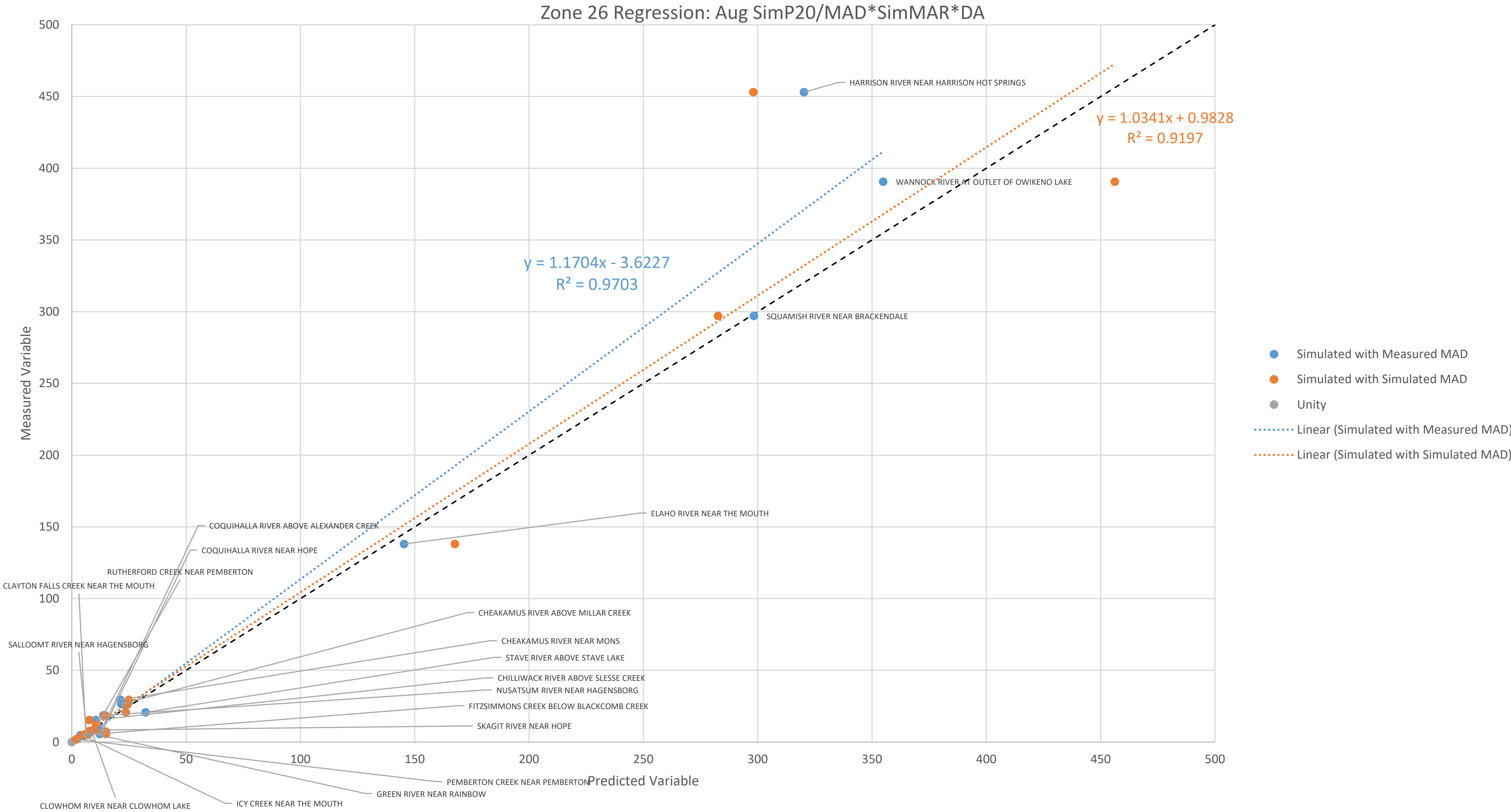
Figure 11

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCSB\MonthlyP20\08\[Zone25_ARM_08_P20_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 11: Zone 26: August SimP20/MMD*MMD

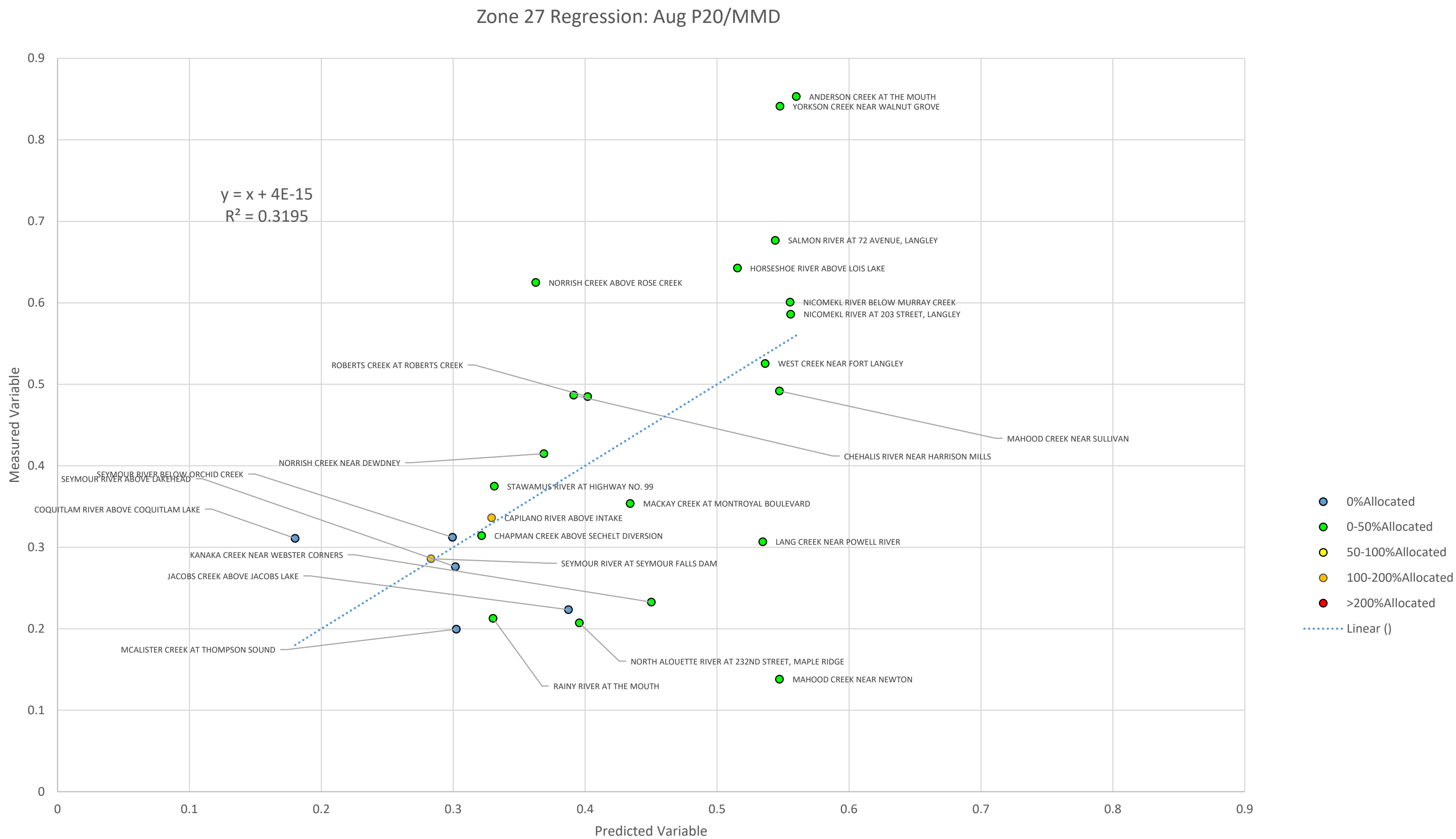


Notes:
1) No comment

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 26: AUGUST SIM_P20/MAD*MAD
Fathom Scientific Ltd.
VER 1.5 | Mar 16, 2023
Figure 12

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Regression_SCS8\MonthlyP20\08\[Zone25_ARM_08_P20_usingWALLY_V2_Datav0.3.xlsm]Data

Figure 12: Zone 26: August Sim P20/MAD*MAD



Notes:
1) When either the MMD or the MAD is used to normalize the P20, the data is compressed into a more gaussian distribution. The outliers (Anderson, Yorkson, Mahood) tend to be urban or agricultural sites. The %GrossAllocated filter is not catching these outliers, in fact the largest %GrossAllocated fit on the best file line.
2) Future iterations could either a) filter out stations with significant agricultural or urban runoff of b) attempt to naturailze these flow. For the current study, we've chosen to keep them in the training data which will accurately capture the uncertainty associated with the model.

BC MINISTRY OF FORESTS

WALLY MODEL UPDATE

ZONE 27: AUGUST SIMP20/MMD

Fathom Scientific Ltd.

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Figure 13

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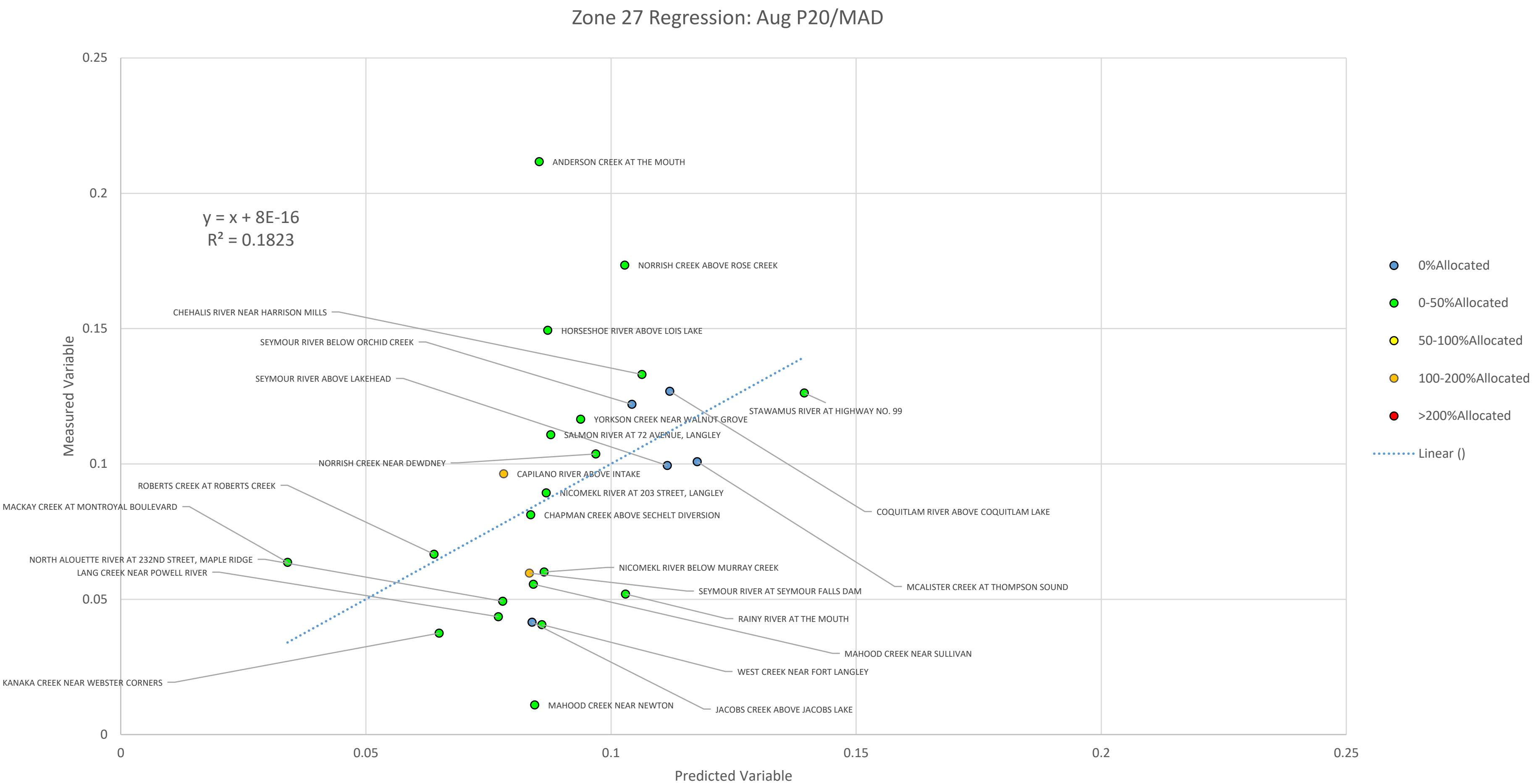
Figure 13: Zone 27: August SIMP20/MMD



Notes:

1) By dividing by MAD instead of MMD, we remove one level of abstraction between the normalized P20 and the absolute flow value. The R2 are slighly higher using this normalizing factor compared to MMD.

2) Anderson and Mahood are still outliers, however Yorkson is not within the cluster near the regression line.

BC MINISTRY OF FORESTS

WALLY MODEL UPDATE

ZONE 27: AUGUST SIM_P20/MAD

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Figure 14

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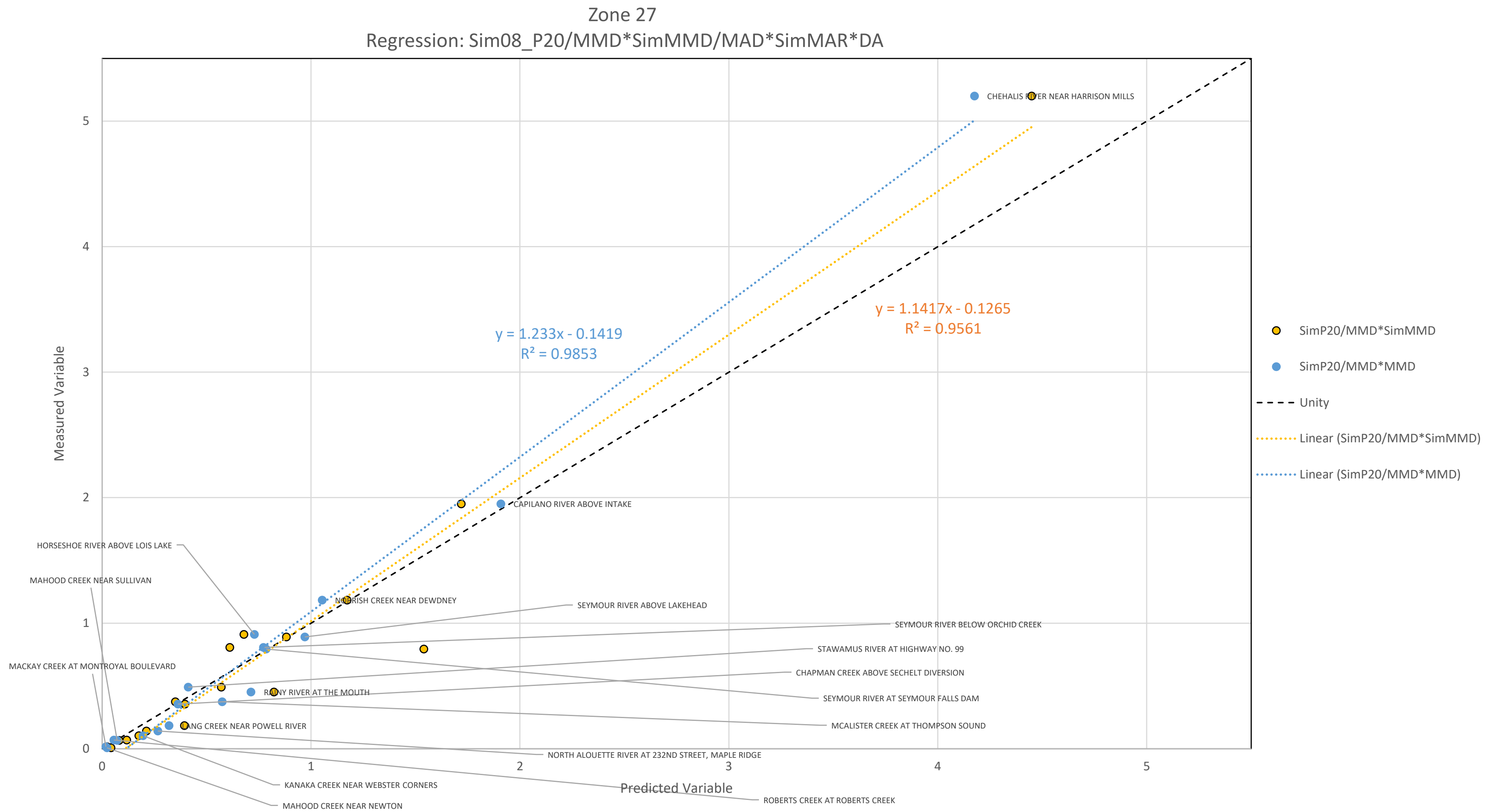
Figure 14: Zone 27: August P20/MAD



Notes:
1After multiplying by the MMD or the SimMMD, the R2 are much higher. The largest outlier is at Seymour River at Seymour Falls Dam (1.54 vs 0.79)

BC MINISTRY OF FORESTS
WALLY MODEL UPDATE
ZONE 27: AUGUST SIMP20/MMD*MMD
Fathom Scientific Ltd. — VER 1.5 — Mar 16, 2023
Figure 15

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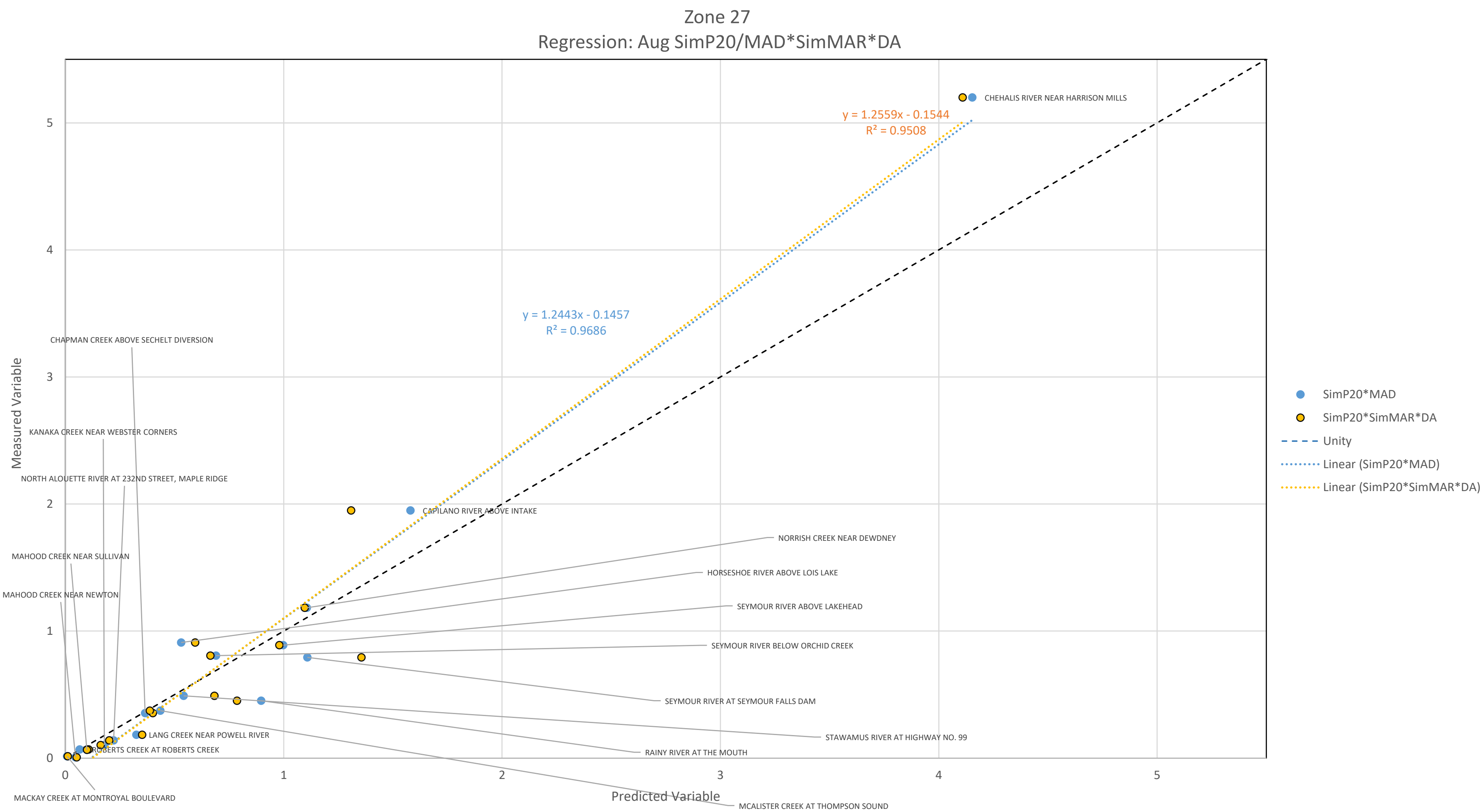
Figure 15: Zone 27: August SimP20/MMD*MMD



Notes:
1) After multiplying by the MAD, the R^2 is much higher than the straight P20 model and no negative values are obtained

BC MINISTRY OF FORESTS	
WALLY MODEL UPDATE	
ZONE 27: AUGUST SIM_P20/MAD*MAD	
Fathom Scientific Ltd. V0.3 Mar 16, 2023	Figure 16

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Figure 16: Zone 27: August Sim P20/MAD*MAD

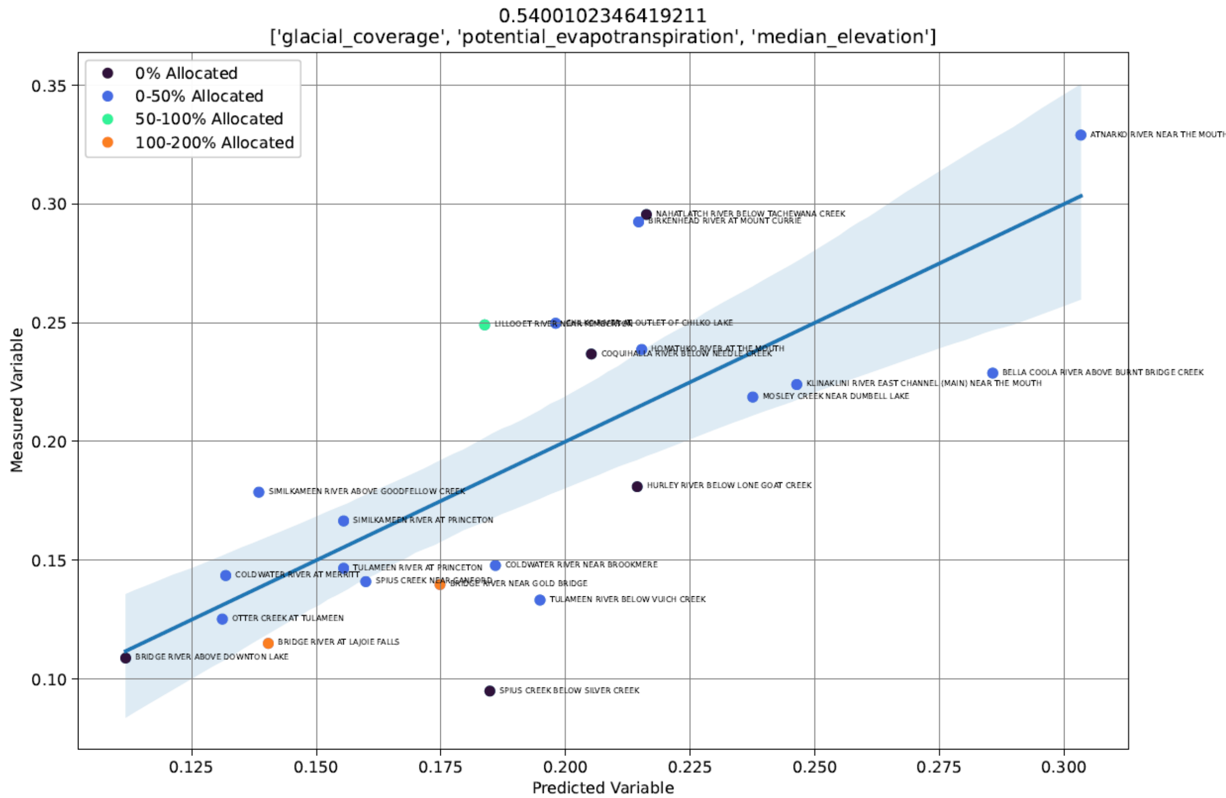


Figure 17: Regression results of HZ25 Annual P20/MAD

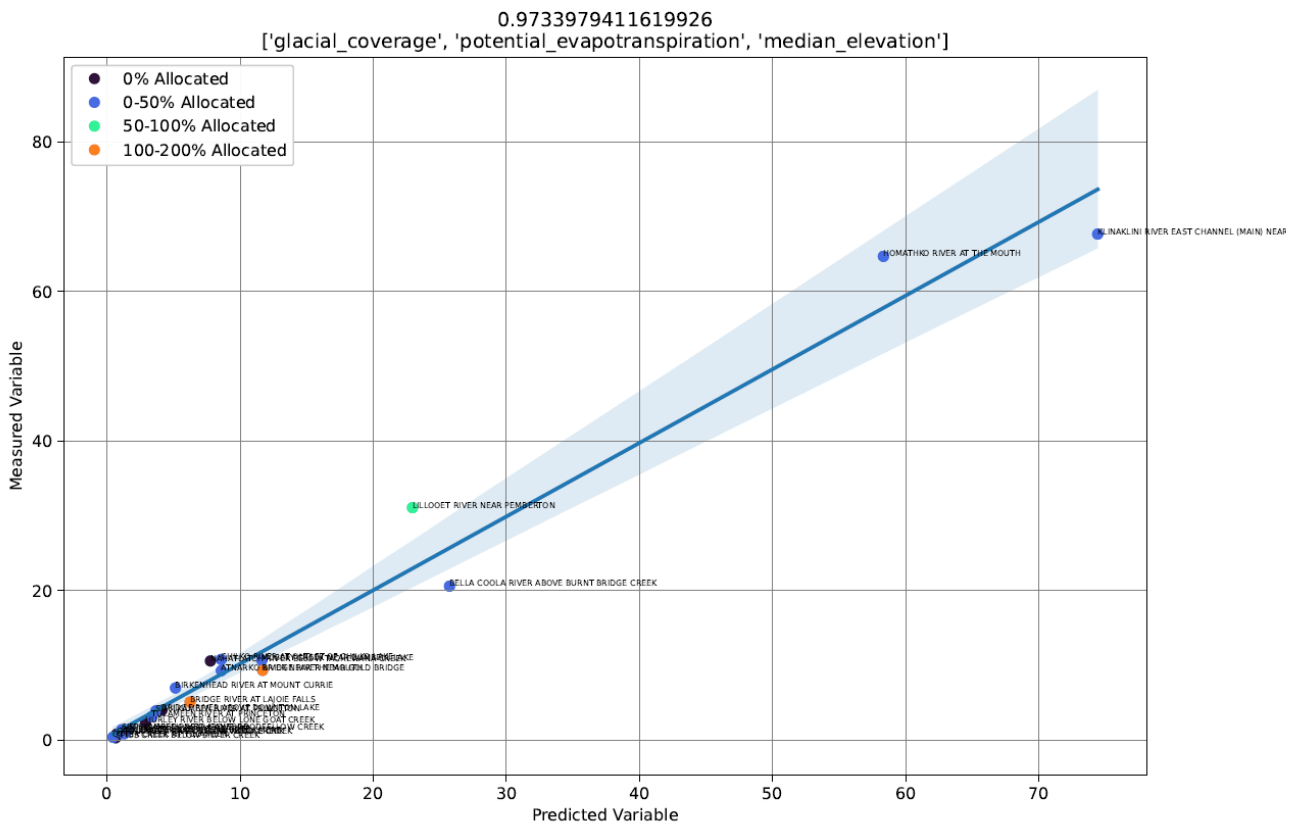


Figure 18: Regression results of HZ25 Annual Sim(P20/MAD)*MAD

Note that the R2 is 0.98, but by using the measured MAD.

