# COLORADO RIVER SALINITY MODELING FOR MINUTE NO. 242 SALINITY DIFFERENTIAL

RIVERSMART STUDY FOR SALINITY UNCERTAINTY ANALYSIS

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BACKGROUND STUDY DESIGN RESULTS

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# BACKGROUND: HYDROS AND RECLAMATION'S YUMA AREA OFFICE

- Yuma Area Office (YAO) manages the Colorado River between Parker Dam and the border with Mexico
- Hydros Consulting has worked with YAO since 2011 developing RiverWare models and providing training for their use by YAO Water Operations staff
- RiverWare Salinity Projection Model related to IBWC Minute 242
  - Using RiverSMART for uncertainty analysis

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# BACKGROUND: IBWC MINUTE NO. 242

- International Boundary and Water Commission (IBWC) Minute No. 242
  - In effect since 1973 – update to 1944 treaty between U.S. and Mexico
  - Average annual salinity of water delivered upstream of Morelos Dam must not be greater than 145 ppm over the average annual salinity of water arriving at Imperial Dam
  - "Salinity Differential" cannot exceed 145 ppm
  - "Salinity" = Total Dissolved Solids (TDS) concentration

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