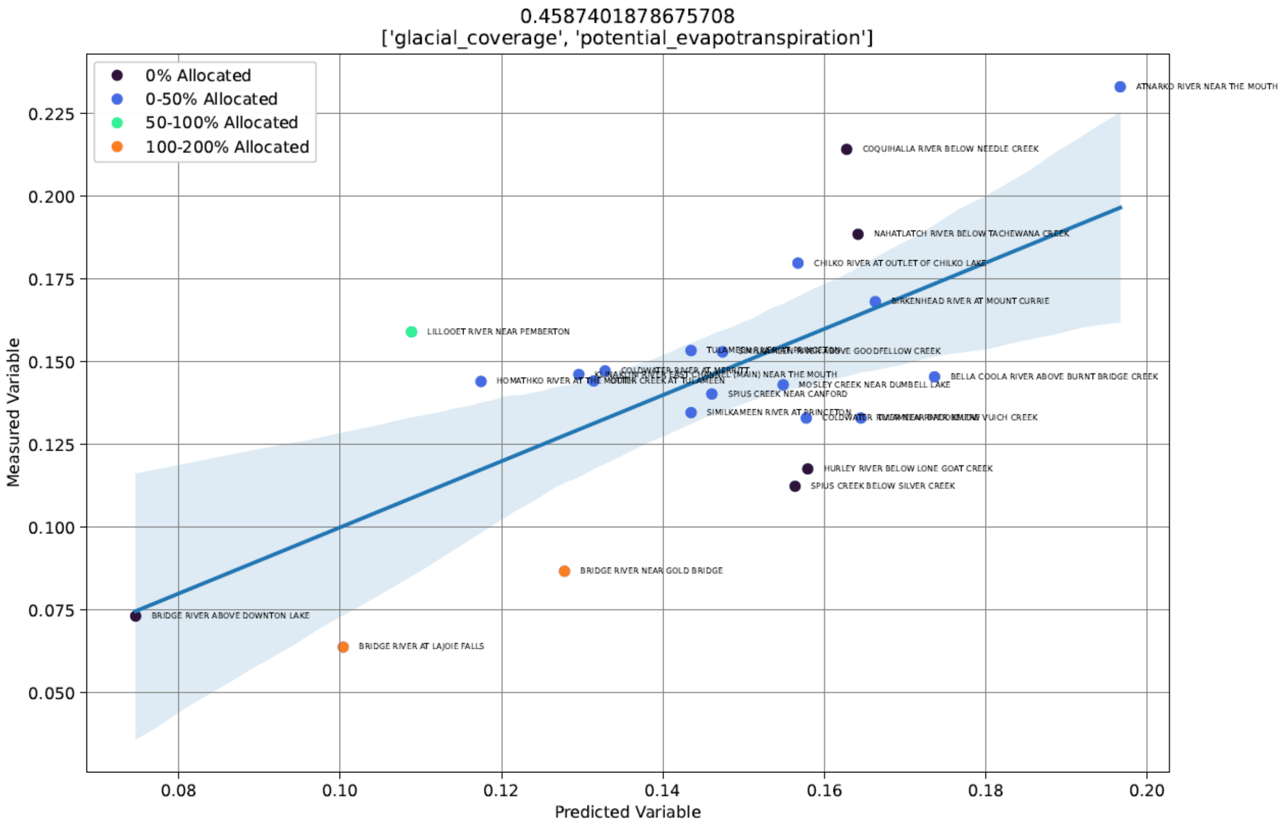


Figure 19: Regression results of February P20/MAD

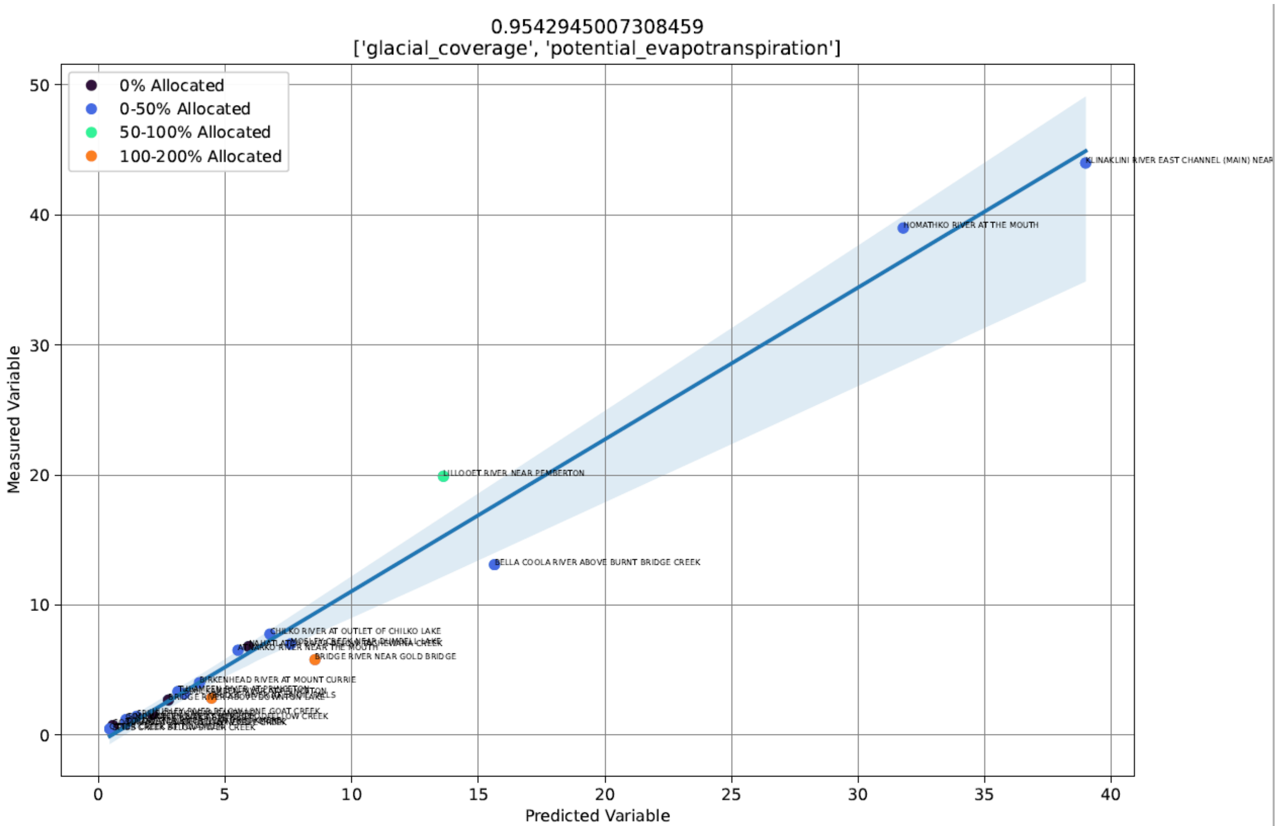


Figure 20: Regression results of February Sim(P20/MAD)*MAD

Note that the R2 is 0.95, but by using the measured MAD.

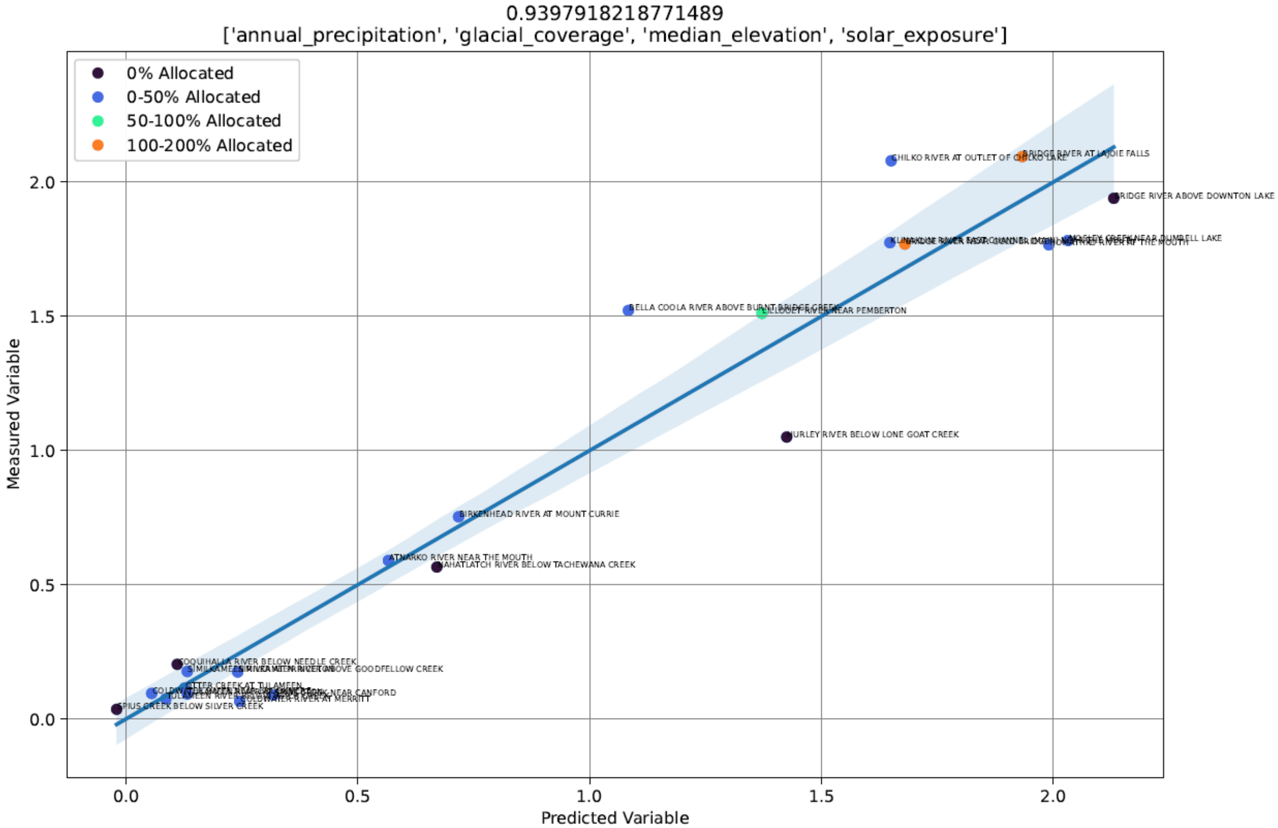


Figure 21: Regression results of HZ25 August P20/MAD

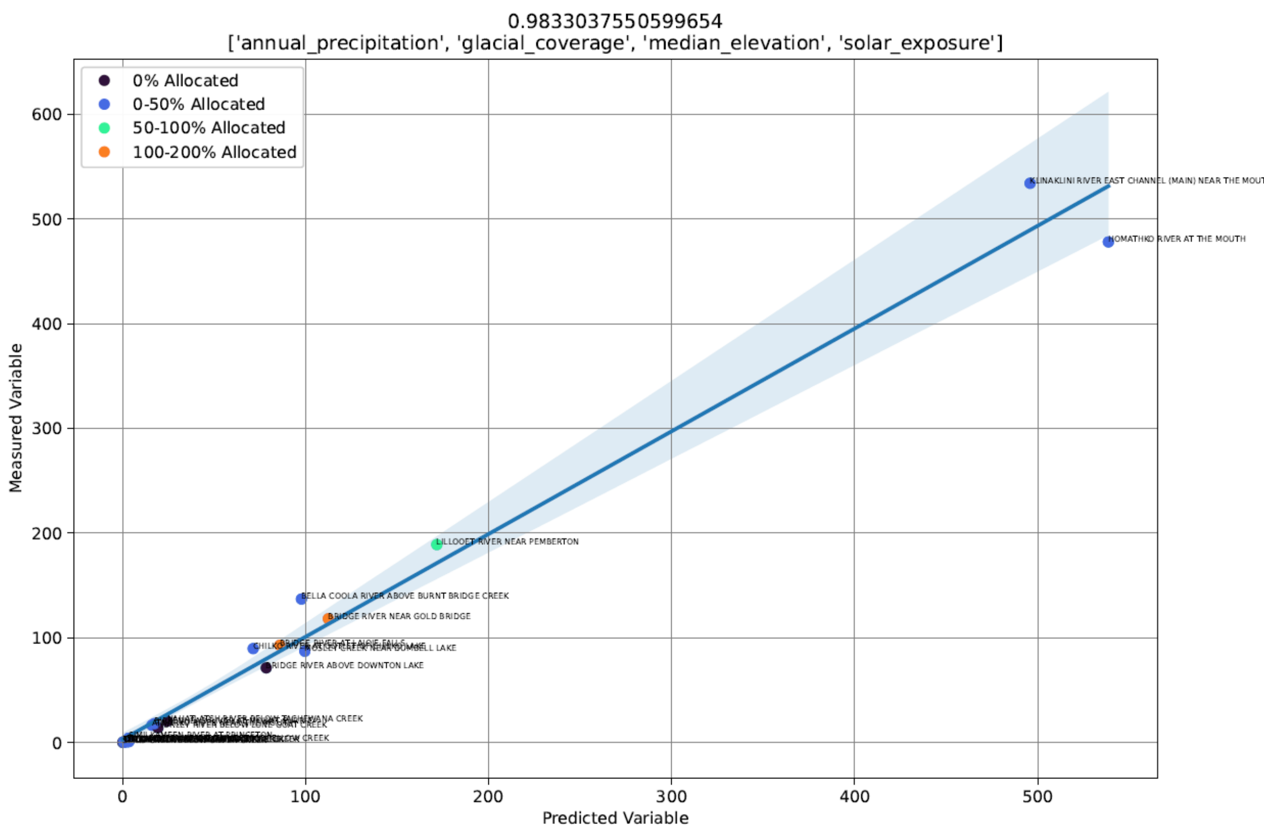


Figure 22: Regression results of HZ25 August Sim(P20/MAD)*MAD

Note that the R2 is 0.98, but by using the measured MAD.

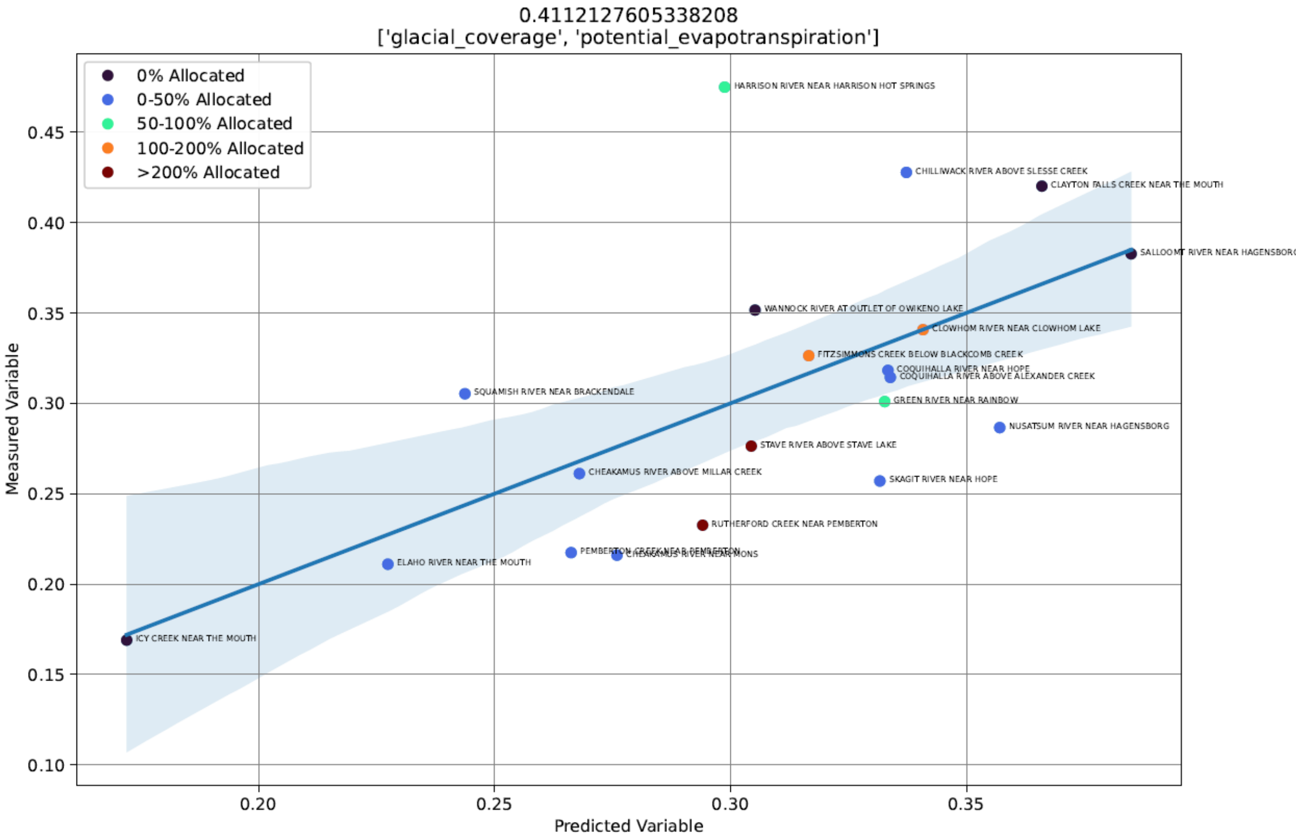


Figure 23: Regression results of HZ26 Annual P20/MAD

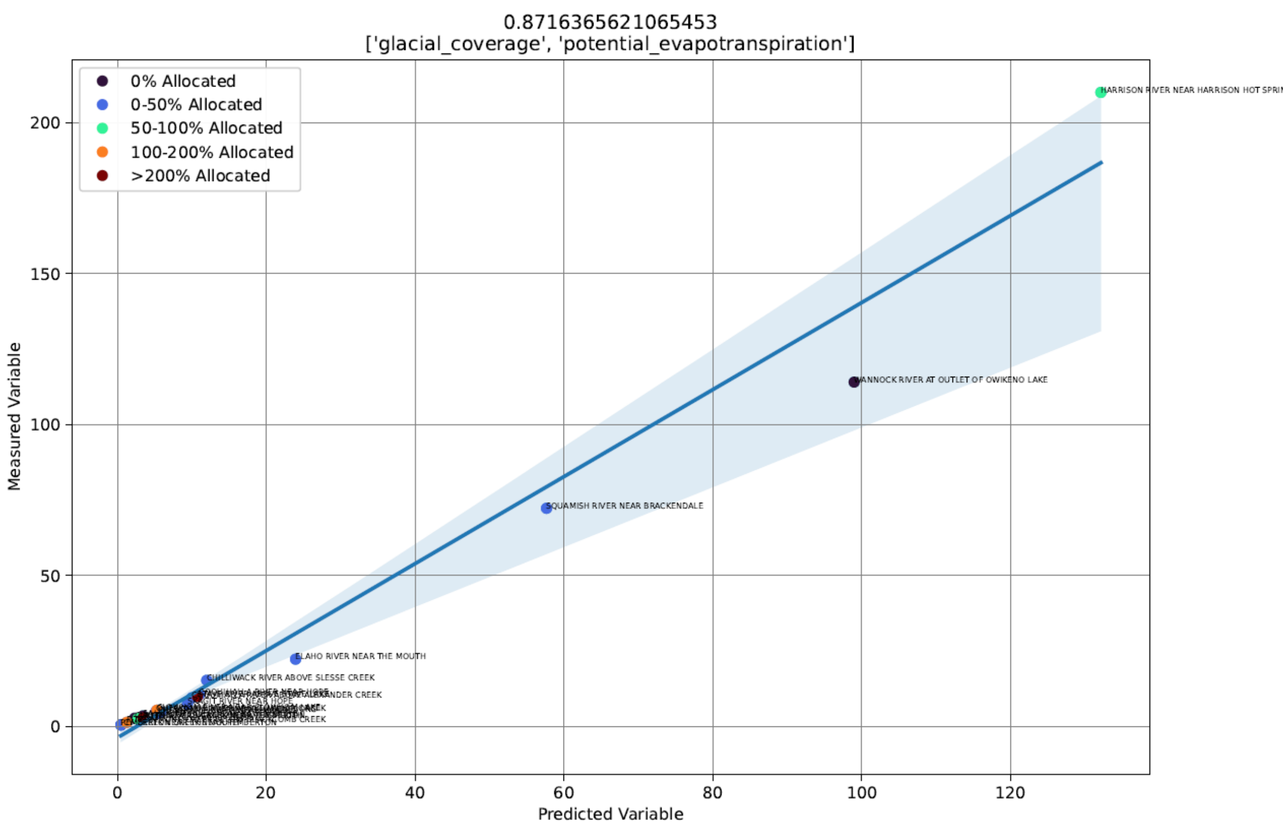


Figure 24: Regression results of HZ26 Annual Sim(P20/MAD)*MAD

Note that the R2 is 0.87, but by using the measured MAD.

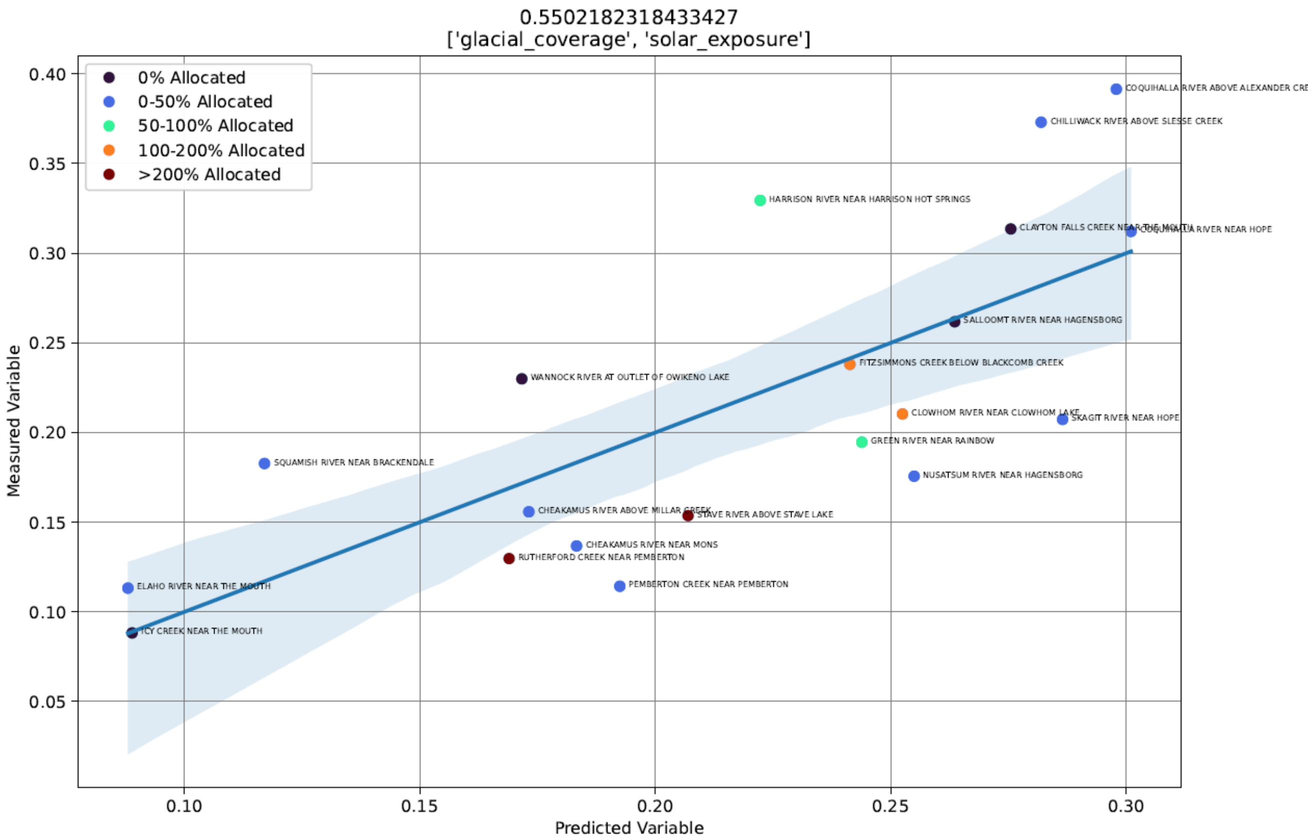


Figure 25: Regression results of HZ26 February P20/MAD

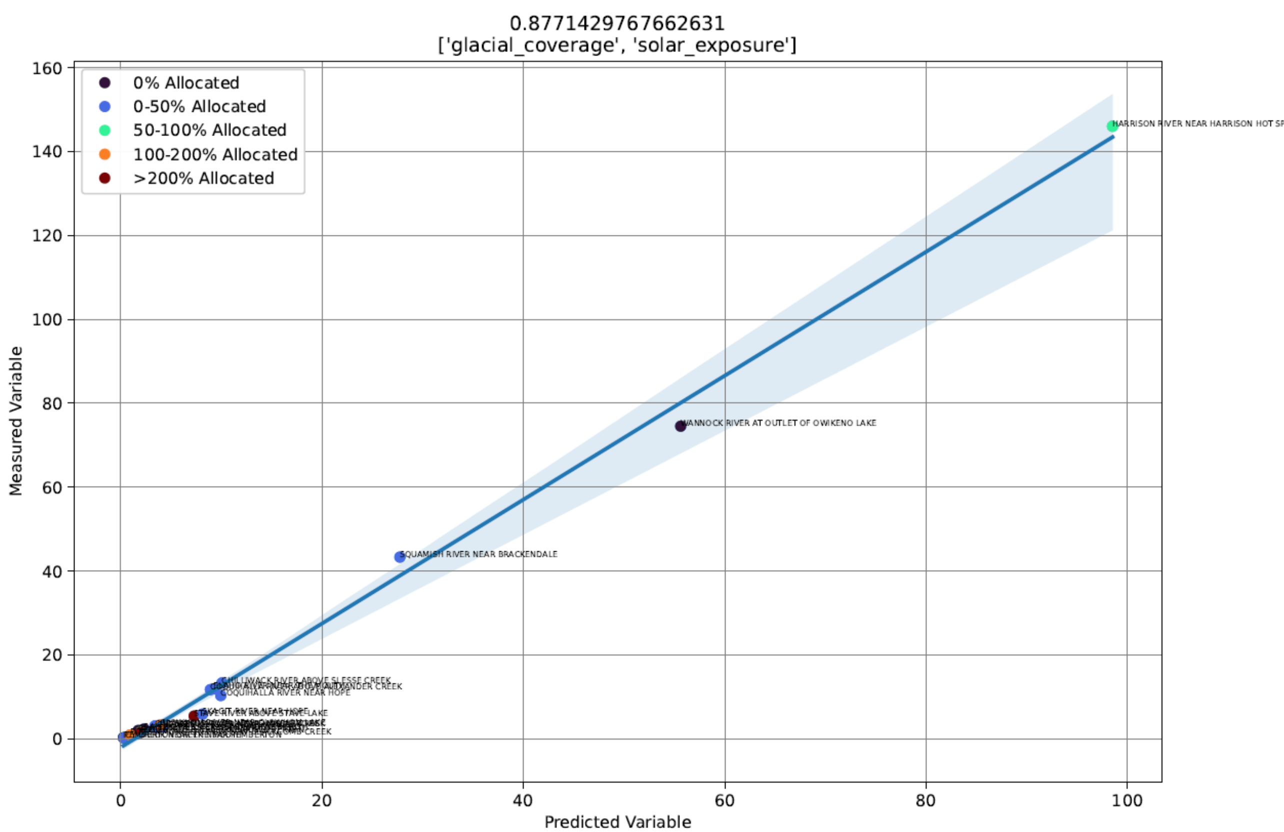


Figure 26: Regression results of HZ26 February Sim(P20/MAD)*MAD

Note that the R2 is 0.88, but by using the measured MAD.

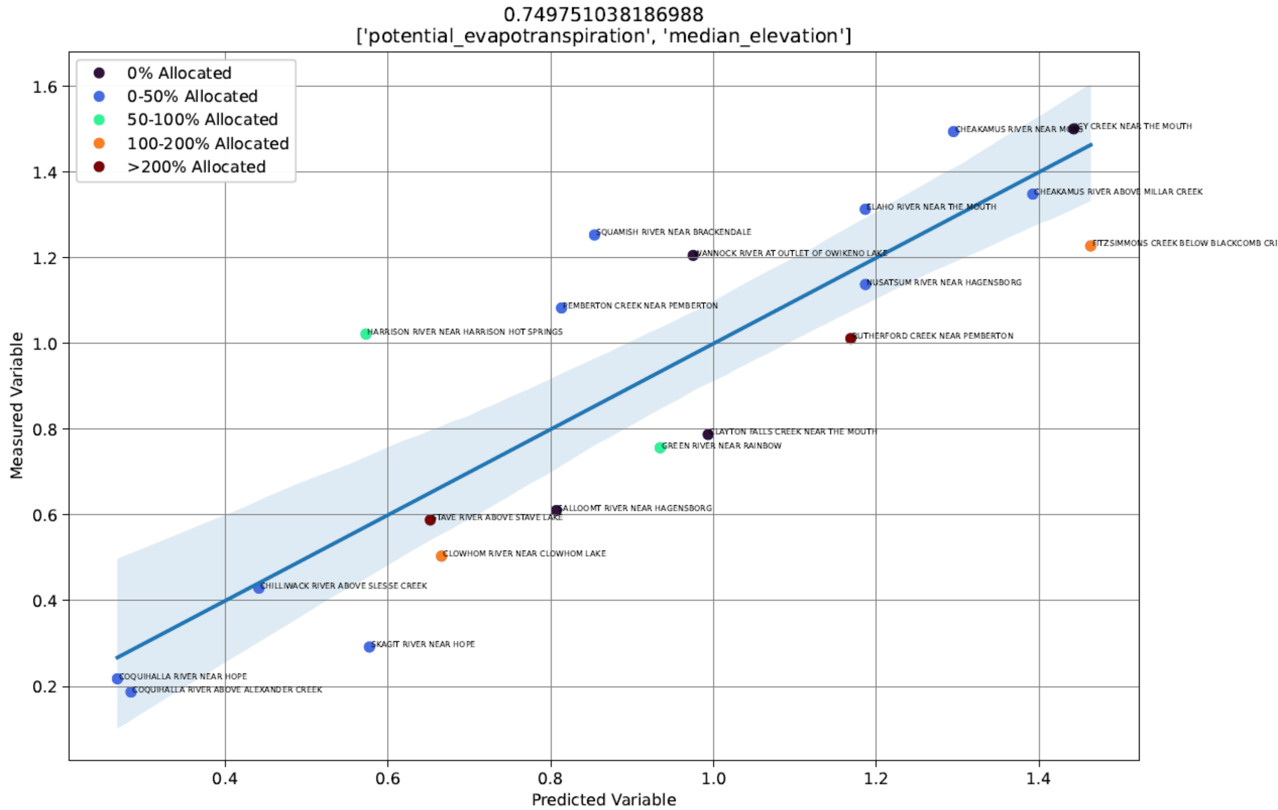


Figure 27: Regression results of HZ26 August P20/MAD

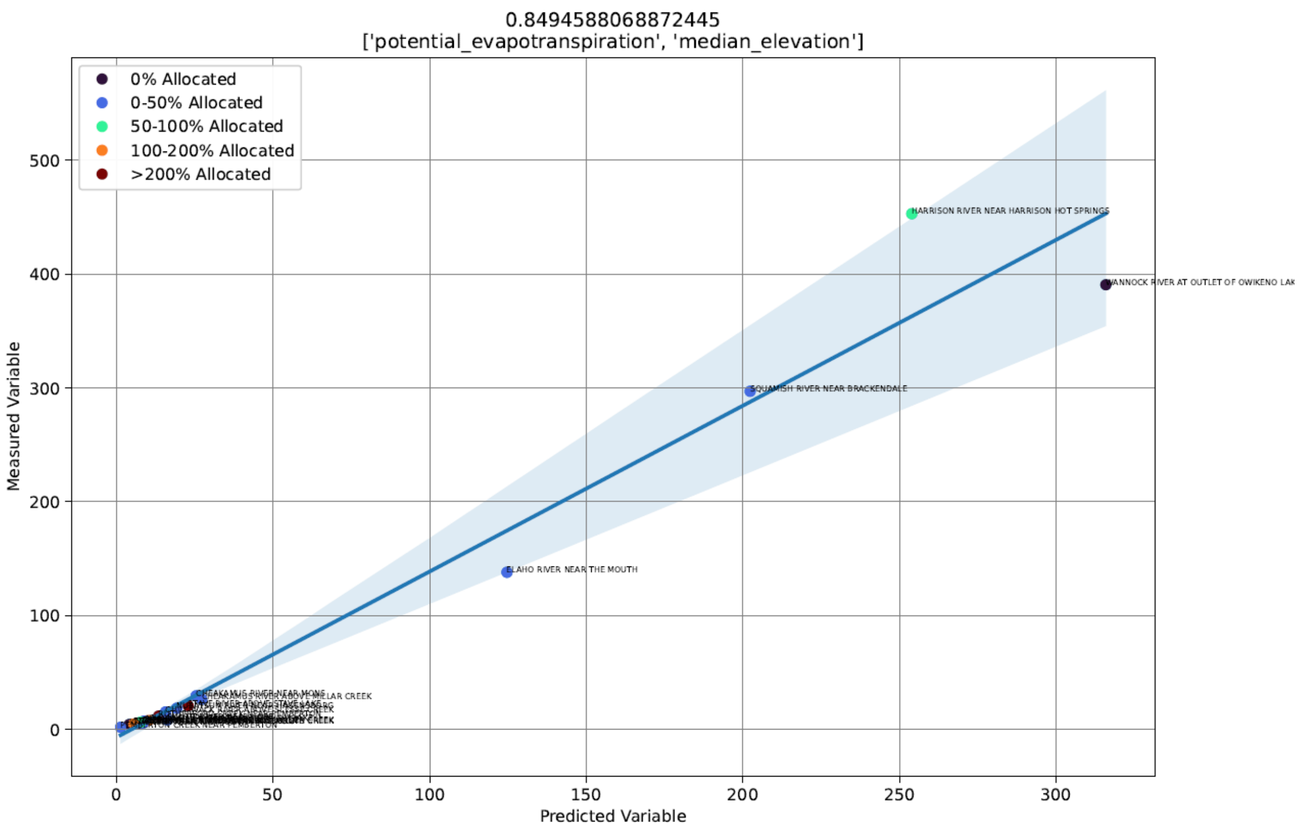


Figure 28: Regression results of HZ26 August Sim(P20/MAD)*MAD

Note that the R2 is 0.85, but by using the measured MAD.

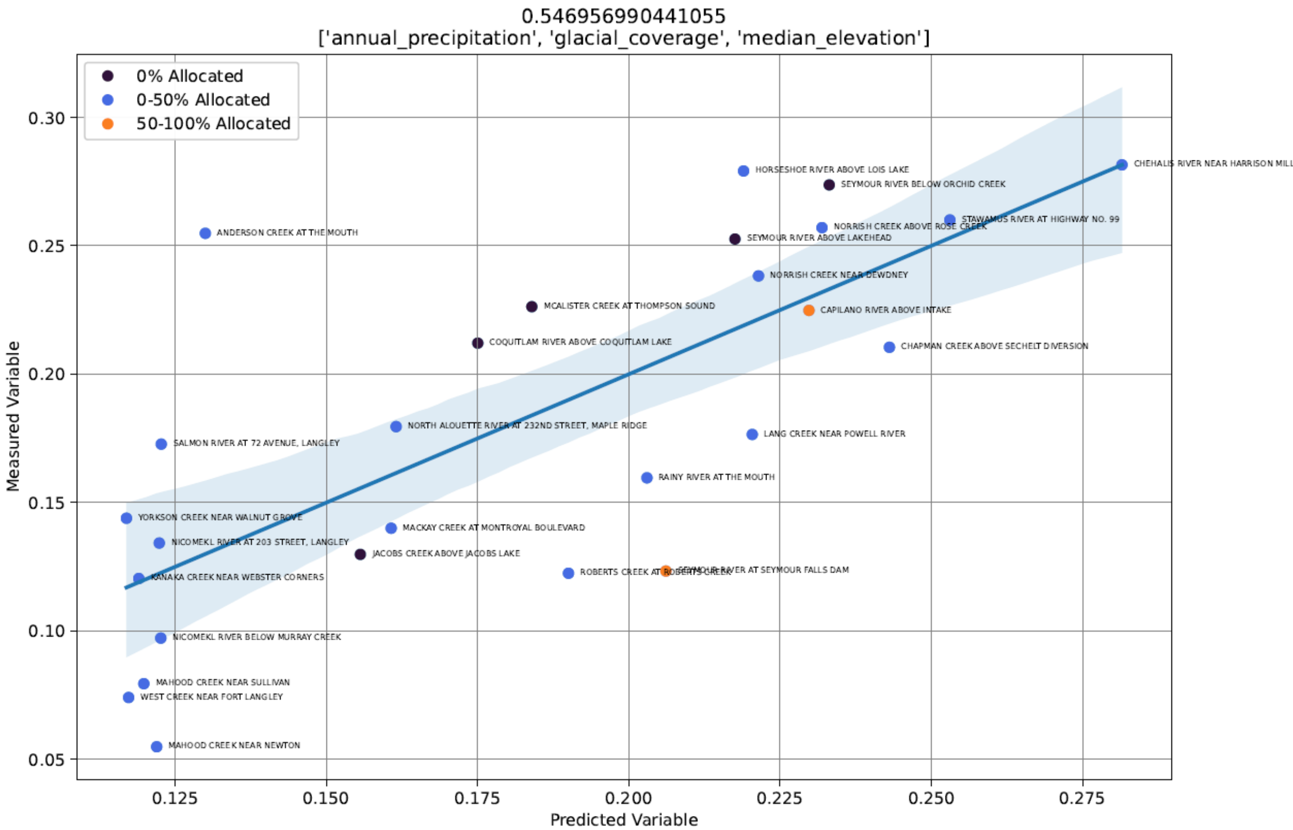


Figure 29: Regression results of HZ27 Annual P20/MAD

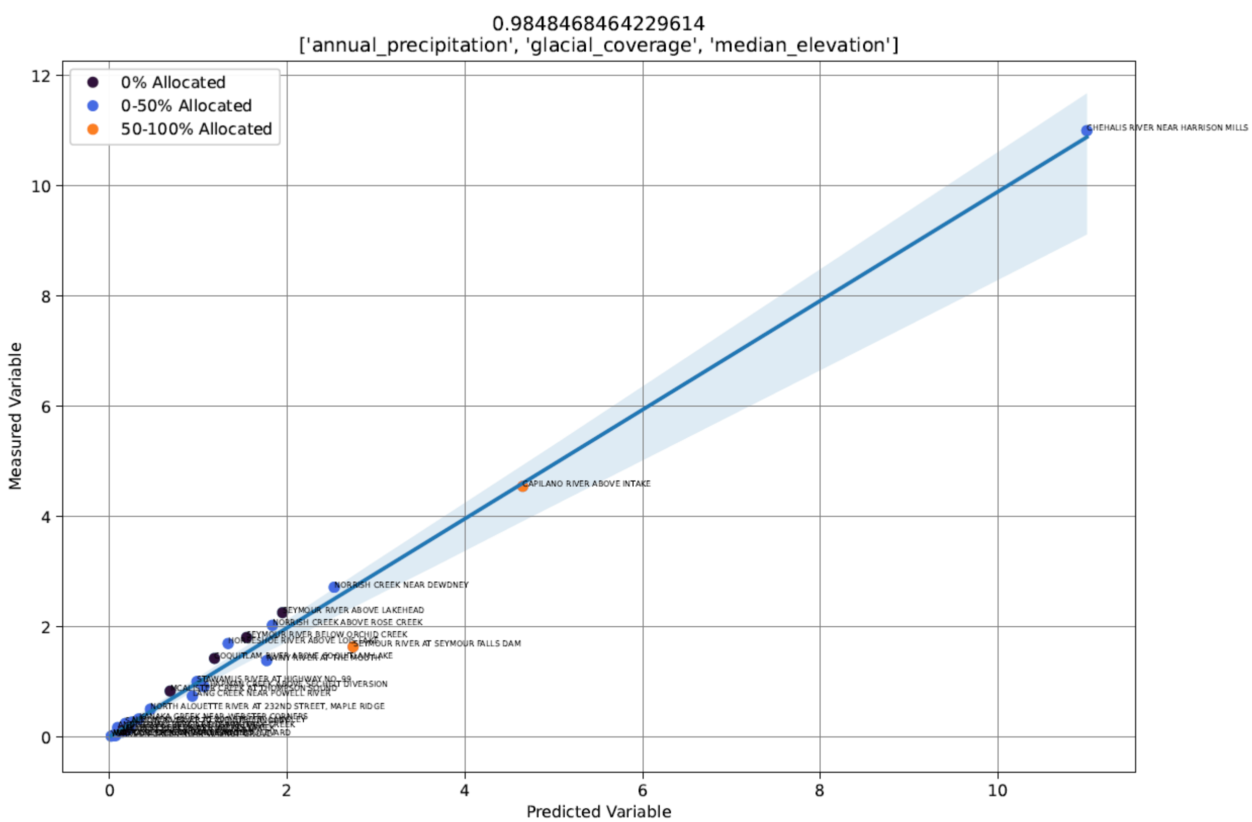


Figure 30: Regression results of HZ27 Annual Sim(P20/MAD)*MAD

Note that the R2 is 0.98, but by using the measured MAD.

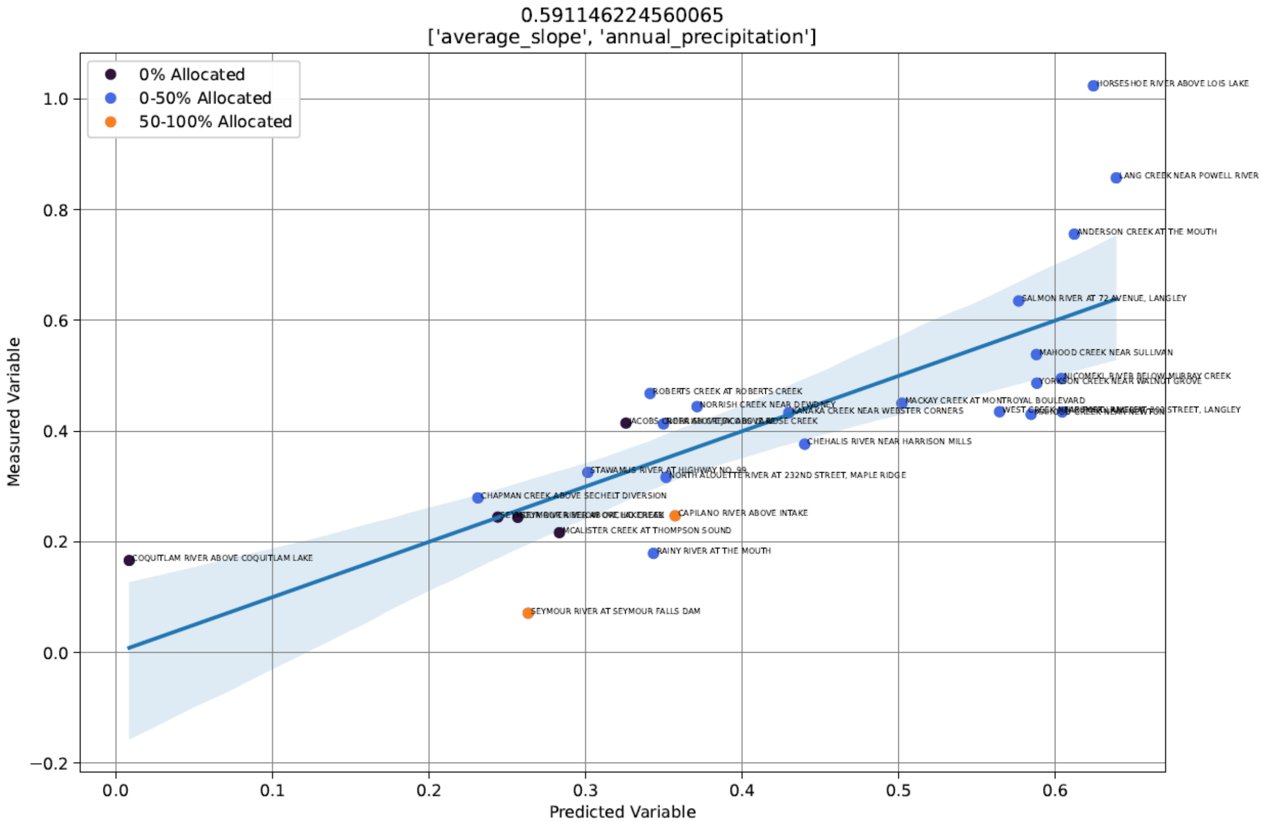


Figure 31: Regression results of HZ27 February P20/MAD

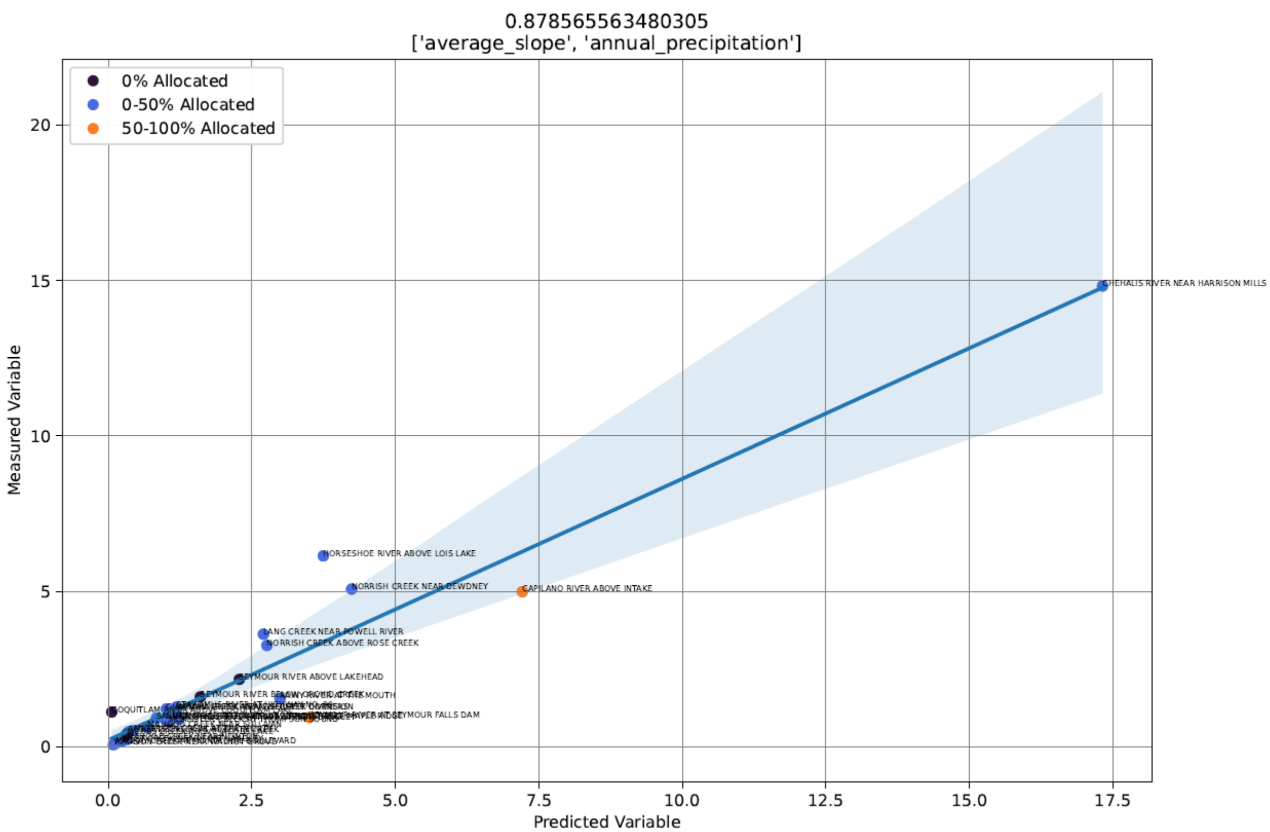


Figure 32: Regression results of HZ27 February Sim(P20/MAD)*MAD

Note that the R2 is 0.88, but by using the measured MAD.

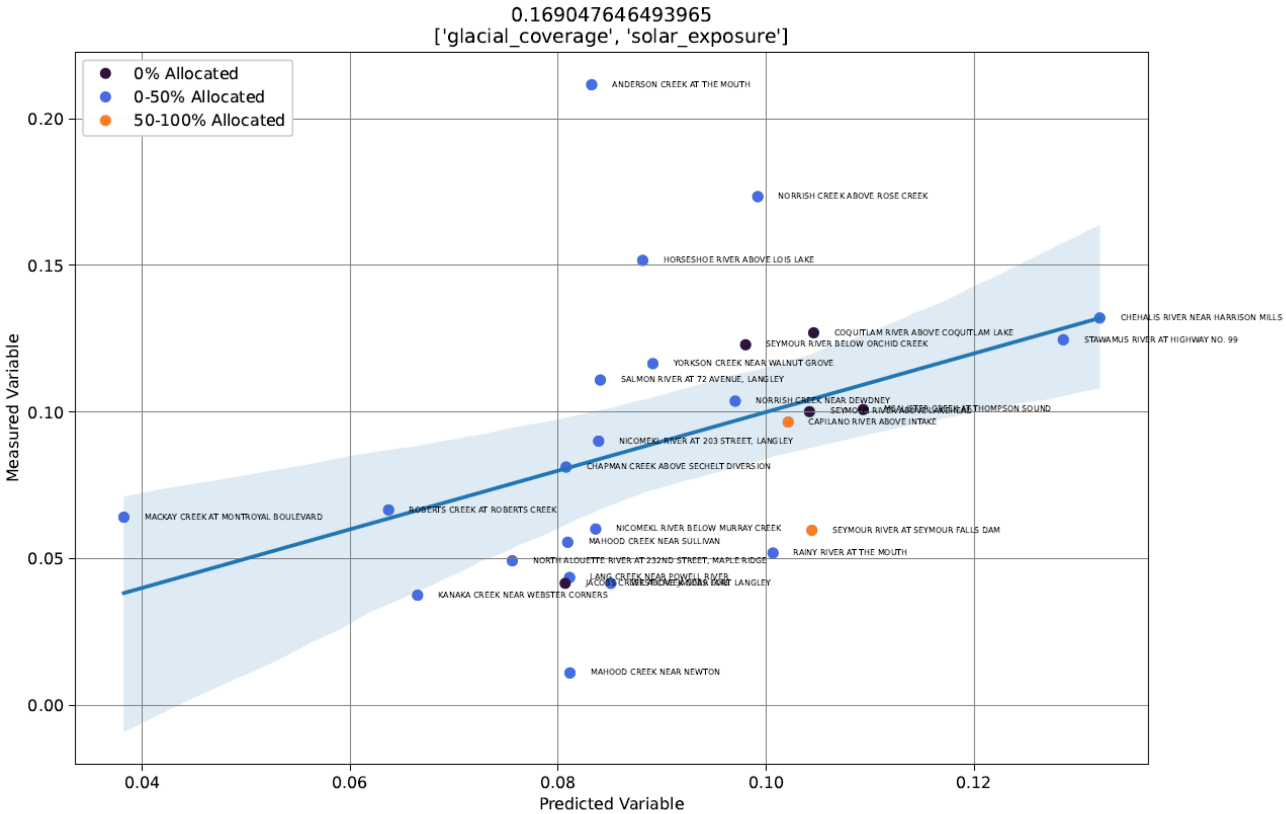


Figure 33: Regression results of HZ27 August P20/MAD

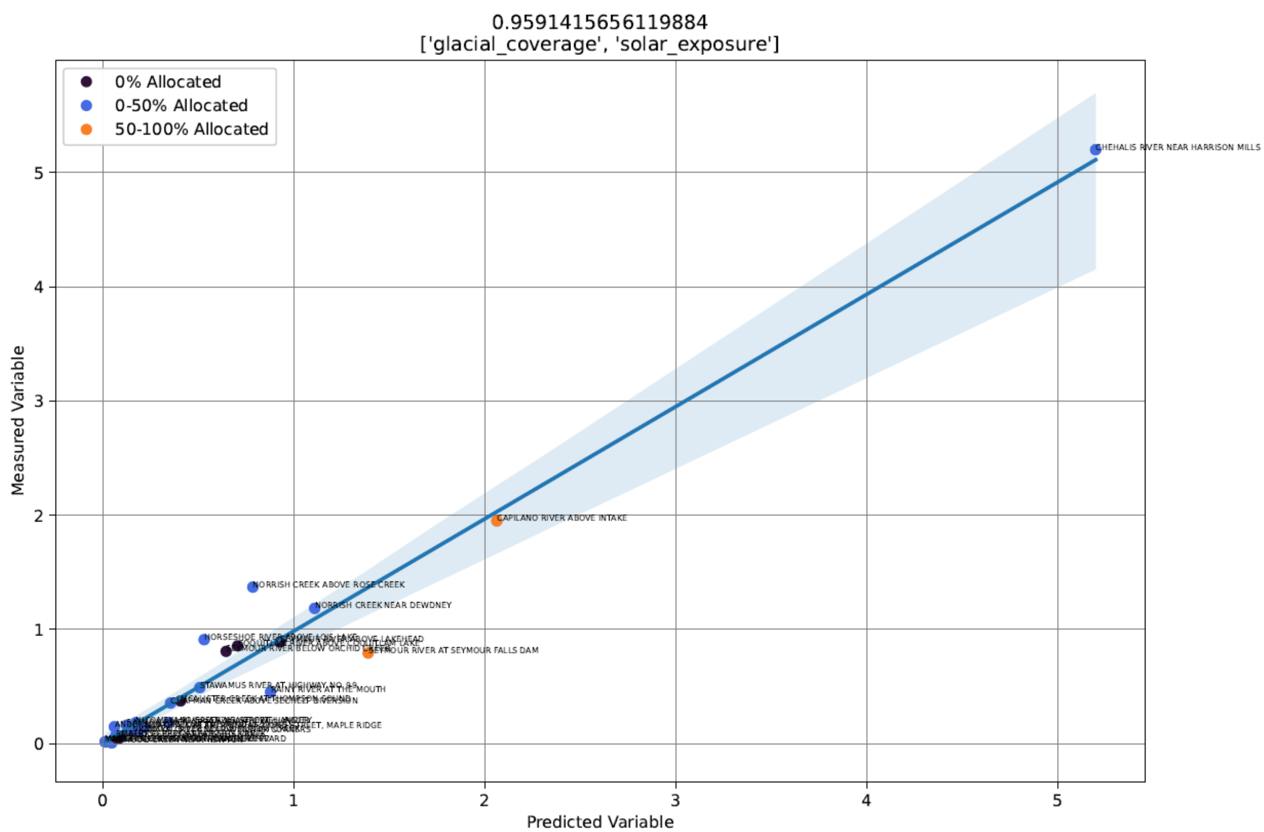


Figure 34: Regression results of HZ27 August Sim(P20/MAD)*MAD

Note that the R2 is 0.96, but by using the measured MAD.

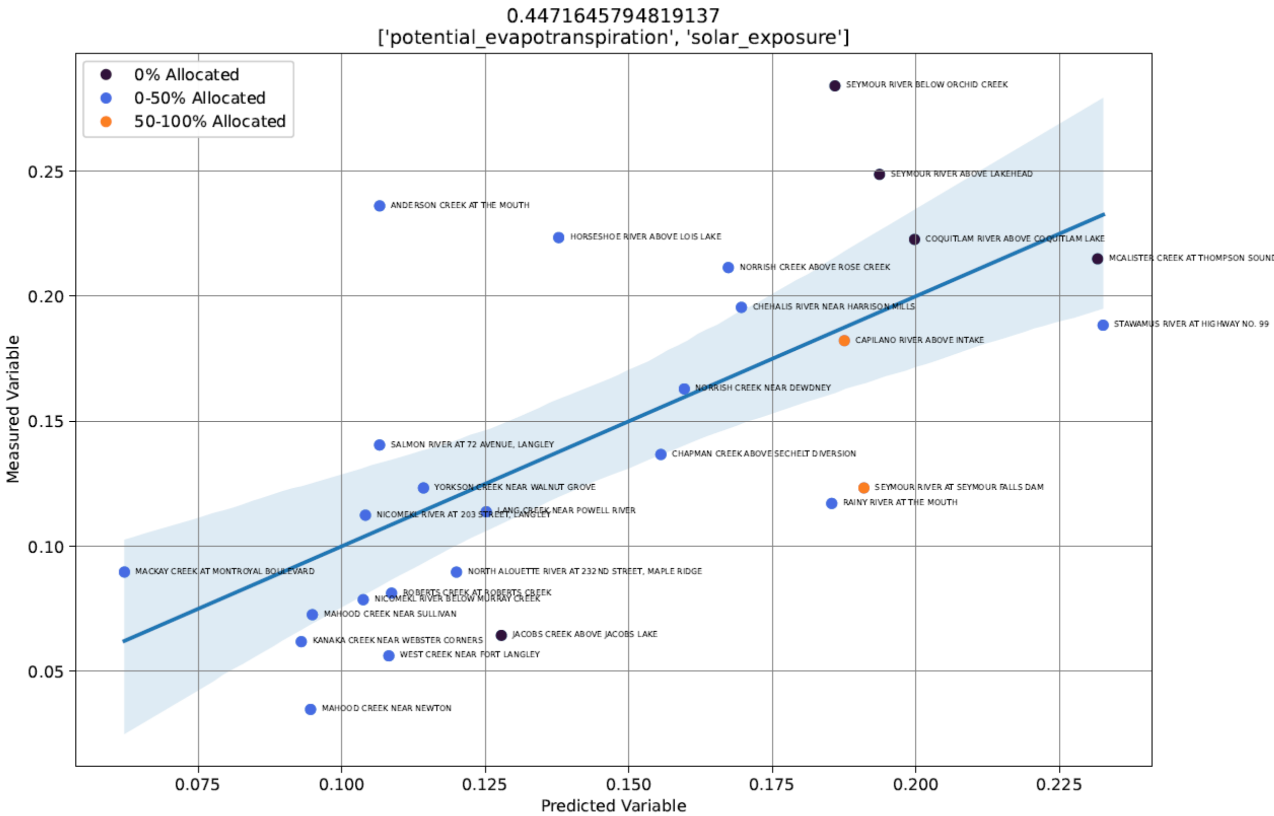


Figure 35: Regression results of HZ27 August P50/MAD

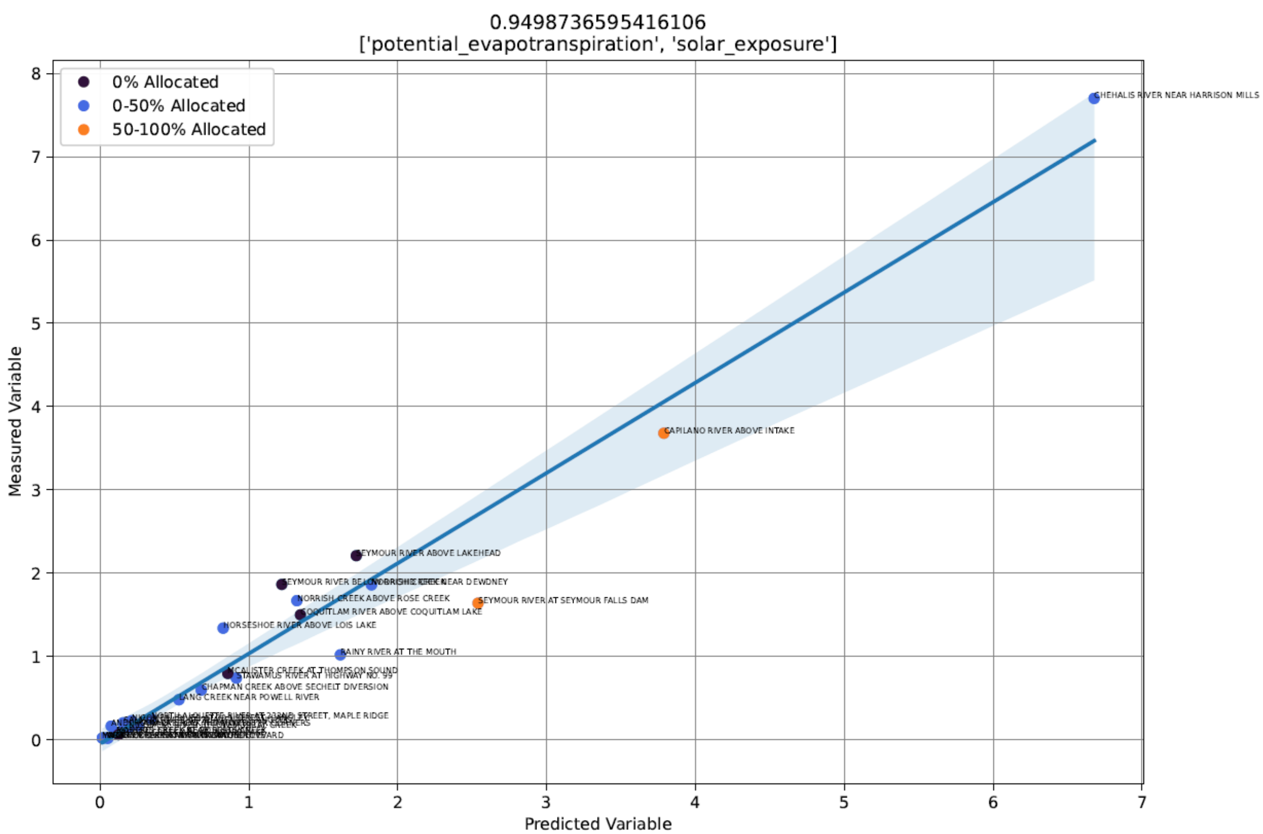


Figure 36: Regression results of HZ27 August Sim(P50/MAD)*MAD

Anderson (08MH104)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m^3/s)							($l/s/km^2$)	(m^3/s)
Hydat MMQ	27.2	1.52	1.30	0.95	0.68	0.35	0.27	0.21	0.17	0.18	0.31	0.93	1.40	26.1	0.69
FSL (2023) MMQ	26.68	1.27	1.21	0.94	0.63	0.27	0.18	0.12	0.09	0.14	0.43	1.21	1.53	**21.7**	**0.58**
Nash Sutcliffe Eff.= 93%	%Diff	-16%	-7%	-1%	-6%	-23%	-33%	-44%	-46%	-23%	40%	30%	10%	-17%	
For Zone 27							%MMD/MAD							($l/s/km^2$)	(m^3/s)
STEYX	26.68	13.3%	13.4%	11.8%	10.8%	15.0%	14.6%	8.2%	5.2%	7.2%	10.3%	16.0%	15.2%	9.08	0.24
							Q (m^3/s)							%	%
STEYX x 2	26.68	0.19	0.19	0.16	0.15	0.21	0.20	0.11	0.07	0.10	0.14	0.22	0.21	70%	84%
FSL 95% SigDiff?															
MM_P50							Q (m^3/s)								
Hydat P50	27.2	0.86	0.83	0.71	0.52	0.28	0.21	0.19	0.16	0.17	0.18	0.57	0.82		
FSL (2023) P50	26.68	0.75	0.66	0.56	0.38	0.16	0.10	0.07	0.06	0.07	0.14	0.63	0.78		
%Diff		-13%	-21%	-22%	-28%	-45%	-52%	-63%	-61%	-59%	-23%	11%	-4%		
							%MAD								
STEYX	26.68	15.4%	14.8%	14.7%	12.8%	12.4%	15.1%	7.0%	5.2%	5.8%	8.1%	15.4%	16.2%		
							Q (m^3/s)								
STEYX x 2	26.68	0.214	0.206	0.205	0.178	0.172	0.210	0.097	0.073	0.081	0.112	0.214	0.225		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
MM_P20							Q (m^3/s)								
Hydat P20	27.2	0.48	0.52	0.48	0.36	0.21	0.18	0.16	0.15	0.14	0.15	0.24	0.47		
FSL (2023) P20	26.68	0.37	0.35	0.32	0.23	0.09	0.06	0.05	0.05	0.05	0.08	0.26	0.39		
%Diff		-23%	-33%	-33%	-37%	-58%	-65%	-67%	-68%	-63%	-50%	10%	-16%		
For Zone 27							%MAD							Notes:	
STEYX	26.68	16.2%	12.2%	10.6%	9.5%	9.6%	9.4%	6.0%	4.3%	3.8%	3.6%	8.2%	14.3%		
							Q (m^3/s)								
STEYX x 2	26.68	0.225	0.170	0.147	0.133	0.134	0.131	0.083	0.060	0.053	0.050	0.113	0.198		
FSL 95% SigDiff?		FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	2212	2212	2212	2212	28362	135174	80662	67587	72151	46001	-41576	-41576		
							Q (m^3/s)								
Net Allocated	27.2	**-0.001**	**-0.001**	**-0.001**	**-0.001**	**-0.011**	**-0.052**	**-0.030**	**-0.025**	**-0.028**	**-0.017**	**0.016**	**0.016**		
P50-P20	27.2	0.39	0.31	0.24	0.15	0.07	0.03	0.02	0.02	0.02	0.06	0.37	0.39		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-0.05	-0.07	-0.11	-0.16	-0.24	-0.31	-0.16	-0.11	-0.12	-0.10	0.04	-0.04		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE		

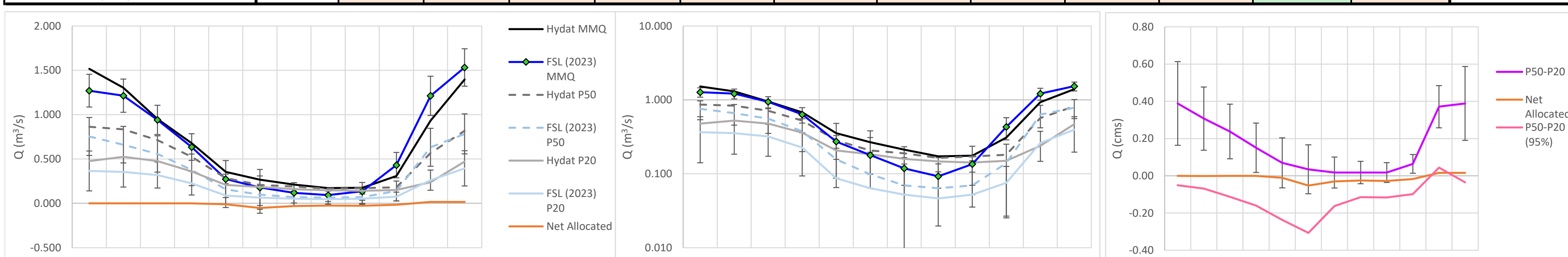
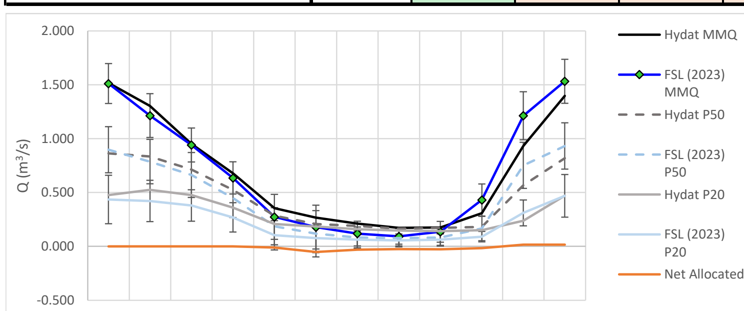
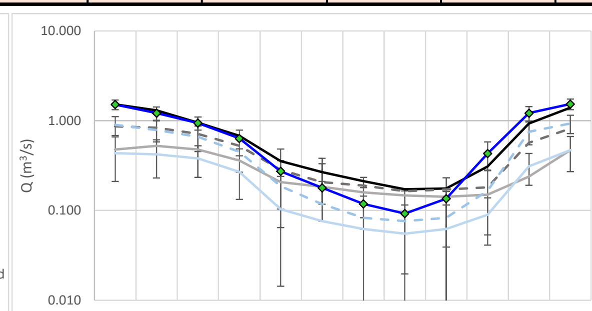


Figure 37: Validation using Anderson Creek (08MH104) and Simulated MAD

Note that if the measured MAD of 0.69 is used, the series are much closer. As with most of the regressions, Anderson is higher than expected.

Anderson (08MH104)	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q								Q (m³/s)						(l/s/km²)	(m³/s)
Hydat MMQ	27.2	1.52	1.30	0.95	0.68	0.35	0.27	0.21	0.17	0.18	0.31	0.93	1.40	26.1	0.69
FSL (2023) MMQ	26.68	1.51	1.21	0.94	0.63	0.27	0.18	0.12	0.09	0.14	0.43	1.21	1.53	**21.7**	**0.69**
Nash Sutcliffe Eff.= 95%	%Diff	0%	-7%	-1%	-6%	-23%	-33%	-44%	-46%	-23%	40%	30%	10%	-17%	
For Zone 27								%MMD/MAD						(l/s/km²)	(m³/s)
STEYX	26.68	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.24
								Q (m³/s)						%	%
STEYX x 2	26.68	0.19	0.20	0.16	0.15	0.21	0.20	0.11	0.07	0.10	0.15	0.22	0.20	70%	70%
FSL 95% SigDiff?															
MM_P50								Q (m³/s)							
Hydat P50	27.2	0.86	0.83	0.71	0.52	0.28	0.21	0.19	0.16	0.17	0.18	0.57	0.82		
FSL (2023) P50	26.68	0.90	0.79	0.66	0.45	0.19	0.12	0.08	0.08	0.08	0.17	0.75	0.93		
%Diff		4%	-6%	-7%	-14%	-34%	-43%	-56%	-54%	-52%	-9%	33%	14%		
								%MAD							
STEYX	26.68	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
								Q (m³/s)							
STEYX x 2	26.68	0.215	0.206	0.209	0.182	0.172	0.215	0.097	0.072	0.080	0.112	0.214	0.215		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
MM_P20								Q (m³/s)							
Hydat P20	27.2	0.48	0.52	0.48	0.36	0.21	0.18	0.16	0.15	0.14	0.15	0.24	0.47		
FSL (2023) P20	26.68	0.43	0.42	0.38	0.27	0.10	0.08	0.06	0.06	0.06	0.09	0.31	0.47		
%Diff		-9%	-20%	-20%	-25%	-50%	-59%	-61%	-62%	-56%	-40%	30%	0%		
For Zone 27								%MAD						Notes:	
STEYX	26.68	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
								Q (m³/s)							
STEYX x 2	26.68	0.224	0.191	0.147	0.137	0.136	0.135	0.082	0.060	0.053	0.049	0.120	0.199		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		
								m3						Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	2212	2212	2212	2212	28362	135174	80662	67587	72151	46001	-41576	-41576		
								Q (m³/s)							
Net Allocated	27.2	**-0.001**	**-0.001**	**-0.001**	**-0.001**	**-0.011**	**-0.052**	**-0.030**	**-0.025**	**-0.028**	**-0.017**	**0.016**	**0.016**		
P50-P20	27.2	0.46	0.37	0.28	0.18	0.08	0.04	0.02	0.02	0.02	0.08	0.44	0.46		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	0.02	-0.03	-0.07	-0.14	-0.23	-0.31	-0.16	-0.11	-0.11	-0.08	0.11	0.05		
OverAllocated? (95%)		FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		





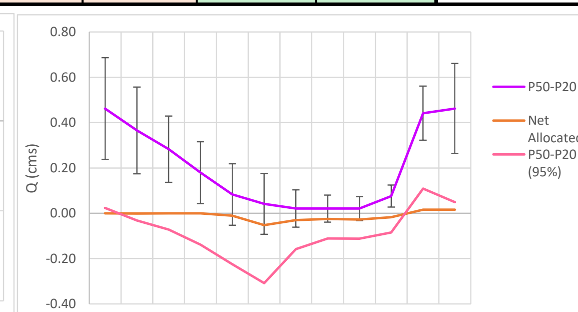


Figure 38: Validation using Anderson Creek (08MH104) and Measured MAD

MacKay (08GA061)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q		Q (m^3/s)												(l/s/km^2)	(m^3/s)
Hydat MMQ	3.63	0.43	0.33	0.32	0.23	0.16	0.10	0.06	0.04	0.07	0.21	0.48	0.41	64.9	0.24
FSL (2023) MMQ	2.53	0.38	0.30	0.33	0.24	0.18	0.09	0.05	0.04	0.08	0.20	0.43	0.42	91.2	**0.23**
Nash Sutcliffe Eff.= 97%	%Diff	-13%	-10%	4%	4%	17%	-11%	-5%	-14%	15%	-6%	-10%	2%	40%	
For Zone 27		%MD												(l/s/km^2)	(m^3/s)
STEYX	2.53	13.3%	13.4%	11.8%	10.8%	15.0%	14.6%	8.2%	5.2%	7.2%	10.3%	16.0%	15.2%	9.08	0.02
		Q (m^3/s)												%	%
STEYX x 2	2.53	0.06	0.06	0.06	0.05	0.07	0.07	0.04	0.02	0.03	0.05	0.08	0.07	28%	20%
FSL 95% SigDiff?															
MM_P50		Q (m^3/s)													
Hydat P50	3.63	0.258	0.222	0.196	0.170	0.120	0.065	0.032	0.021	0.028	0.087	0.304	0.265		
FSL (2023) P50	2.53	0.219	0.226	0.180	0.185	0.132	0.058	0.023	0.014	0.037	0.111	0.270	0.263		
%Diff		-15%	2%	-8%	8%	10%	-12%	-27%	-35%	31%	28%	-11%	-1%		
		%MAD													
STEYX	2.53	15.4%	14.8%	14.7%	12.8%	12.4%	15.1%	7.0%	5.2%	5.8%	8.1%	15.4%	16.2%		
		Q (m^3/s)													
STEYX x 2	2.53	0.073	0.070	0.069	0.060	0.058	0.071	0.033	0.025	0.027	0.038	0.073	0.076		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
MM_P20		Q (m^3/s)													
Hydat P20	3.63	0.112	0.106	0.110	0.105	0.062	0.034	0.019	0.015	0.014	0.026	0.116	0.117		
FSL (2023) P20	2.53	0.097	0.115	0.104	0.113	0.065	0.021	0.014	0.009	0.012	0.035	0.095	0.113		
%Diff		-14%	9%	-5%	8%	3%	-39%	-28%	-39%	-18%	32%	-19%	-3%		
For Zone 27		%MAD												Notes:	
STEYX	2.53	16.2%	12.2%	10.6%	9.5%	9.6%	9.4%	6.0%	4.3%	3.8%	3.6%	8.2%	14.3%		
		Q (m^3/s)													
STEYX x 2	2.53	0.076	0.058	0.050	0.045	0.045	0.045	0.028	0.020	0.018	0.017	0.038	0.067		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
		m3												Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	2.53	277	277	277	277	277	553	277	277	277	277	277	277		
		Q (m^3/s)													
Net Allocated	3.63	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	2.53	0.12	0.11	0.08	0.07	0.07	0.04	0.01	0.00	0.03	0.08	0.18	0.15		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	2.53	-0.03	-0.02	-0.04	-0.03	-0.04	-0.08	-0.05	-0.04	-0.02	0.02	0.06	0.01		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		

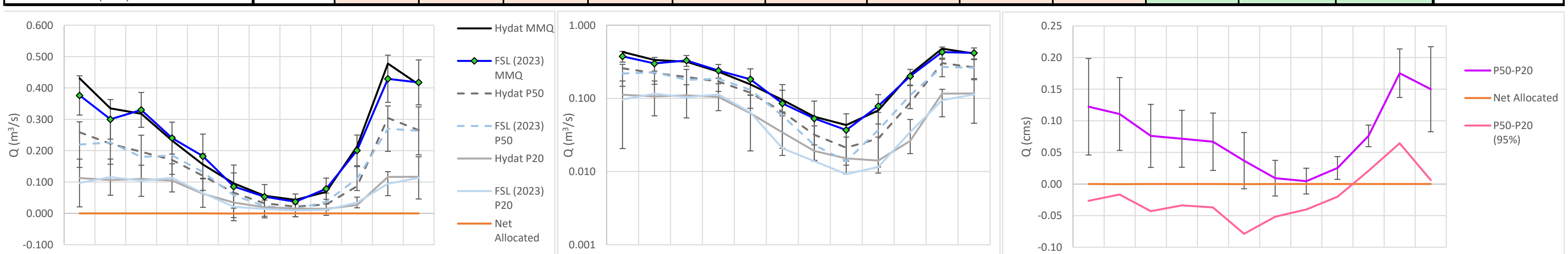


Figure 39: Validation using MacKay Creek (08GA061)

MacKay Creek series are very close with not significantly different flows.

Stawamus (08GA076)	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m³/s)							(l/s/km²)	(m³/s)
Hydat MMQ	52.8	4.33	3.17	3.71	4.48	6.18	5.52	2.95	1.27	1.42	4.14	5.75	4.43	74.4	**3.93**
FSL (2023) MMQ	51.8	5.37	4.57	4.22	6.06	8.20	7.01	3.63	1.79	2.29	5.37	6.26	5.77	95.9	**4.97**
Nash Sutcliffe Eff.= 36%	%Diff	24%	44%	14%	35%	33%	27%	23%	41%	62%	30%	9%	30%	29%	
For Zone 27							%MMD/MAD							(l/s/km²)	(m³/s)
STEYX	51.8	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.47
							Q (m³/s)							%	%
STEYX x 2	51.8	1.05	1.15	0.89	0.85	1.18	1.15	0.65	0.41	0.54	0.84	1.26	1.16	24%	19%
FSL 95% SigDiff?		FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
MM_P50							Q (m³/s)								
Hydat P50	52.8	2.55	2.14	2.40	3.56	5.59	4.58	1.93	0.55	0.67	1.86	3.07	2.25		
FSL (2023) P50	52.8	3.28	2.34	3.18	5.22	7.31	6.16	2.44	1.14	1.09	2.49	3.53	2.93		
%Diff		29%	9%	33%	46%	31%	35%	26%	107%	64%	34%	15%	30%		
							%MAD								
STEYX	52.8	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m³/s)								
STEYX x 2	52.8	1.214	1.165	1.181	1.027	0.973	1.216	0.547	0.410	0.452	0.635	1.209	1.214		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
MM_P20							Q (m³/s)								
Hydat P20	27.2	1.29	1.28	1.41	2.23	3.60	2.96	1.11	0.22	0.40	0.54	1.47	1.28		
FSL (2023) P20	27.2	1.59	1.49	2.24	3.33	4.82	3.73	1.29	0.65	0.65	0.80	2.14	1.64		
%Diff		23%	17%	59%	49%	34%	26%	16%	193%	60%	47%	45%	28%		
For Zone 27							%MAD							Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m³/s)								
STEYX x 2	27.2	1.270	1.084	0.830	0.773	0.769	0.761	0.466	0.339	0.300	0.275	0.676	1.123		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	276554	276554	276554	276554	345692	829661	553108	553108	345692	276554	276554	276554		
							Q (m³/s)								
Net Allocated	52.8	**-0.103**	**-0.114**	**-0.103**	**-0.107**	**-0.129**	**-0.320**	**-0.207**	**-0.207**	**-0.133**	**-0.103**	**-0.107**	**-0.103**		
P50-P20	27.2	1.69	0.84	0.94	1.89	2.49	2.44	1.14	0.50	0.45	1.69	1.39	1.29		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-0.79	-1.40	-1.07	0.09	0.74	0.46	0.13	-0.25	-0.30	0.78	-0.49	-1.05		
OverAllocated? (95%)		TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE		

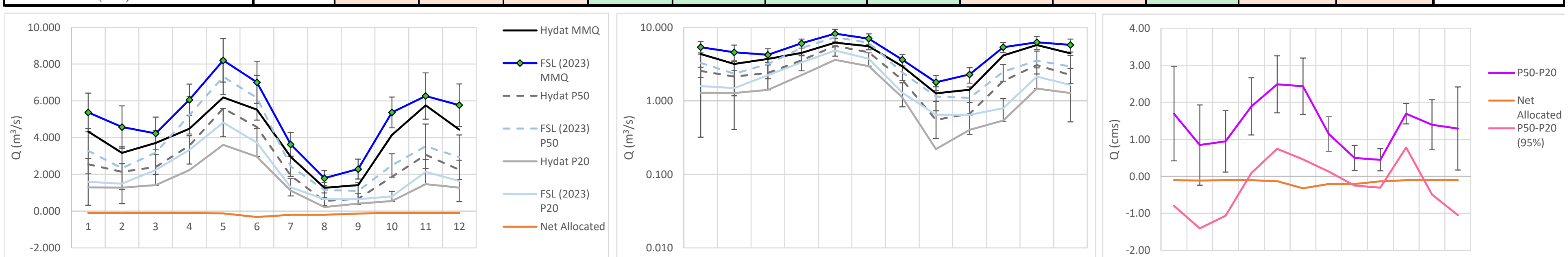


Figure 40: Validation using Stawamus Creek (08GA076) and Simulated MAD

Stawamus (08GA076)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							*Q (m^3/s)*							($l/s/km^2$)	(m^3/s)
Hydat MMQ	52.8	4.33	3.17	3.71	4.48	6.18	5.52	2.95	1.27	1.42	4.14	5.75	4.43	74.4	**3.93**
FSL (2023) MMQ	51.8	4.24	3.62	3.34	4.79	6.48	5.54	2.87	1.41	1.81	4.24	4.95	4.56	75.9	**3.93**
Nash Sutcliffe Eff.= 95%	%Diff	-2%	14%	-10%	7%	5%	0%	-3%	12%	28%	3%	-14%	3%	2%	
For Zone 27							%MMD/MAD							($l/s/km^2$)	(m^3/s)
STEYX	51.8	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.47
							Q (m^3/s)							%	%
STEYX x 2	51.8	1.05	1.15	0.89	0.85	1.18	1.15	0.65	0.41	0.54	0.84	1.26	1.16	24%	24%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50							*Q (m^3/s)*								
Hydat P50	52.8	2.55	2.14	2.40	3.56	5.59	4.58	1.93	0.55	0.67	1.86	3.07	2.25		
FSL (2023) P50	52.8	2.59	1.85	2.52	4.13	5.78	4.87	1.93	0.90	0.86	1.97	2.79	2.32		
%Diff		2%	-14%	5%	16%	3%	6%	0%	64%	30%	6%	-9%	3%		
							%MAD								
STEYX	52.8	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m^3/s)								
STEYX x 2	52.8	1.214	1.165	1.181	1.027	0.973	1.216	0.547	0.410	0.452	0.635	1.209	1.214		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
MM_P20							*Q (m^3/s)*								
Hydat P20	27.2	1.29	1.28	1.41	2.23	3.60	2.96	1.11	0.22	0.40	0.54	1.47	1.28		
FSL (2023) P20	27.2	1.26	1.18	1.77	2.63	3.81	2.95	1.02	0.51	0.51	0.63	1.69	1.30		
%Diff		-3%	-8%	26%	18%	6%	0%	-8%	131%	27%	16%	15%	1%		
For Zone 27							%MAD							Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m^3/s)								
STEYX x 2	27.2	1.270	1.084	0.830	0.773	0.769	0.761	0.466	0.339	0.300	0.275	0.676	1.123		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	276554	276554	276554	276554	345692	829661	553108	553108	345692	276554	276554	276554		
							Q (m^3/s)								
Net Allocated	52.8	**-0.103**	**-0.114**	**-0.103**	**-0.107**	**-0.129**	**-0.320**	**-0.207**	**-0.207**	**-0.133**	**-0.103**	**-0.107**	**-0.103**		
P50-P20	27.2	1.34	0.67	0.75	1.49	1.97	1.93	0.90	0.39	0.35	1.34	1.10	1.02		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-1.15	-1.58	-1.26	-0.31	0.22	-0.05	-0.11	-0.36	-0.40	0.43	-0.79	-1.32		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE		

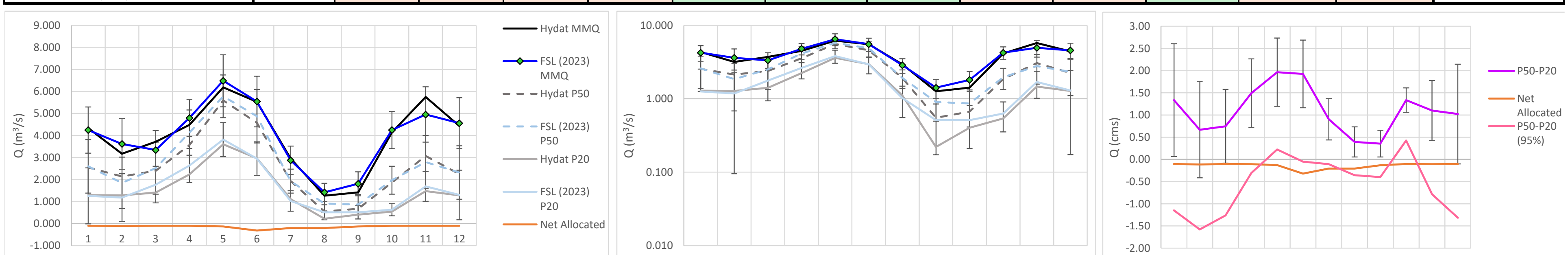


Figure 41: Validation using Stawamus Creek (08GA076) and Measured MAD

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Validation\[Wally_Validation_V0.4.xlsx]HZ27-MahoodNewton (2) 2023-03-31 10:27

Mahood Newton (08MH018)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m^3/s)							($l/s/km^2$)	(m^3/s)
Hydat MMQ	18.4	1.14	1.00	0.63	0.39	0.19	0.11	0.06	0.04	0.10	0.39	1.04	1.29	29.7	0.55
FSL (2023) MMQ	17.7	1.40	1.12	0.85	0.56	0.24	0.09	0.07	0.06	0.12	0.40	1.10	1.41	**35.0**	**0.62**
Nash Sutcliffe Eff.= 93%	%Diff	23%	13%	34%	44%	25%	-12%	34%	43%	14%	1%	5%	9%	18%	
For Zone 27							%MMD/MAD							($l/s/km^2$)	(m^3/s)
STEYX	17.7	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.16
							Q (m^3/s)							%	%
STEYX x 2	17.7	0.15	0.16	0.12	0.12	0.16	0.16	0.09	0.06	0.08	0.12	0.17	0.16	61%	52%
FSL 95% SigDiff?		TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50							Q (m^3/s)								
Hydat P50	18.4	0.54	0.57	0.39	0.244	0.103	0.041	0.023	0.008	0.031	0.12	0.58	0.67		
FSL (2023) P50	17.7	0.78	0.69	0.58	0.378	0.130	0.019	0.050	0.056	0.068	0.15	0.67	0.82		
%Diff		45%	22%	48%	55%	26%	-55%	116%	598%	120%	22%	16%	21%		
							%MAD								
STEYX	17.7	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m^3/s)								
STEYX x 2	17.7	0.169	0.162	0.164	0.143	0.135	0.169	0.076	0.057	0.063	0.088	0.168	0.169		
FSL 95% SigDiff?		TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
MM_P20							Q (m^3/s)								
Hydat P20	18.4	0.22	0.23	0.21	0.119	0.048	0.017	0.009	0.000	0.008	0.038	0.21	0.26		
FSL (2023) P20	17.7	0.38	0.36	0.31	0.223	0.087	0.025	0.056	0.050	0.056	0.068	0.26	0.41		
%Diff		73%	53%	47%	88%	81%	46%	534%	#DIV/0!	597%	79%	24%	57%		
For Zone 27							%MAD							Notes:	
STEYX	17.7	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m^3/s)								
STEYX x 2	17.7	0.176	0.151	0.115	0.107	0.107	0.106	0.065	0.047	0.042	0.038	0.094	0.156		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	17.7	138	138	138	138	138	277	138	138	138	138	138	138		
							Q (m^3/s)								
Net Allocated	17.7	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	17.7	0.40	0.33	0.27	0.16	0.04	-0.01	-0.01	0.01	0.01	0.08	0.41	0.41		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	17.7	0.06	0.02	-0.01	-0.10	-0.20	-0.28	-0.15	-0.10	-0.09	-0.05	0.15	0.08		
OverAllocated? (95%)		FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		

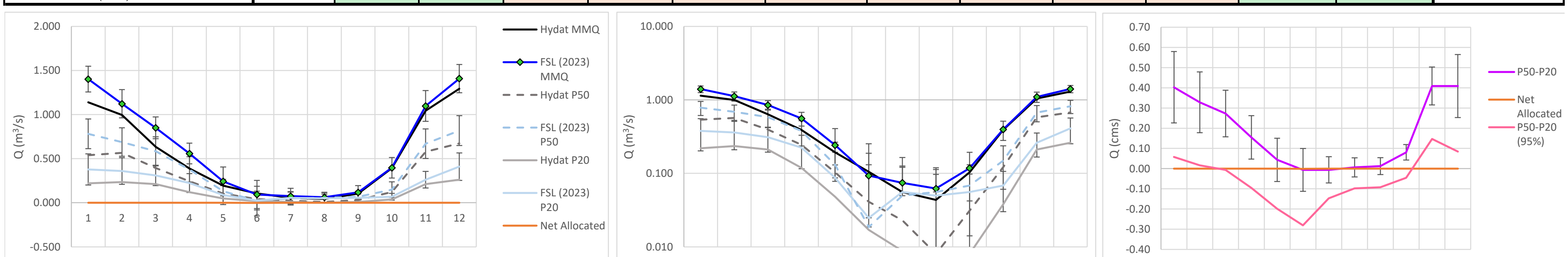


Figure 42: Validation using Mahood Creek near Newton (08MH018) Simulated MAD

C:\gsentlin\FATHOM_SCI\CUSTOMERS\BCMoF\Projects\Wally_Resurrect\Validation\[Wally_Validation_V0.4.xlsx]HZ27-MahoodNewton (2) 2023-03-31 10:29

Mahood Newton (08MH018)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m^3/s)							(l/s/km^2)	(m^3/s)
Hydat MMQ	18.4	1.14	1.00	0.63	0.39	0.19	0.11	0.06	0.04	0.10	0.39	1.04	1.29	29.7	0.55
FSL (2023) MMQ	17.7	1.24	1.00	0.75	0.50	0.21	0.08	0.07	0.06	0.10	0.35	0.97	1.25	**35.0**	**0.55**
Nash Sutcliffe Eff.= 98%	%Diff	9%	0%	19%	27%	11%	-22%	19%	27%	1%	-10%	-7%	-3%	18%	
For Zone 27							%MMD/MAD							(l/s/km^2)	(m^3/s)
STEYX	17.7	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.16
							Q (m^3/s)							%	%
STEYX x 2	17.7	0.15	0.16	0.12	0.12	0.16	0.16	0.09	0.06	0.08	0.12	0.17	0.16	61%	58%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50							Q (m^3/s)								
Hydat P50	18.4	0.54	0.57	0.39	0.244	0.103	0.041	0.023	0.008	0.031	0.12	0.58	0.67		
FSL (2023) P50	17.7	0.69	0.61	0.52	0.336	0.116	0.017	0.044	0.050	0.061	0.13	0.59	0.73		
%Diff		29%	8%	31%	37%	12%	-60%	91%	519%	95%	8%	3%	8%		
							%MAD								
STEYX	17.7	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m^3/s)								
STEYX x 2	17.7	0.169	0.162	0.164	0.143	0.135	0.169	0.076	0.057	0.063	0.088	0.168	0.169		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
MM_P20							Q (m^3/s)								
Hydat P20	18.4	0.22	0.23	0.21	0.119	0.048	0.017	0.009	0.000	0.008	0.038	0.21	0.26		
FSL (2023) P20	17.7	0.34	0.32	0.28	0.198	0.077	0.022	0.050	0.044	0.050	0.061	0.23	0.36		
%Diff		53%	36%	31%	66%	60%	29%	463%	#DIV/0!	519%	59%	10%	39%		
For Zone 27							%MAD							Notes:	
STEYX	17.7	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m^3/s)								
STEYX x 2	17.7	0.176	0.151	0.115	0.107	0.107	0.106	0.065	0.047	0.042	0.038	0.094	0.156		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	17.7	138	138	138	138	138	277	138	138	138	138	138	138		
							Q (m^3/s)								
Net Allocated	17.7	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	17.7	0.36	0.29	0.24	0.14	0.04	-0.01	-0.01	0.01	0.01	0.07	0.36	0.36		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	17.7	0.01	-0.02	-0.04	-0.11	-0.20	-0.28	-0.15	-0.10	-0.09	-0.05	0.10	0.04		
OverAllocated? (95%)		FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		

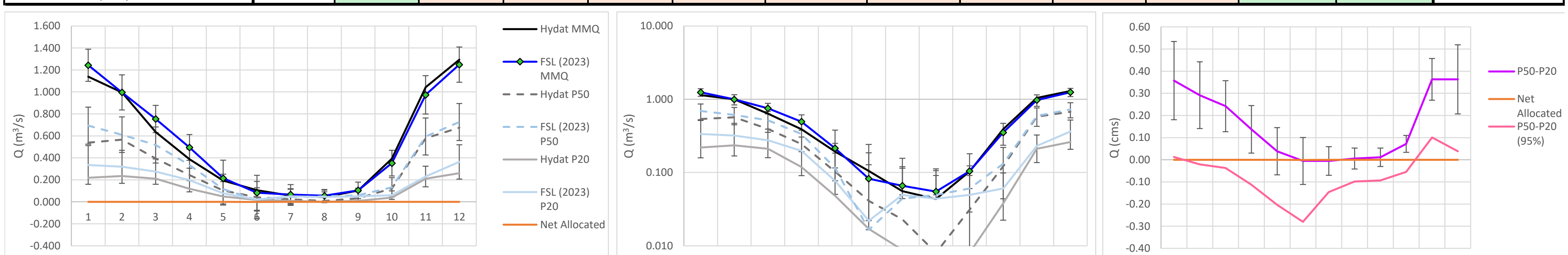


Figure 43: Validation using Mahood Creek near Newton (08MH018) Measured MAD

Seymour (08GA028)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							*Q (m^3/s)*							($l/s/km^2$)	(m^3/s)
Hydat MMQ	148.0	13.02	9.30	12.51	16.09	21.95	18.12	8.73	2.77	4.65	14.63	17.21	17.12	89.8	**13.29**
FSL (2023) MMQ	123.0	16.73	12.62	13.05	15.74	20.56	17.58	9.22	4.54	6.81	16.02	19.99	17.02	115.3	**14.18**
Nash Sutcliffe Eff.= 87%	%Diff	29%	36%	4%	-2%	-6%	-3%	6%	64%	46%	10%	16%	-1%	28%	
For Zone 27							%MMD/MAD							($l/s/km^2$)	(m^3/s)
STEYX	123.0	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	1.12
							Q (m^3/s)							%	%
STEYX x 2	123.0	3.55	3.90	3.01	2.86	3.99	3.88	2.19	1.39	1.84	2.84	4.26	3.91	20%	16%
FSL 95% SigDiff?		TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE
MM_P50							*Q (m^3/s)*								
Hydat P50	148.0	6.29	3.19	9.15	13.60	19.39	16.09	4.13	0.93	1.35	6.29	11.30	9.37		
FSL (2023) P50	148.0	8.22	6.66	8.51	12.48	18.01	14.75	5.81	2.69	2.69	7.52	11.06	8.22		
%Diff		31%	109%	-7%	-8%	-7%	-8%	41%	189%	99%	20%	-2%	-12%		
							%MAD								
STEYX	148.0	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m^3/s)								
STEYX x 2	148.0	4.106	3.940	3.994	3.475	3.290	4.113	1.849	1.387	1.529	2.146	4.089	4.106		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
MM_P20							*Q (m^3/s)*								
Hydat P20	27.2	1.61	0.95	4.01	8.29	12.42	6.09	1.64	0.11	0.65	1.50	2.58	3.96		
FSL (2023) P20	27.2	3.83	3.69	4.40	7.23	11.34	8.65	3.12	1.42	1.56	2.13	4.68	3.97		
%Diff		138%	290%	10%	-13%	-9%	42%	90%	1155%	140%	42%	81%	0%		
For Zone 27							%MAD							Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m^3/s)								
STEYX x 2	27.2	4.296	3.664	2.806	2.615	2.602	2.575	1.576	1.145	1.015	0.929	2.288	3.799		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	0	0	0	0	0	0	0	0	0	0	0	0		
							Q (m^3/s)								
Net Allocated	148.0	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	27.2	4.40	2.98	4.11	5.25	6.66	6.10	2.69	1.28	1.13	5.39	6.38	4.25		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-4.01	-4.63	-2.69	-0.84	0.77	-0.59	-0.73	-1.26	-1.41	2.31	0.00	-3.65		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE		

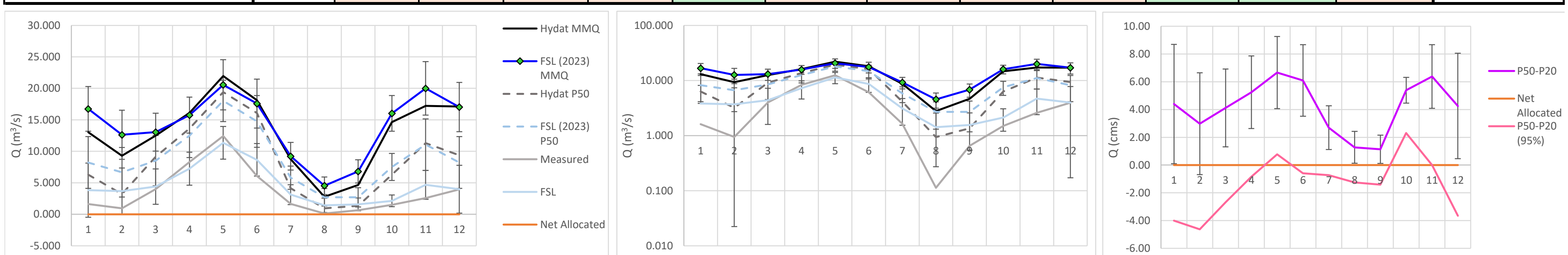


Figure 44: Validation using Seymour River at Seymour Falls Dam (08GA028) Simulated MAD

Seymour (08GA028)	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m³/s)							(l/s/km²)	(m³/s)
Hydat MMQ	148.0	13.02	9.30	12.51	16.09	21.95	18.12	8.73	2.77	4.65	14.63	17.21	17.12	89.8	**13.29**
FSL (2023) MMQ	123.0	15.68	11.83	12.23	14.75	19.27	16.48	8.64	4.25	6.38	15.02	18.74	15.95	108.0	**13.29**
Nash Sutcliffe Eff.= 90%	%Diff	20%	27%	-2%	-8%	-12%	-9%	-1%	53%	37%	3%	9%	-7%	20%	
For Zone 27							%MMD/MAD							(l/s/km²)	(m³/s)
STEYX	123.0	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	1.12
							Q (m³/s)							%	%
STEYX x 2	123.0	3.55	3.90	3.01	2.86	3.99	3.88	2.19	1.39	1.84	2.84	4.26	3.91	20%	17%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50							Q (m³/s)								
Hydat P50	148.0	6.29	3.19	9.15	13.60	19.39	16.09	4.13	0.93	1.35	6.29	11.30	9.37		
FSL (2023) P50	148.0	7.71	6.25	7.97	11.70	16.88	13.82	5.45	2.53	2.53	7.04	10.37	7.71		
%Diff		23%	96%	-13%	-14%	-13%	-14%	32%	170%	86%	12%	-8%	-18%		
							%MAD								
STEYX	148.0	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m³/s)								
STEYX x 2	148.0	4.106	3.940	3.994	3.475	3.290	4.113	1.849	1.387	1.529	2.146	4.089	4.106		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
MM_P20							Q (m³/s)								
Hydat P20	27.2	1.61	0.95	4.01	8.29	12.42	6.09	1.64	0.11	0.65	1.50	2.58	3.96		
FSL (2023) P20	27.2	3.59	3.46	4.12	6.78	10.63	8.11	2.92	1.33	1.46	1.99	4.39	3.72		
%Diff		123%	266%	3%	-18%	-14%	33%	78%	1077%	125%	33%	70%	-6%		
For Zone 27							%MAD							Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m³/s)								
STEYX x 2	27.2	4.296	3.664	2.806	2.615	2.602	2.575	1.576	1.145	1.015	0.929	2.288	3.799		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	0	0	0	0	0	0	0	0	0	0	0	0		
							Q (m³/s)								
Net Allocated	148.0	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	27.2	4.12	2.79	3.85	4.92	6.25	5.71	2.53	1.20	1.06	5.05	5.98	3.99		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-4.28	-4.81	-2.95	-1.17	0.35	-0.97	-0.90	-1.34	-1.48	1.97	-0.40	-3.92		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE		

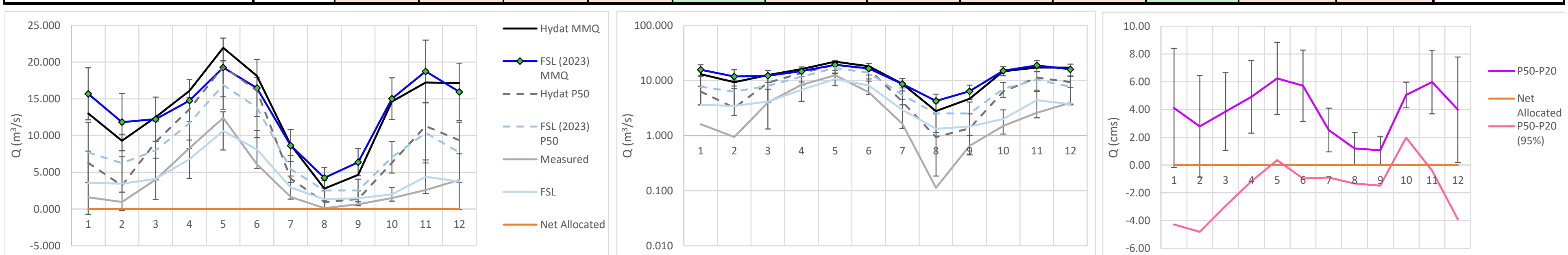


Figure 45: Validation using Seymour River at Seymour Falls Dam (08GA028) Measured MAD

Squamish (08GA022)	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							*Q (m^3/s)*							($l/s/km^2$)	(m^3/s)
Hydat MMQ	2,350.0	95.14	89.11	91.02	140.70	315.52	463.02	486.74	394.56	264.89	216.81	172.48	111.25	100.4	**237**
FSL (2023) MMQ	2,378.0	98.12	86.97	98.12	158.33	345.65	419.24	419.24	338.96	240.84	220.77	185.09	98.12	93.8	**223**
Nash Sutcliffe Eff.= 95%	%Diff	3%	-2%	8%	13%	10%	-9%	-14%	-14%	-9%	2%	7%	-12%	-7%	
For Zone 27							%MMD/MAD							($l/s/km^2$)	(m^3/s)
STEYX	2,378.0	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	21.59
							Q (m^3/s)							%	%
STEYX x 2	2,378.0	63.32	69.50	53.59	50.99	71.22	69.19	39.07	24.85	32.82	50.66	75.91	69.76	18%	19%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE
MM_P50							*Q (m^3/s)*								
Hydat P50	2,350.0	67.50	66.00	70.50	120.00	294.00	445.00	470.00	379.00	241.00	158.00	120.00	81.80		
FSL (2023) P50	2,350.0	60.60	46.23	66.12	133.80	315.15	432.76	417.71	321.49	212.19	145.44	99.75	69.53		
%Diff		-10%	-30%	-6%	12%	7%	-3%	-11%	-15%	-12%	-8%	-17%	-15%		
							35.3								
STEYX	2,350.0	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m^3/s)								
STEYX x 2	2,350.0	73.214	70.269	71.222	61.963	58.675	73.346	32.970	24.727	27.267	38.270	72.923	73.227		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
MM_P20							*Q (m^3/s)*								
Hydat P20	27.2	43.60	43.30	47.20	81.74	191.00	335.80	379.00	297.00	168.00	95.74	74.56	51.80		
FSL (2023) P20	27.2	35.30	26.38	40.57	84.68	193.65	274.90	292.18	188.02	116.72	95.77	61.01	42.16		
%Diff		-19%	-39%	-14%	4%	1%	-18%	-23%	-37%	-31%	0%	-18%	-19%		
For Zone 27							%MAD							Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m^3/s)								
STEYX x 2	27.2	76.605	65.348	50.032	46.627	46.393	45.921	28.102	20.424	18.097	16.573	40.795	67.741		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	10336	10336	10336	10336	12310	30540	16257	15270	12310	10336	10336	10336		
							Q (m^3/s)								
Net Allocated	2,350.0	**-0.004**	**-0.004**	**-0.004**	**-0.004**	**-0.005**	**-0.012**	**-0.006**	**-0.006**	**-0.005**	**-0.004**	**-0.004**	**-0.004**		
P50-P20	27.2	25.30	19.85	25.55	49.12	121.50	157.86	125.53	133.47	95.47	49.67	38.74	27.37		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-124.52	-115.77	-95.70	-59.47	16.43	38.59	64.46	88.32	50.11	-5.17	-74.98	-113.60		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE		

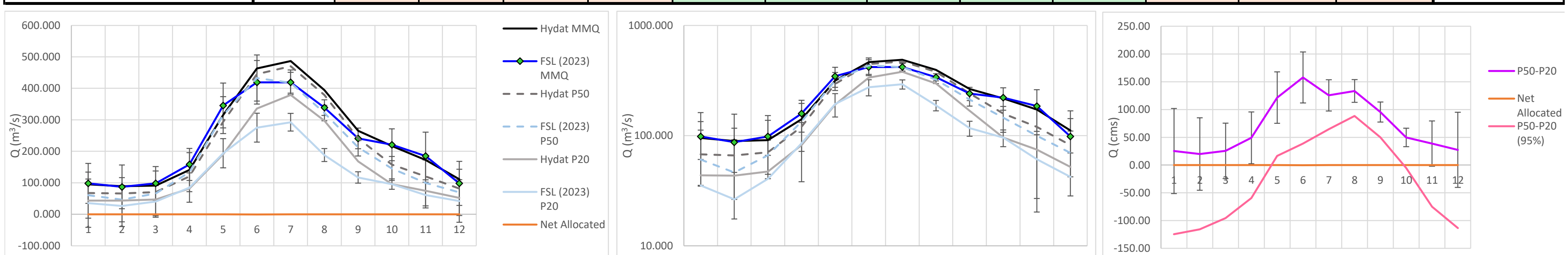


Figure 46: Validation using Squamish River Near Brackendale (08GA022) Synthetic MAD

Squamish (08GA022)	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q								*Q (m³/s)*						(l/s/km²)	(m³/s)
Hydat MMQ	2,350.0	95.14	89.11	91.02	140.70	315.52	463.02	486.74	394.56	264.89	216.81	172.48	111.25	100.4	**237**
FSL (2023) MMQ	2,378.0	104.28	92.43	104.28	168.27	367.35	445.56	445.56	360.24	255.96	234.63	196.71	104.28	99.7	**237**
Nash Sutcliffe Eff.= 97%	%Diff	10%	4%	15%	20%	16%	-4%	-8%	-9%	-3%	8%	14%	-6%	-1%	
For Zone 27								%MMD/MAD						(l/s/km²)	(m³/s)
STEYX	2,378.0	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	21.59
								Q (m³/s)						%	%
STEYX x 2	2,378.0	63.32	69.50	53.59	50.99	71.22	69.19	39.07	24.85	32.82	50.66	75.91	69.76	18%	18%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50								*Q (m³/s)*							
Hydat P50	2,350.0	67.50	66.00	70.50	120.00	294.00	445.00	470.00	379.00	241.00	158.00	120.00	81.80		
FSL (2023) P50	2,350.0	60.60	46.23	66.12	133.80	315.15	432.76	417.71	321.49	212.19	145.44	99.75	69.53		
%Diff		-10%	-30%	-6%	12%	7%	-3%	-11%	-15%	-12%	-8%	-17%	-15%		
								35.3							
STEYX	2,350.0	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
								Q (m³/s)							
STEYX x 2	2,350.0	73.214	70.269	71.222	61.963	58.675	73.346	32.970	24.727	27.267	38.270	72.923	73.227		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
MM_P20								*Q (m³/s)*							
Hydat P20	27.2	43.60	43.30	47.20	81.74	191.00	335.80	379.00	297.00	168.00	95.74	74.56	51.80		
FSL (2023) P20	27.2	35.30	26.38	40.57	84.68	193.65	274.90	292.18	188.02	116.72	95.77	61.01	42.16		
%Diff		-19%	-39%	-14%	4%	1%	-18%	-23%	-37%	-31%	0%	-18%	-19%		
For Zone 27								%MAD						Notes:	
STEYX	27.2	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
								Q (m³/s)							
STEYX x 2	27.2	76.605	65.348	50.032	46.627	46.393	45.921	28.102	20.424	18.097	16.573	40.795	67.741		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
								m3						Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	27.2	10336	10336	10336	10336	12310	30540	16257	15270	12310	10336	10336	10336		
								Q (m³/s)							
Net Allocated	2,350.0	**-0.004**	**-0.004**	**-0.004**	**-0.004**	**-0.005**	**-0.012**	**-0.006**	**-0.006**	**-0.005**	**-0.004**	**-0.004**	**-0.004**		
P50-P20	27.2	25.30	19.85	25.55	49.12	121.50	157.86	125.53	133.47	95.47	49.67	38.74	27.37		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	27.2	-124.52	-115.77	-95.70	-59.47	16.43	38.59	64.46	88.32	50.11	-5.17	-74.98	-113.60		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE		

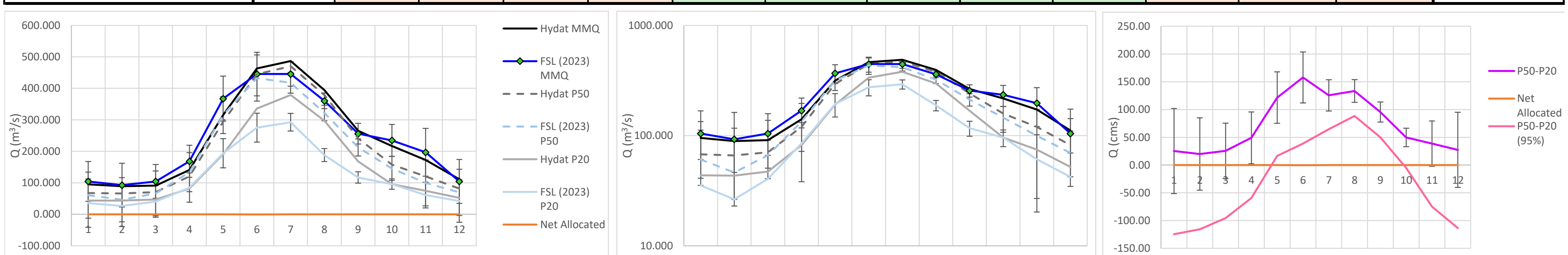


Figure 47: Validation using Squamish River Near Brackendale (08GA022) Measured MAD

Tyson Creek Intake	DA (km^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q		*Q (m^3/s)*												(l/s/km^2)	(m^3/s)
Sentlinger (2006)	10.9	0.29	0.30	0.33	0.44	2.00	3.51	3.25	1.62	1.21	2.22	1.07	0.51	122.0	**1.33**
FSL (2023) MMQ	11.9	0.48	0.44	0.40	0.72	1.86	2.24	2.96	1.94	1.35	0.98	1.35	0.72	112.6	**1.34**
Nash Sutcliffe Eff.= 75%	%Diff	67%	47%	21%	66%	-7%	-36%	-9%	20%	12%	-56%	26%	43%	-8%	
For Zone 27		%MMD/MAD												(l/s/km^2)	(m^3/s)
STEYX	11.9	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.11
		Q (m^3/s)												%	%
STEYX x 2	11.9	0.36	0.39	0.30	0.29	0.40	0.39	0.22	0.14	0.18	0.28	0.43	0.39	15%	16%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
MM_P50		*Q (m^3/s)*													
Sentlinger (2006) P50	10.9	0.16	0.22	0.24	0.29	1.47	3.18	3.04	1.49	0.84	1.16	0.48	0.31		
FSL (2023) P50	11.9	0.37	0.35	0.36	0.59	1.70	1.61	2.54	1.91	1.14	0.97	0.62	0.46		
%Diff		137%	61%	51%	104%	16%	-49%	-17%	28%	35%	-16%	29%	50%		
		35.3													
STEYX	11.9	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
		Q (m^3/s)													
STEYX x 2	11.9	0.411	0.394	0.400	0.348	0.329	0.412	0.185	0.139	0.153	0.215	0.409	0.411		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
MM_P20		*Q (m^3/s)*													
Sentlinger (2006) P20	10.9	0.07	0.14	0.19	0.08	0.72	2.38	2.37	1.07	0.67	0.55	0.25	0.13		
FSL (2023) P20	11.9	0.27	0.36	0.25	0.35	0.74	2.16	2.19	1.66	0.90	0.51	0.38	0.41		
%Diff		301%	164%	31%	360%	3%	-9%	-8%	54%	35%	-7%	49%	218%		
For Zone 27		%MAD												Notes:	
STEYX	11.9	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
		Q (m^3/s)													
STEYX x 2	11.9	0.430	0.367	0.281	0.262	0.260	0.258	0.158	0.115	0.102	0.093	0.229	0.380		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE		
		m3												Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	10.9	0	0	0	0	0	0	0	0	0	0	0	0		
		Q (m^3/s)													
Net Allocated	10.9	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	10.9	0.10	-0.01	0.11	0.24	0.96	-0.55	0.35	0.25	0.24	0.46	0.24	0.05		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	10.9	-0.74	-0.77	-0.57	-0.37	0.37	-1.22	0.01	0.00	-0.01	0.15	-0.40	-0.74		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE		

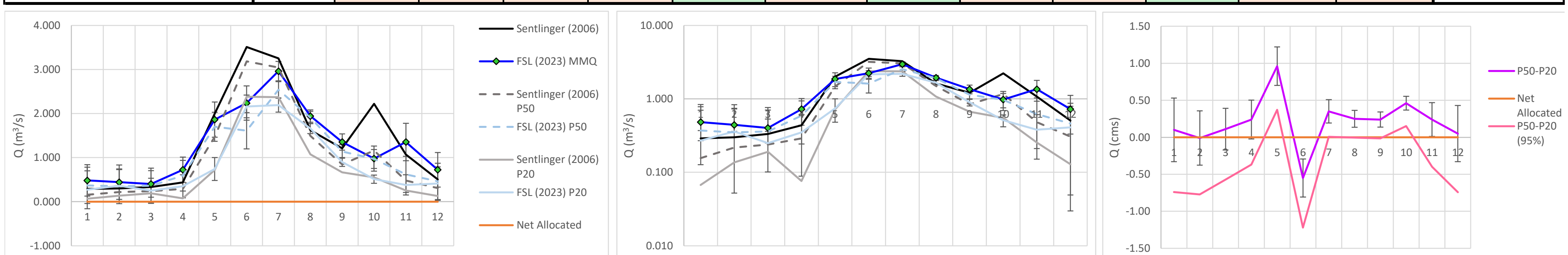


Figure 48: Validation using Tyson Creek Intake (Sentlinger 2006) Synthetic MAD

Skookum Creek Intake	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q								*Q (m³/s)*						(l/s/km²)	(m³/s)
Sentlinger (2010)	67.0	3.16	1.25	1.50	3.19	8.83	13.93	10.36	6.09	3.20	5.26	6.18	2.43	81.6	**5.47**
FSL (2023) MMQ	68.5	2.70	2.70	2.56	4.45	10.59	14.38	14.89	10.00	7.23	8.18	7.37	2.85	106.5	**7.30**
Nash Sutcliffe Eff.= 58%	%Diff	-15%	116%	71%	40%	20%	3%	44%	64%	126%	56%	19%	17%	30%	
For Zone 27								%MMD/MAD						(l/s/km²)	(m³/s)
STEYX	68.5	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.62
								Q (m³/s)						%	%
STEYX x 2	68.5	1.46	1.60	1.24	1.18	1.64	1.60	0.90	0.57	0.76	1.17	1.75	1.61	22%	17%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
MM_P50								*Q (m³/s)*							
Sentlinger (2010) P50	67.0	1.52	0.79	1.08	2.49	7.47	13.27	8.95	5.13	2.72	2.79	2.83	1.39		
FSL (2023) P50	68.5	1.82	1.46	2.15	3.68	10.30	13.57	16.37	9.44	6.32	5.18	2.58	2.28		
%Diff		20%	84%	99%	48%	38%	2%	83%	84%	132%	85%	-9%	64%		
								35.3							
STEYX	68.5	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
								Q (m³/s)							
STEYX x 2	68.5	1.690	1.622	1.644	1.430	1.354	1.693	0.761	0.571	0.629	0.883	1.683	1.690		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		
MM_P20								*Q (m³/s)*							
Sentlinger (2010) P20	67.0	0.45	0.42	0.53	0.92	3.50	9.52	5.77	3.39	2.00	1.14	0.70	0.60		
FSL (2023) P20	68.5	1.20	1.14	1.40	2.27	4.74	10.97	10.44	7.91	4.47	2.87	1.66	0.97		
%Diff		164%	173%	163%	147%	35%	15%	81%	134%	124%	152%	137%	62%		
For Zone 27								%MAD						Notes:	
STEYX	68.5	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
								Q (m³/s)							
STEYX x 2	68.5	1.768	1.508	1.155	1.076	1.071	1.060	0.649	0.471	0.418	0.383	0.942	1.563		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE		
								m3						Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	67.0	0	0	0	0	0	0	0	0	0	0	0	0		
								Q (m³/s)							
Net Allocated	67.0	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		
P50-P20	67.0	0.62	0.32	0.75	1.41	5.56	2.60	5.93	1.53	1.85	2.31	0.92	1.31		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	67.0	-2.84	-2.81	-2.05	-1.10	3.14	-0.15	4.52	0.49	0.80	1.04	-1.70	-1.94		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE		

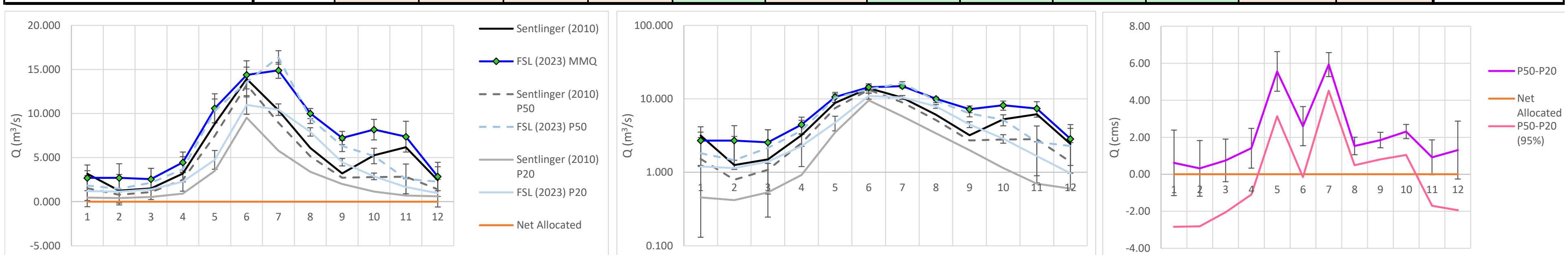


Figure 49: Validation using Skookum Creek Intake (Sentlinger 2006) Synthetic MAD

Skookum Creek Intake	DA (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAR	MAD
MEAN MONTHLY Q							Q (m³/s)							(l/s/km²)	(m³/s)
Sentlinger (2010)	67.0	3.16	1.25	1.50	3.19	8.83	13.93	10.36	6.09	3.20	5.26	6.18	2.43	81.6	**5.47**
FSL (2023) MMQ	68.5	2.02	2.02	1.91	3.34	7.93	10.78	11.16	7.49	5.42	6.13	5.52	2.13	79.8	**5.47**
Nash Sutcliffe Eff.= 87%	%Diff	-36%	62%	28%	5%	-10%	-23%	8%	23%	69%	17%	-11%	-12%	-2%	
For Zone 27							%MMD/MAD							(l/s/km²)	(m³/s)
STEYX	68.5	13.4%	14.7%	11.3%	10.8%	15.0%	14.6%	8.2%	5.2%	6.9%	10.7%	16.0%	14.7%	9.08	0.62
							Q (m³/s)							%	%
STEYX x 2	68.5	1.46	1.60	1.24	1.18	1.64	1.60	0.90	0.57	0.76	1.17	1.75	1.61	22%	23%
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
MM_P50							Q (m³/s)								
Sentlinger (2010) P50	67.0	1.52	0.79	1.08	2.49	7.47	13.27	8.95	5.13	2.72	2.79	2.83	1.39		
FSL (2023) P50	68.5	1.36	1.09	1.61	2.76	7.72	10.17	12.27	7.07	4.74	3.88	1.93	1.71		
%Diff		-10%	38%	49%	11%	3%	-23%	37%	38%	74%	39%	-32%	23%		
							1.2								
STEYX	68.5	15.4%	14.8%	15.0%	13.1%	12.4%	15.5%	7.0%	5.2%	5.8%	8.1%	15.4%	15.4%		
							Q (m³/s)								
STEYX x 2	68.5	1.690	1.622	1.644	1.430	1.354	1.693	0.761	0.571	0.629	0.883	1.683	1.690		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		
MM_P20							Q (m³/s)								
Sentlinger (2010) P20	67.0	0.45	0.42	0.53	0.92	3.50	9.52	5.77	3.39	2.00	1.14	0.70	0.60		
FSL (2023) P20	68.5	0.90	0.85	1.05	1.70	3.55	8.22	7.82	5.93	3.35	2.15	1.24	0.73		
%Diff		98%	104%	97%	85%	2%	-14%	35%	75%	68%	89%	78%	21%		
For Zone 27							%MAD							Notes:	
STEYX	68.5	16.2%	13.8%	10.6%	9.8%	9.8%	9.7%	5.9%	4.3%	3.8%	3.5%	8.6%	14.3%		
							Q (m³/s)								
STEYX x 2	68.5	1.768	1.508	1.155	1.076	1.071	1.060	0.649	0.471	0.418	0.383	0.942	1.563		
FSL 95% SigDiff?		FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE		
							m3							Notes: 95% Confidence limits adds the uncertainty bars of the P50 and P20 estimates as if they are independent, but are not independent	
Net Allocated (m3)	67.0	0	0	0	0	0	0	0	0	0	0	0	0		
							Q (m³/s)								
Net Allocated	67.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
P50-P20	67.0	0.46	0.24	0.56	1.06	4.17	1.95	4.44	1.15	1.39	1.73	0.69	0.98		
OverAllocated?		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE		
P50-P20 (95%)	67.0	-2.99	-2.89	-2.24	-1.45	1.74	-0.80	3.03	0.10	0.34	0.47	-1.94	-2.27		
OverAllocated? (95%)		TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE		

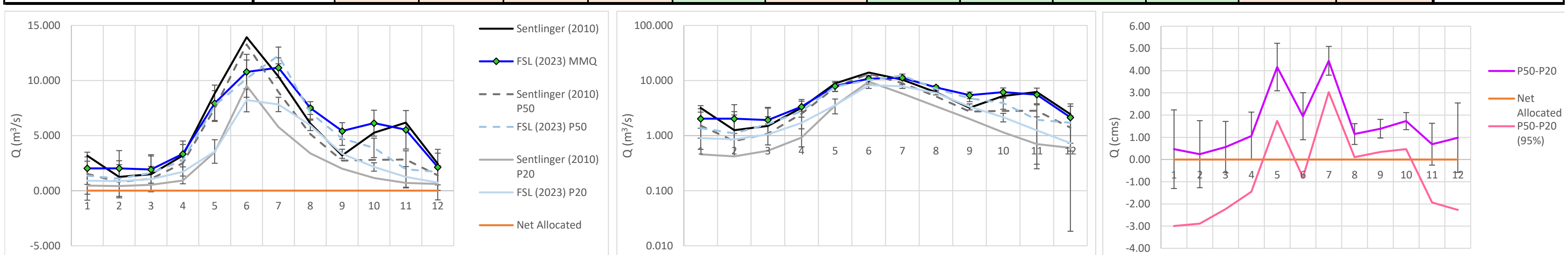


Figure 50: Validation using Skookum Creek Intake (Sentlinger 2006) Measured MAD

6 APPENDIX

Table 5: HZ 25 Monthly Model Results

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HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	%MAD Alloc	N	numVars	R2	ADJ R2	MIN R2	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Better?	By how much?
25	M_MMD/MAD	1	0.254812	2.31E-05	0	8.69E-05	-1.01576	0	-2.9E-05	0	0	23	4	0.76	0.71	0.54	0.30	0.10	0.05	17%	33%	TRUE	17%
25	M_MMD/MAD	2	0.541722	0	0	5.91E-05	-0.66225	0	-0.00019	0	-0.03184	23	4	0.74	0.68	0.59	0.29	0.11	0.06	20%	39%	TRUE	18%
25	M_MMD/MAD	3	0.808614	0	-0.003302466	7.25E-05	-0.73061	0	-0.0003	0	0	23	4	0.80	0.76	0.72	0.33	0.14	0.07	20%	44%	TRUE	24%
25	M_MMD/MAD	4	-3.2729	0	0	3.08E-05	0	0.006547	-0.00081	0	0	23	3	0.86	0.84	0.78	0.81	0.51	0.20	24%	63%	TRUE	39%
25	M_MMD/MAD	5	-5.74322	0	-0.081342625	0.000391	-3.45872	0.011969	0	0	0	23	4	0.91	0.89	0.85	2.41	1.38	0.42	17%	57%	TRUE	40%
25	M_MMD/MAD	6	-4.65126	0	0	0	-3.07923	0	0	11.26144	0	23	2	0.58	0.54	0.41	2.70	0.53	0.35	13%	20%	TRUE	7%
25	M_MMD/MAD	7	5.642654	0	0	0	2.683922	-0.00727	0.0012	0	0	23	3	0.88	0.86	0.84	1.81	0.83	0.30	16%	46%	TRUE	30%
25	M_MMD/MAD	8	16.83443	0	0	-0.0006	6.275	0	0.000969	-24.8228	0	23	4	0.95	0.94	0.91	1.20	0.99	0.22	18%	82%	TRUE	64%
25	M_MMD/MAD	9	9.868931	0	0	-0.00031	3.103547	-0.00249	0.000377	-11.1096	0	23	5	0.94	0.92	0.87	0.74	0.59	0.15	21%	79%	TRUE	59%
25	M_MMD/MAD	10	3.664536	0	0	0	0	-0.00387	0	0	0	23	1	0.83	0.82	0.80	0.55	0.23	0.10	18%	42%	TRUE	24%
25	M_MMD/MAD	11	-1.68272	7.77E-05	0	0.000277	-2.38366	0	0.000475	1.694741	0	23	5	0.76	0.69	0.50	0.54	0.18	0.09	17%	33%	TRUE	17%
25	M_MMD/MAD	12	0.740398	1.78E-05	0	9.75E-05	-1.38474	-0.00055	0	0	0	23	4	0.74	0.69	0.57	0.37	0.12	0.06	17%	32%	TRUE	15%
25	M_P10/MAD	1	0.839604	0	0	0	-0.46817	-0.00084	0	0	0	23	2	0.51	0.46	0.31	0.13	0.04	0.03	25%	35%	TRUE	10%
25	M_P10/MAD	2	0.736619	0	0	0	-0.31542	-0.00061	-6.52E-05	0	0	23	3	0.53	0.45	0.29	0.12	0.03	0.02	20%	28%	TRUE	8%
25	M_P10/MAD	3	0.253862	0	0.002806549	0	-0.17557	0	-0.00011	0	0	23	3	0.68	0.63	0.50	0.14	0.03	0.02	14%	25%	TRUE	10%
25	M_P10/MAD	4	0.050811	0	0.004235471	0	-0.13376	0.000683	-0.00029	0	0	23	4	0.82	0.78	0.72	0.24	0.09	0.04	16%	38%	TRUE	22%
25	M_P10/MAD	5	-1.44664	-6.47E-05	0	0	0	0.004963	-0.001	0	-0.16291	23	4	0.87	0.84	0.80	0.90	0.53	0.20	22%	59%	TRUE	37%
25	M_P10/MAD	6	5.333921	0	0	0	-0.97285	-0.00512	0	0	0	23	2	0.43	0.37	0.26	1.14	0.34	0.26	23%	29%	TRUE	7%
25	M_P10/MAD	7	4.792498	0	0.034833844	-0.00039	3.938101	-0.00528	0	0	0	23	4	0.95	0.93	0.89	1.02	0.78	0.19	18%	77%	TRUE	59%
25	M_P10/MAD	8	13.95511	0	0	-0.00047	5.276659	0	0	-19.1585	0	23	3	0.90	0.88	0.84	0.77	0.71	0.23	30%	92%	TRUE	62%
25	M_P10/MAD	9	1.396034	0.00011	0	0	0.031424	0	0.000923	-3.8742	0	23	4	0.86	0.83	0.70	0.38	0.32	0.12	32%	84%	TRUE	52%
25	M_P10/MAD	10	1.571747	0	0.006661129	-9.46E-05	0	-0.00169	0	0	0	23	3	0.72	0.67	0.62	0.22	0.15	0.08	36%	67%	TRUE	31%
25	M_P10/MAD	11	1.873301	0	0	0	-0.57538	-0.00152	0	-0.6297	0	23	3	0.56	0.49	0.37	0.19	0.08	0.06	30%	45%	TRUE	14%
25	M_P10/MAD	12	1.039597	0	0	0	-0.5097	-0.00106	0	0	0	23	2	0.50	0.45	0.36	0.15	0.05	0.04	27%	37%	TRUE	10%
25	M_P20/MAD	1	1.400291	1.15E-05	0	0	-0.43404	0	0	-1.83495	0	23	3	0.52	0.45	0.23	0.15	0.05	0.03	22%	31%	TRUE	9%
25	M_P20/MAD	2	1.205218	0	0	0	-0.26935	0	-5.92E-05	-1.41658	0	23	3	0.52	0.44	0.24	0.14	0.04	0.03	19%	27%	TRUE	8%
25	M_P20/MAD	3	0.345238	0	0.002506875	0	-0.22921	0	-0.00014	0	0	23	3	0.75	0.71	0.56	0.17	0.04	0.02	14%	27%	TRUE	13%
25	M_P20/MAD	4	-0.09671	0	0	3.73E-05	-0.23159	0.00109	-0.00033	0	0	23	4	0.80	0.76	0.70	0.32	0.15	0.07	21%	46%	TRUE	25%
25	M_P20/MAD	5	-12.4909	0	0	0.000275	0	0.005433	-0.00108	15.70254	0	23	4	0.89	0.87	0.82	1.19	0.69	0.23	20%	58%	TRUE	38%
25	M_P20/MAD	6	1.057348	0	0.027121042	-0.00013	0	0	0	0	0	23	2	0.26	0.19	0.02	1.47	0.33	0.29	20%	22%	TRUE	3%
25	M_P20/MAD	7	14.99183	0	0	-0.00044	3.728001	-0.0036	0.000886	-17.6983	0	23	5	0.96	0.94	0.89	1.18	0.85	0.18	15%	72%	TRUE	57%
25	M_P20/MAD	8	11.70674	0	0	-0.00043	4.4385	-0.00255	0.000771	-14.3416	0	23	5	0.95	0.93	0.90	0.88	0.80	0.19	21%	91%	TRUE	69%
25	M_P20/MAD	9	3.826656	0	0	0	1.504023	-0.00431	0	0	0	23	2	0.82	0.80	0.76	0.46	0.38	0.17	36%	83%	TRUE	47%
25	M_P20/MAD	10	2.317689	0	0	0	0	-0.00254	0	0	0	23	1	0.65	0.64	0.59	0.27	0.17	0.10	38%	63%	TRUE	25%
25	M_P20/MAD	11	2.415954	0	0	0	-0.72431	-0.00148	0	-1.39298	0	23	3	0.58	0.51	0.32	0.24	0.09	0.06	25%	37%	TRUE	12%
25	M_P20/MAD	12	1.163994	0	0	0	-0.61939	-0.00117	0	0	0	23	2	0.48	0.43	0.27	0.18	0.06	0.05	25%	34%	TRUE	9%
25	M_P30/MAD	1	1.557728	0	0	0	-0.4332	0	0	-2.01011	0	23	2	0.46	0.40	0.23	0.18	0.05	0.04	22%	29%	TRUE	7%
25	M_P30/MAD	2	0.552222	0	0	0	-0.49843	-0.00044	0	0	0	23	2	0.50	0.45	0.22	0.17	0.04	0.03	20%	27%	TRUE	8%
25	M_P30/MAD	3	1.000652	0	0	0	-0.29333	0	-0.00016	-0.81996	0	23	3	0.78	0.74	0.69	0.19	0.05	0.03	14%	28%	TRUE	15%
25	M_P30/MAD	4	-0.58525	0	0	0	0	0.002061	-0.00044	0	0	23	2	0.78	0.76	0.73	0.40	0.21	0.10	24%	51%	TRUE	27%
25	M_P30/MAD	5	-17.0955	0	0	0.000452	-3.21189	0	-0.00119	29.69071	0	23	4	0.91	0.89	0.83	1.47	0.85	0.26	18%	58%	TRUE	40%
25	M_P30/MAD	6	1.51598	0	0.016055657	0	-0.96995	0	0	0	0	23	2	0.10	0.01	-0.19	1.81	0.31	0.30	17%	17%	TRUE	0%
25	M_P30/MAD	7	3.646699	0	0.042066117	-0.00044	3.720437	-0.00494	0.000714	0	0	23	5	0.95	0.94	0.89	1.31	0.89	0.20	15%	68%	TRUE	53%
25	M_P30/MAD	8	12.88854	0	0	-0.00047	4.953849	-0.0028	0.000778	-15.6493	0	23	5	0.95	0.93	0.90	0.98	0.88	0.20	21%	90%	TRUE	69%
25	M_P30/MAD	9	7.75715	0	0	-0.00025	1.980972	-0.0023	0.00028	-8.29872	0	23	5	0.90	0.88	0.79	0.53	0.44	0.14	26%	83%	TRUE	57%
25	M_P30/MAD	10	5.475468	0	0	-0.00014	0	-0.00167	0	-5.38702	0	23	3	0.78	0.75	0.68	0.31	0.18	0.09	28%	59%	TRUE	31%
25	M_P30/MAD	11	2.828405	0	0	0	-0.89586	-0.00156	0	-1.82519	0	23	3	0.61	0.55	0.40	0.28	0.10	0.06	22%	34%	TRUE	12%
25	M_P30/MAD	12	1.21305	0	0	0	-0.70517	-0.00118	0	0	0	23	2	0.44	0.39	0.28	0.21	0.07	0.05	25%	33%	TRUE	8%
25	M_P40/MAD	1	0.734554	8.52E-06	0	0	-0.67955	-0.00062	0	0	0	23	3	0.52	0.45	0.30	0.20	0.06	0.04	21%	29%	TRUE	9%
25	M_P40/MAD	2	0.772438	0	0	0	-0.44647	-0.00048	-0.00011	0	0	23	3	0.62	0.56	0.38	0.19	0.05	0.03	18%	28%	TRUE	10%
25	M_P40/MAD	3	0.468327	0	0	1.92E-05	-0.30916	0	-0.00017	0	0	23	3	0.78	0.74	0.68	0.21	0.06	0.03	15%	30%	TRUE	16%
25	M_P40/MAD	4	-1.24583	0	0	0	0	0.003164	-0.00053	0	0	23	2	0.83	0.81	0.78	0.49	0.28	0.12	24%	56%	TRUE	32%
25	M_P40/MAD	5	-20.7778	0	0	0.000491	-3.74214	0	-0.00138	36.01738	0	23	4	0.91	0.88	0.84	1.76	1.01	0.32	18%	58%	TRUE	39%
25	M_P40/MAD	6	2.22518	0	0	0	-1.43158	0	0	0	0	23	1	0.13	0.09	-0.05	2.12	0.35	0.34	16%	17%	TRUE	1%
25	M_P40/MAD	7	18.35438	0	0	-0.00056	4.699038	0	0.001189	-27.155	0	23	4	0.94	0.92	0.87	1.44	0.93	0.23	16%	64%	TRUE	48%
25	M_P40/MAD	8	13.72711	0	0	-0.00049	5.408217	-0.00301	0.000805	-16.5698	0	23	5	0.95	0.94	0.89	1.06	0.94	0.21	20%	89%	TRUE	69%
25	M_P40/MAD	9	5.512337	8.58E-05	0	-0.0002	2.026964	0	0.000886	-9.29805	0	23	5	0.93	0.91	0.84	0.60	0.51	0.13	22%	84%	TRUE	62%
25	M_P40/MAD	10	5.822617	0	0	-0.00014	0	-0.00189	0	-5.56494	0	23	3	0.79	0.76	0.71	0.36	0.20	0.09	26%	55%	TRUE	30%
25	M_P40/MAD	11	2.738915	0	0	3.82E-05	-1.10193	-0.00183	0	-1.36069	0	23	4	0.63	0.55	0.35	0.33	0.11	0.06	20%	32%	TRUE	12%
25	M_P40/MAD	12	2.393757	0	3.59E-05	0	-0.5643	0	0	-3.15331	0	23	3	0.43	0.34	0.18	0.24	0.08	0.06	25%	32%	TRUE	7%
25	M_P50/MAD	1	1.412482	0	0	2.08E-05	-0.6885	-0.00068	-9.14E-05	-0.71409	0	23	5	0.63	0.52	0.30	0.23	0.07	0.04	18%	29%	TRUE	11%
25	M_P50/MAD	2	0.398824	0	0.002496691	0	-0.41601	0	-0.00014	0	0	23	3	0.66	0.60	0.47	0.21	0.06	0.04	18%	30%	TRUE	12%
25	M_P50/MAD	3	0.730855	0	0.001597598	0	-0.46194	0	-0.00021	-0.24295	0	23	4	0.78	0.73	0.65	0.24	0.08	0.04	16%	33%	TRUE	17%
25	M_P50/MAD	4	-1.78359	0	-0.003178286	0	0	0.004238	-0.00062	0	0	23	3	0.84	0.82	0.77	0.61	0.37	0.15	25%	61%	TRUE	36%
25	M_P50/MAD	5	-5.57765	0	-0.052158509	0	-3.52015	0.011298	0	0	0	23	3	0.89	0.87	0.84	2.11	1.21	0.41	19%	57%	TRUE	38%
25	M_P50/MAD	6	2.617289	0	0	0	-2.57569	0	0	0	0	23	1	0.29	0.26	0.14	2.44	0.43	0.37	15%	18%	TRUE	2%
25	M_P50/MAD	7	3.360901	0	0.052530501	-0.00049	3.665348	-0.00467	0.000835	0	0	23	5	0.95	0.93	0.87	1.59	0.95	0.22	14%	60%	TRUE	46%
25	M_P50/MAD	8	16.01017	0	0	-0.0006	6.559826	0	0.000942	-23.6497	0	23	4	0.95	0.94	0.91	1.14	1.00	0.23	20%	87%	TRUE	67%
25	M_P50/MAD	9	10.00261	0	0	-0.0003	3.407565	-0.00265	0	-10.3999	0	23	4	0.91	0.89	0.84	0.68	0.57	0.18	26%	84%	TRUE	58%
25	M_P50/MAD	10	6.162334	0	0	-0.00013	0	-0.00209	0	-5.76853	0	23	3	0.81	0.78	0.71	0.41	0.21	0.09	23%	51%	TRUE	28%
25	M_P50/MAD	11	2.811085	0	0	6.32E-05	-1.33729	-0.00205	0	-1.16222	0	23	4	0.66	0.58	0.47	0.38	0.12	0.07	19%	31%	TRUE	13%
25	M_P50/MAD	12	1.342814	0	0	0	-0.91514	-0.00125	0	0	0	23	2	0.44	0.39	0.25	0.27	0.08	0.06	24%	32%	TRUE	7%
			Count	8	16	35	59	45	38	33	2												
			Total	72	72	72	72	72	72	72	72												
			%Time	11%	22%	49%	82%	63%	53%	46%	3%												

Table 6: HZ 26 Monthly Model Results

HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	%MAD Alloc	N	numVars	R2	ADJ R2	MIN R2	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Model Better?	By how much?
26	M_MMD/MAD	1	1.804719	0	0	0.000102	-0.94471	0.001192	-0.00056	-2.51177	0	20	5	0.90	0.87	0.69	0.50	0.19	0.06	12%	38%	TRUE	26%
26	M_MMD/MAD	2	0.226157	0	0.007959	0	-0.5705	0.000872	-0.00048	0	0	20	4	0.85	0.81	0.65	0.42	0.15	0.06	15%	37%	TRUE	22%
26	M_MMD/MAD	3	0.367195	0	0.00131	0	-0.34613	0.001075	-0.00056	0	0	20	4	0.79	0.74	0.62	0.42	0.15	0.07	17%	36%	TRUE	19%
26	M_MMD/MAD	4	-0.17496	0	0	0	-0.52468	0.002421	-0.00067	0	0	20	3	0.77	0.73	0.61	0.70	0.24	0.12	17%	35%	TRUE	18%
26	M_MMD/MAD	5	0.716156	0	-0.01842	-0.00015	0	0.004626	-0.00125	0	0	20	4	0.67	0.58	0.41	1.57	0.44	0.26	17%	28%	TRUE	11%
26	M_MMD/MAD	6	-1.23566	0	0	-0.00022	0	0.001594	0.000285	3.56861	0	20	4	0.63	0.54	0.36	2.09	0.31	0.19	9%	15%	TRUE	6%
26	M_MMD/MAD	7	-1.04744	0	0	0	1.817513	0	0.001967	0	0	20	2	0.83	0.81	0.75	1.85	0.48	0.20	11%	26%	TRUE	15%
26	M_MMD/MAD	8	1.013308	0	0	0	2.674785	-0.00294	0.00163	0	-0.02478	20	4	0.92	0.90	0.84	1.27	0.56	0.16	13%	44%	TRUE	31%
26	M_MMD/MAD	9	2.696144	0	0	0	1.448298	-0.0036	0.000594	0	0	20	3	0.93	0.92	0.76	0.91	0.35	0.10	11%	39%	TRUE	28%
26	M_MMD/MAD	10	1.627864	0	0	9.77E-05	0	-0.00375	0	2.945266	0	20	3	0.88	0.86	0.71	0.89	0.22	0.08	9%	25%	TRUE	16%
26	M_MMD/MAD	11	1.367232	0	0	0.000156	-0.61404	0	-0.00064	0	0	20	3	0.75	0.70	0.57	0.82	0.23	0.12	14%	28%	TRUE	13%
26	M_MMD/MAD	12	2.398452	0	0	0	-1.27218	0	-0.00059	-1.39211	0	20	3	0.84	0.81	0.59	0.56	0.19	0.08	14%	35%	TRUE	20%
26	M_P10/MAD	1	0.839928	0	0	0	-0.62755	0	0	-0.90596	0	20	2	0.52	0.47	0.31	0.19	0.07	0.05	28%	39%	TRUE	11%
26	M_P10/MAD	2	-0.01379	0	0.007736	0	-0.5204	0	0.00E+00	0	0	20	2	0.52	0.47	0.31	0.18	0.08	0.06	31%	44%	TRUE	13%
26	M_P10/MAD	3	0.086121	0	0.005451	0	-0.54965	0	0	0	-0.01971	20	3	0.63	0.56	0.43	0.19	0.08	0.05	25%	40%	TRUE	15%
26	M_P10/MAD	4	0.806703	0	0	0	-0.54414	0	-0.00033	0	0	20	2	0.64	0.59	0.45	0.29	0.12	0.07	25%	40%	TRUE	15%
26	M_P10/MAD	5	-0.46343	0.00E+00	0	0	0	0.002705	-0.00067	0	0	20	2	0.76	0.74	0.68	0.68	0.21	0.11	16%	31%	TRUE	16%
26	M_P10/MAD	6	0.173411	4.21E-05	0	0	0	0	0.000702	0	0	20	2	0.46	0.40	0.21	1.18	0.18	0.14	12%	15%	TRUE	4%
26	M_P10/MAD	7	1.06841	0	0	0	0	-0.00343	0.001951	0	0	20	2	0.75	0.72	0.64	1.11	0.43	0.22	20%	39%	TRUE	19%
26	M_P10/MAD	8	0.403886	0	0	0	1.713533	-0.00178	0.001135	0	0	20	3	0.84	0.81	0.63	0.79	0.38	0.16	20%	49%	TRUE	28%
26	M_P10/MAD	9	1.133804	4.69E-05	0	1.17E-05	0	-0.00216	0.000645	0	0	20	4	0.90	0.87	0.74	0.44	0.17	0.06	13%	39%	TRUE	26%
26	M_P10/MAD	10	1.500666	3.3E-05	-0.00084	0.00E+00	-0.44288	-0.00196	0.000245	0	0	20	5	0.92	0.89	0.47	0.30	0.10	0.03	10%	34%	TRUE	24%
26	M_P10/MAD	11	0.886603	0	0	0	0	-0.00032	-0.00027	0	0	20	2	0.31	0.23	-0.17	0.27	0.08	0.07	27%	32%	TRUE	5%
26	M_P10/MAD	12	0.464188	0	0	0	-0.40398	0	-0.00014	0	0	20	2	0.46	0.40	0.18	0.23	0.08	0.06	27%	36%	TRUE	9%
26	M_P20/MAD	1	0.235755	0.00E+00	0.00581	0	-0.56289	0	-9.4E-05	0	0	20	3	0.59	0.52	0.30	0.23	0.09	0.06	25%	38%	TRUE	13%
26	M_P20/MAD	2	0.545851	0	0	0	-0.46027	0	-2.04E-04	0	0	20	2	0.59	0.54	0.35	0.22	0.09	0.06	27%	41%	TRUE	14%
26	M_P20/MAD	3	0.59301	0	0	0	-0.46979	0	-0.00023	0	0	20	2	0.64	0.60	0.36	0.23	0.09	0.06	25%	40%	TRUE	15%
26	M_P20/MAD	4	-0.03624	0	0	0.00E+00	0	0.001493	-0.00054	0	0	20	2	0.74	0.71	0.59	0.37	0.14	0.07	20%	39%	TRUE	18%
26	M_P20/MAD	5	-0.26699	0	0	0	-0.69715	0.002556	-0.00054	0	0	20	3	0.79	0.75	0.60	0.88	0.25	0.12	13%	29%	TRUE	15%
26	M_P20/MAD	6	-1.4158	0	0	0	-0.61612	0	0.000893	2.615072	0	20	3	0.64	0.57	0.44	1.41	0.20	0.12	9%	14%	TRUE	5%
26	M_P20/MAD	7	1.208881	0	0	0	0	-0.00374	0.002141	0	0	20	2	0.78	0.75	0.64	1.28	0.46	0.23	18%	36%	TRUE	19%
26	M_P20/MAD	8	0.544141	0	0	0	1.767173	-0.00218	0.00135	0	-0.03577	20	4	0.86	0.82	0.67	0.90	0.43	0.16	18%	48%	TRUE	29%
26	M_P20/MAD	9	1.329314	4.99E-05	0.000564	1.27E-05	0	-0.00267	0.000839	0	0	20	5	0.88	0.84	0.55	0.53	0.22	0.08	14%	41%	TRUE	26%
26	M_P20/MAD	10	2.033551	3.24E-05	-0.00628	0	0	-0.00196	0	0	0	20	3	0.81	0.78	0.35	0.37	0.12	0.05	15%	33%	TRUE	18%
26	M_P20/MAD	11	-0.0978	0	0.015394	0	-0.50513	0	0	0	0	20	2	0.39	0.32	0.10	0.34	0.11	0.09	25%	32%	TRUE	6%
26	M_P20/MAD	12	1.15763	0	0	0	-0.68959	0	-0.00015	-0.94208	0	20	3	0.58	0.50	0.35	0.27	0.10	0.07	24%	36%	TRUE	12%
26	M_P30/MAD	1	0.019933	0	0.010529	0	-0.78166	0	0	0	0	20	2	0.62	0.57	0.32	0.27	0.11	0.07	25%	39%	TRUE	14%
26	M_P30/MAD	2	0.336723	0	0	0	-0.70069	0	0	0	-0.02691	20	2	0.58	0.53	0.39	0.25	0.10	0.07	27%	40%	TRUE	13%
26	M_P30/MAD	3	0.659488	0	0	0	-0.55087	0	-0.00025	0	0	20	2	0.67	0.63	0.40	0.26	0.10	0.06	23%	39%	TRUE	16%
26	M_P30/MAD	4	-0.13283	0	0	0	0	0.001839	-0.00061	0	0	20	2	0.75	0.72	0.59	0.44	0.17	0.08	19%	38%	TRUE	19%
26	M_P30/MAD	5	-0.37506	0	0	0	-0.72266	0.003031	-0.0006	0	0	20	3	0.73	0.68	0.44	1.05	0.30	0.16	15%	28%	TRUE	13%
26	M_P30/MAD	6	-1.39412	0	0	-0.00016	0	0	0.000428	4.416003	0	20	3	0.72	0.67	0.29	1.60	0.22	0.12	8%	14%	TRUE	6%
26	M_P30/MAD	7	1.198519	0	0	0	0	-0.00377	0.002272	0	0	20	2	0.79	0.77	0.72	1.42	0.48	0.22	16%	34%	TRUE	18%
26	M_P30/MAD	8	0.868235	6.53E-05	0	0	1.610857	-0.00315	0.00167	0	0	20	4	0.93	0.91	0.74	0.99	0.46	0.13	13%	47%	TRUE	34%
26	M_P30/MAD	9	1.40771	4.33E-05	-0.00273	0	0.81287	-0.00238	0.000718	0	0	20	5	0.93	0.91	0.57	0.61	0.25	0.07	11%	41%	TRUE	30%
26	M_P30/MAD	10	1.909958	0	0	0	0	-0.00193	0	0	0	20	1	0.60	0.57	0.46	0.44	0.14	0.09	21%	31%	TRUE	11%
26	M_P30/MAD	11	-0.11657	0	0.018753	0	-0.67636	0	0	0	0	20	2	0.46	0.40	0.22	0.41	0.13	0.10	23%	31%	TRUE	8%
26	M_P30/MAD	12	0.399557	0	0	0	-0.77302	0	0	0	0	20	1	0.49	0.46	0.30	0.31	0.11	0.08	27%	36%	TRUE	10%
26	M_P40/MAD	1	-0.02454	0.00E+00	0.013761	0	-0.94599	0	0	0	0	20	2	0.65	0.61	0.45	0.31	0.13	0.08	24%	40%	TRUE	16%
26	M_P40/MAD	2	0.721171	0	0	0	-0.56086	0	-0.00028	0	0	20	2	0.66	0.62	0.49	0.28	0.11	0.06	23%	39%	TRUE	16%
26	M_P40/MAD	3	0.719666	0	0	0.00E+00	-0.62482	0	-0.00026	0	0	20	2	0.68	0.64	0.49	0.29	0.11	0.06	22%	38%	TRUE	16%
26	M_P40/MAD	4	-0.33283	0	0	0	0	0.002304	-0.00067	0	0	20	2	0.76	0.73	0.61	0.51	0.20	0.10	19%	38%	TRUE	19%
26	M_P40/MAD	5	0.251301	0	0	-0.0001	-0.77901	0.003179	-0.00081	0	0	20	4	0.71	0.64	0.50	1.22	0.35	0.19	16%	28%	TRUE	13%
26	M_P40/MAD	6	-2.41987	0	0	0	0	0	0.000714	5.032037	0	20	2	0.47	0.41	0.35	1.78	0.26	0.19	11%	14%	TRUE	4%
26	M_P40/MAD	7	1.299432	0	0	0	0	-0.0039	0.002364	0	0	20	2	0.81	0.79	0.71	1.55	0.49	0.22	14%	32%	TRUE	17%
26	M_P40/MAD	8	-1.44448	0	0	0	2.717562	-0.00328	0.00152	4.224335	-0.08752	20	5	0.91	0.88	0.67	1.08	0.51	0.15	14%	47%	TRUE	33%
26	M_P40/MAD	9	1.519264	4.53E-05	-0.00284	0	0.906754	-0.00267	0.000848	0	0	20	5	0.93	0.90	0.67	0.69	0.29	0.08	11%	42%	TRUE	30%
26	M_P40/MAD	10	1.16912	0	0	0	0	-0.00279	0	2.339631	-0.02926	20	3	0.74	0.69	0.50	0.52	0.15	0.08	15%	29%	TRUE	14%
26	M_P40/MAD	11	-0.12412	0	0.021877	0.00E+00	-0.85159	0	0	0	0	20	2	0.52	0.47	0.38	0.48	0.15	0.10	22%	30%	TRUE	9%
26	M_P40/MAD	12	-0.50386	0	1.65E-02	0	-0.83752	0.000553	0	0	0	20	3	0.64	0.57	0.31	0.36	0.13	0.08	23%	38%	TRUE	14%
26	M_P50/MAD	1	-0.12713	0	0.013924	0.00E+00	-0.70873	0.000631	-2.66E-04	0	0	20	4	0.75	0.69	0.53	0.36	0.14	0.07	20%	40%	TRUE	20%
26	M_P50/MAD	2	0.487729	0	0.00741	0	-0.71373	0	-0.00024	0	0	20	3	0.72	0.66	0.44	0.31	0.12	0.07	21%	39%	TRUE	17%
26	M_P50/MAD	3	0.054131	0	0	6.66E-06	0	0.001196	-0.00048	0	0	20	3	0.71	0.66	0.51	0.33	0.12	0.07	21%	37%	TRUE	17%
26	M_P50/MAD	4	-0.39351	-2.8E-05	0	0	0	0.002783	-0.00082	0	0	20	3	0.81	0.77	0.69	0.59	0.22	0.10	17%	38%	TRUE	21%
26	M_P50/MAD	5	-1.18337	0	0	0	0	0.005005	-0.00091	0	0	20	2	0.64	0.59	0.47	1.40	0.40	0.25	18%	28%	TRUE	11%
26	M_P50/MAD	6	-1.54159	0	0	-0.00021	0	0.001403	0.000299	4.00027	0	20	4	0.62	0.52	0.29	1.96	0.31	0.20	10%	16%	TRUE	6%
26	M_P50/MAD	7	-1.34193	0	-0.00595	0	1.724894	-0.00356	0.002063	4.599903	0	20	5	0.89	0.85	0.71	1.70	0.51	0.18	10%	30%	TRUE	20%
26	M_P50/MAD	8	-1.04705	0	0	0	2.908101	-0.00345	0.001621	3.708661	-0.084	20	5	0.92	0.90	0.74	1.18	0.55	0.16	13%	46%	TRUE	33%
26	M_P50/MAD	9	1.441803	4.6E-05	0	0	1.130641	-0.00279	0.000941	0	0	20	4	0.93	0.91	0.78	0.77	0.32	0.09	11%	42%	TRUE	31%
26	M_P50/MAD	10	2.531339	0	0	0	0	-0.00251	0	0	-0.00102	20	2	0.68	0.64	0.53	0.61	0.17	0.10	16%	27%	TRUE	11%
26	M_P50/MAD	11	-0.12886	0	0.025298	0.00E+00	-1.02403	0	0	0	0	20	2	0.56	0.51	0.32	0.57	0.17	0.11	20%	29%	TRUE	9%
26	M_P50/MAD	12	0.529283	0	0.00926	0	-0.95808	0	-0.00023	0	0	20	3	0.68	0.62	0.45	0.41	0.15	0.09	22%	37%	TRUE	15%
			Count	10	22	11	47	43	55	14	8												
			Total	72	72	72	72	72	72	72	72												
			%Time	14%	31%	15%	65%	60%	76%	19%	11%												

Table 7: HZ 27 Monthly Model Results

HZ	Model	month	Intercept	DA (1/km2)	Slope (1/%)	Precip (1/mm)	Glc (1/%)	PET (1/mm)	Med.Elev. (1/m)	SolExp (1/%)	%MAD Alloc	N	numVars	R2	ADJ R2	MIN R2	AVG	STDEV	STEYX[A]	STEYX%	STDEV%	Better?	By how much?
27	M_MMD/MAD	1	-0.74156	0	0	-1.5E-05	-75.2678	0.003216	-0.00071	0	0	27	4	0.93	0.92	0.89	1.61	0.49	0.13	8%	30%	TRUE	22%
27	M_MMD/MAD	2	-1.74142	0	0	-0.00022	0	0.002744	0	1.759955	0	27	3	0.90	0.89	0.87	1.29	0.42	0.13	10%	33%	TRUE	22%
27	M_MMD/MAD	3	-2.3178	0	0	0	-77.567	0.002388	0	2.036029	0	27	3	0.75	0.72	0.70	1.16	0.23	0.12	10%	20%	TRUE	10%
27	M_MMD/MAD	4	1.079606	0	0	-0.00015	0	0	0.000635	0	0	27	2	0.55	0.51	0.41	1.04	0.16	0.11	10%	15%	TRUE	5%
27	M_MMD/MAD	5	2.357135	0	0	0	0	-0.00218	0.000936	0	0	27	2	0.91	0.90	0.88	0.98	0.49	0.15	15%	50%	TRUE	35%
27	M_MMD/MAD	6	6.700692	0	0	0.000117	56.60823	-0.00463	0	-3.22892	0	27	4	0.91	0.90	0.85	0.76	0.49	0.15	19%	65%	TRUE	45%
27	M_MMD/MAD	7	3.288781	0	0	5.61E-05	19.811	-0.00228	0	-1.50614	0	27	4	0.89	0.87	0.81	0.41	0.24	0.08	20%	58%	TRUE	38%
27	M_MMD/MAD	8	1.740901	0	0	0	0	-0.00125	0	-0.62154	0	27	2	0.77	0.75	0.63	0.23	0.11	0.05	23%	47%	TRUE	24%
27	M_MMD/MAD	9	-0.00625	0	0	0.000136	0	0	0	0	0	27	1	0.75	0.74	0.69	0.35	0.14	0.07	21%	40%	TRUE	20%
27	M_MMD/MAD	10	1.288085	0	0	0.000176	-59.8727	-0.00106	0	0.086707	0	27	4	0.83	0.79	0.74	0.89	0.24	0.10	12%	27%	TRUE	16%
27	M_MMD/MAD	11	-1.49693	0	0	0	147.8808	0.001758	0	2.263936	0	27	3	0.54	0.48	0.39	1.60	0.23	0.16	10%	14%	TRUE	4%
27	M_MMD/MAD	12	-1.66436	0	0	-0.0002	-487.93	0.004452	0	0	0	27	3	0.91	0.89	0.87	1.65	0.49	0.15	9%	29%	TRUE	20%
27	M_P10/MAD	1	0.635007	0	0	-0.00012	0	0	0	0	0	27	1	0.40	0.37	0.29	0.31	0.18	0.14	45%	57%	TRUE	12%
27	M_P10/MAD	2	0.675008	0	0	-0.00038	-181.287	0	6.50E-04	0.408482	0	27	4	0.66	0.60	0.41	0.32	0.18	0.11	34%	58%	TRUE	23%
27	M_P10/MAD	3	0.829813	0	0	-0.00031	-164.232	0	0.000592	0	0	27	3	0.58	0.53	0.29	0.33	0.14	0.09	29%	43%	TRUE	15%
27	M_P10/MAD	4	0.632016	0	0	-0.00025	0	0	0.000755	0	0	27	2	0.59	0.55	0.36	0.37	0.13	0.09	23%	35%	TRUE	12%
27	M_P10/MAD	5	1.131478	0.00E+00	0	0	0	0	0.000544	-1.48813	0	27	2	0.88	0.87	0.83	0.40	0.25	0.09	22%	63%	TRUE	40%
27	M_P10/MAD	6	3.151098	0	0	0	0	-0.00198	2.16E-05	-1.69712	0	27	3	0.79	0.77	0.68	0.27	0.20	0.09	34%	74%	TRUE	39%
27	M_P10/MAD	7	0.632853	0	0.00118	0	92.73023	0	0	-0.77743	0	27	3	0.40	0.32	0.22	0.12	0.07	0.05	47%	59%	TRUE	12%
27	M_P10/MAD	8	0.311909	0	0	0	0	0	0	-0.34474	0	27	1	0.09	0.05	-0.03	0.07	0.04	0.04	59%	61%	TRUE	2%
27	M_P10/MAD	9	0.228243	0	0	0	0	0	0	-0.22399	0	27	1	0.05	0.01	-0.10	0.07	0.04	0.04	55%	55%	TRUE	0%
27	M_P10/MAD	10	0.288509	0	0	0.00E+00	0	5.43E-05	0	-0.33329	0	27	2	0.11	0.03	-0.10	0.10	0.03	0.03	32%	33%	TRUE	1%
27	M_P10/MAD	11	0.091678	0	0	-0.00018	0	0	0.000435	0.584139	0	27	3	0.41	0.33	-0.01	0.26	0.09	0.07	28%	35%	TRUE	7%
27	M_P10/MAD	12	0.616999	0	0	-0.00034	0	0	0.000578	0.448115	0	27	3	0.63	0.58	0.37	0.34	0.18	0.11	32%	52%	TRUE	20%
27	M_P20/MAD	1	0.876621	0.00E+00	0	-0.00017	0	0	0	0	0	27	1	0.48	0.46	0.39	0.43	0.22	0.16	38%	51%	TRUE	14%
27	M_P20/MAD	2	1.133722	0	0	-0.00039	0	0	5.62E-04	0	0	27	2	0.68	0.65	0.51	0.42	0.21	0.12	29%	50%	TRUE	21%
27	M_P20/MAD	3	1.003131	0	0	-0.00034	-181.481	0	0.000616	0	0	27	3	0.60	0.55	0.34	0.43	0.16	0.11	24%	38%	TRUE	13%
27	M_P20/MAD	4	0.236405	0	0	-2.77E-04	-51.3091	0	0.000921	0.688055	0	27	4	0.63	0.57	0.50	0.48	0.15	0.10	20%	32%	TRUE	12%
27	M_P20/MAD	5	1.363351	0	0	-5.1E-05	0	0	0.000829	-1.7017	0	27	3	0.91	0.90	0.87	0.50	0.31	0.10	19%	63%	TRUE	43%
27	M_P20/MAD	6	4.579407	0	0	0	160.5102	-0.00308	0	-2.24124	0	27	3	0.88	0.87	0.85	0.36	0.27	0.09	26%	75%	TRUE	49%
27	M_P20/MAD	7	1.328434	0	0	0	0	-0.00058	0	-0.97448	0	27	2	0.54	0.50	0.47	0.15	0.09	0.06	40%	57%	TRUE	18%
27	M_P20/MAD	8	0.404573	0	0	0	45.57419	0	0	-0.45541	0	27	2	0.17	0.10	0.02	0.09	0.05	0.04	48%	52%	TRUE	4%
27	M_P20/MAD	9	0.363171	0	0	0	0	0	0	-0.38874	0	27	1	0.13	0.10	-0.01	0.09	0.04	0.04	41%	43%	TRUE	2%
27	M_P20/MAD	10	0.117765	0	0.001415	0	13.20365	0	0	0	0	27	2	0.21	0.15	0.07	0.14	0.04	0.04	25%	28%	TRUE	3%
27	M_P20/MAD	11	0.126601	0	0	-0.00021	34.99865	0	0.000463	0.833098	0	27	4	0.48	0.39	0.15	0.40	0.11	0.08	20%	28%	TRUE	7%
27	M_P20/MAD	12	1.008228	0	0	-0.00019	0	0	0	-0.05935	0	27	2	0.60	0.56	0.52	0.47	0.22	0.14	31%	47%	TRUE	17%
27	M_P30/MAD	1	1.14297	0	0	-0.00022	0	0	0	0	0	27	1	0.60	0.59	0.52	0.56	0.26	0.17	30%	46%	TRUE	17%
27	M_P30/MAD	2	0.662265	0	0	-0.0002	25.12987	0	0	0.562412	0	27	3	0.65	0.60	0.57	0.53	0.24	0.14	27%	45%	TRUE	18%
27	M_P30/MAD	3	1.124716	0	-0.00215	-0.00034	0	0	0.000636	0	0	27	3	0.59	0.54	0.37	0.53	0.18	0.12	23%	35%	TRUE	12%
27	M_P30/MAD	4	0.284771	0	0	-0.00029	0	0	0.00101	0.746882	0	27	3	0.61	0.56	0.41	0.58	0.18	0.12	20%	31%	TRUE	11%
27	M_P30/MAD	5	3.014016	0	0	0	0	-0.00175	0.000561	-1.75783	0.06084	27	4	0.93	0.92	0.89	0.60	0.37	0.10	17%	62%	TRUE	45%
27	M_P30/MAD	6	5.753577	0	0	0	0	-0.00402	0	-2.6416	0	27	2	0.90	0.89	0.84	0.44	0.33	0.11	25%	76%	TRUE	51%
27	M_P30/MAD	7	1.698013	0	0	0	126.302	-0.0009	0	-1.06585	0	27	3	0.68	0.64	0.60	0.18	0.11	0.06	33%	58%	TRUE	25%
27	M_P30/MAD	8	0.442235	0	0	0	0	0	2.18E-05	-0.50373	0	27	2	0.23	0.16	0.09	0.10	0.05	0.05	43%	49%	TRUE	5%
27	M_P30/MAD	9	0.50584	0	0	0	0	-0.00011	0	-0.43081	0	27	2	0.18	0.11	0.01	0.11	0.05	0.04	39%	42%	TRUE	3%
27	M_P30/MAD	10	0.400569	0	0.002811	0	0	0	0	-0.36207	0	27	2	0.48	0.44	0.31	0.20	0.06	0.05	24%	32%	TRUE	9%
27	M_P30/MAD	11	0.970231	0	0	-0.00025	0	0	0.000448	0	0	27	2	0.45	0.40	0.26	0.55	0.14	0.11	19%	26%	TRUE	6%
27	M_P30/MAD	12	1.233114	0	0	-0.00024	0	0	0	0	0	27	1	0.67	0.65	0.61	0.60	0.27	0.16	26%	45%	TRUE	18%
27	M_P40/MAD	1	1.432485	0.00E+00	0	-0.00027	-33.485	0	0	0	0	27	2	0.71	0.69	0.66	0.71	0.29	0.16	22%	41%	TRUE	19%
27	M_P40/MAD	2	1.312437	0	0	-0.00025	-5.27105	0	0	0	0	27	2	0.72	0.69	0.66	0.65	0.27	0.15	23%	42%	TRUE	19%
27	M_P40/MAD	3	1.274174	0	-0.00326	-3.54E-04	0	0	0.000637	0	0	27	3	0.60	0.55	0.36	0.63	0.20	0.13	21%	32%	TRUE	11%
27	M_P40/MAD	4	0.913816	0	0.001721	-0.0003	0	0	0.000964	0	0	27	3	0.59	0.53	0.35	0.69	0.20	0.13	19%	29%	TRUE	10%
27	M_P40/MAD	5	0.097732	0	0	0	0	0	0.001108	0	0	27	1	0.90	0.89	0.88	0.70	0.43	0.14	20%	61%	TRUE	41%
27	M_P40/MAD	6	6.759852	0	0	0	0	-0.00488	0	-2.90491	0	27	2	0.90	0.89	0.84	0.52	0.40	0.13	25%	76%	TRUE	51%
27	M_P40/MAD	7	2.212139	0	0	0	119.5445	-0.00131	0	-1.23625	0	27	3	0.78	0.75	0.69	0.22	0.13	0.06	29%	60%	TRUE	31%
27	M_P40/MAD	8	0.51852	0	0	0	0	0	4.13E-05	-0.60424	0	27	2	0.34	0.29	0.18	0.12	0.06	0.05	39%	47%	TRUE	8%
27	M_P40/MAD	9	0.397145	0.00E+00	0	0	0	0	4.96E-05	-0.41466	0	27	2	0.26	0.20	0.07	0.14	0.06	0.05	37%	42%	TRUE	5%
27	M_P40/MAD	10	1.292321	0	0	0	0	-0.00118	0	0	0	27	1	0.63	0.62	0.52	0.27	0.09	0.06	21%	34%	TRUE	13%
27	M_P40/MAD	11	0.244065	0	0	-9.95E-05	220.0755	0	0	1.067591	0	27	3	0.41	0.34	0.27	0.73	0.18	0.14	19%	25%	TRUE	5%
27	M_P40/MAD	12	1.066254	0	0.00E+00	-0.00028	0	0	0	0.631105	0	27	2	0.76	0.74	0.68	0.75	0.31	0.15	20%	41%	TRUE	21%
27	M_P50/MAD	1	1.798271	0	0	-3.35E-04	-61.7314	0	0.00E+00	0	0	27	2	0.80	0.78	0.75	0.91	0.34	0.15	17%	37%	TRUE	20%
27	M_P50/MAD	2	0.606673	0	0	-0.00028	-0.41289	0	0	1.340377	0	27	3	0.79	0.76	0.74	0.80	0.32	0.15	19%	40%	TRUE	21%
27	M_P50/MAD	3	0.592502	0	0	-0.00015	-46.0788	0	0	0.839023	0	27	3	0.55	0.49	0.44	0.77	0.21	0.15	19%	28%	TRUE	9%
27	M_P50/MAD	4	1.062493	0	0	-0.0003	0	-0.0006	0.001008	0.706938	0	27	4	0.64	0.57	0.41	0.80	0.21	0.13	16%	26%	TRUE	10%
27	M_P50/MAD	5	3.652475	0	0	0	0	-0.00227	0.000784	-1.87723	0	27	3	0.94	0.93	0.90	0.81	0.48	0.12	15%	59%	TRUE	44%
27	M_P50/MAD	6	6.471899	0	0	8.87E-05	0	-0.00458	0	-3.06983	0	27	3	0.90	0.88	0.84	0.61	0.46	0.15	25%	75%	TRUE	51%
27	M_P50/MAD	7	2.745945	0	0	0	128.4345	-0.00177	0	-1.37137	0	27	3	0.82	0.80	0.76	0.26	0.16	0.07	26%	61%	TRUE	35%
27	M_P50/MAD	8	0.594518	0	0	0	19.37487	0	6.9E-05	-0.70553	0	27	3	0.45	0.37	0.30	0.14	0.07	0.05	36%	48%	TRUE	12%
27	M_P50/MAD	9	0.105714	0	0	0	0	0	0.000106	0	0	27	1	0.31	0.29	0.22	0.16	0.07	0.06	36%	42%	TRUE	7%
27	M_P50/MAD	10	0.224025	0	0.009553	0	0	0	0	0	0	27	1	0.70	0.69	0.64	0.39	0.15	0.08	21%	37%	TRUE	16%
27	M_P50/MAD	11	-0.08439	0	0	-1.02E-04	244.7104	0	0	1.873021	0	27	3	0.47	0.40	0.28	0.95	0.21	0.15	16%	22%	TRUE	6%
27	M_P50/MAD	12	1.905397	0	0	-0.00036	0	0	0	0	0	27	1	0.81	0.80	0.78	0.95	0.36	0.16	17%	38%	TRUE	21%
			Count	0	7	40	28	25	29	46	1												
			Total	72	72	72	72	72	72	72	72												
			%Time	0%	10%	56%	39%	35%	40%	64%	1%												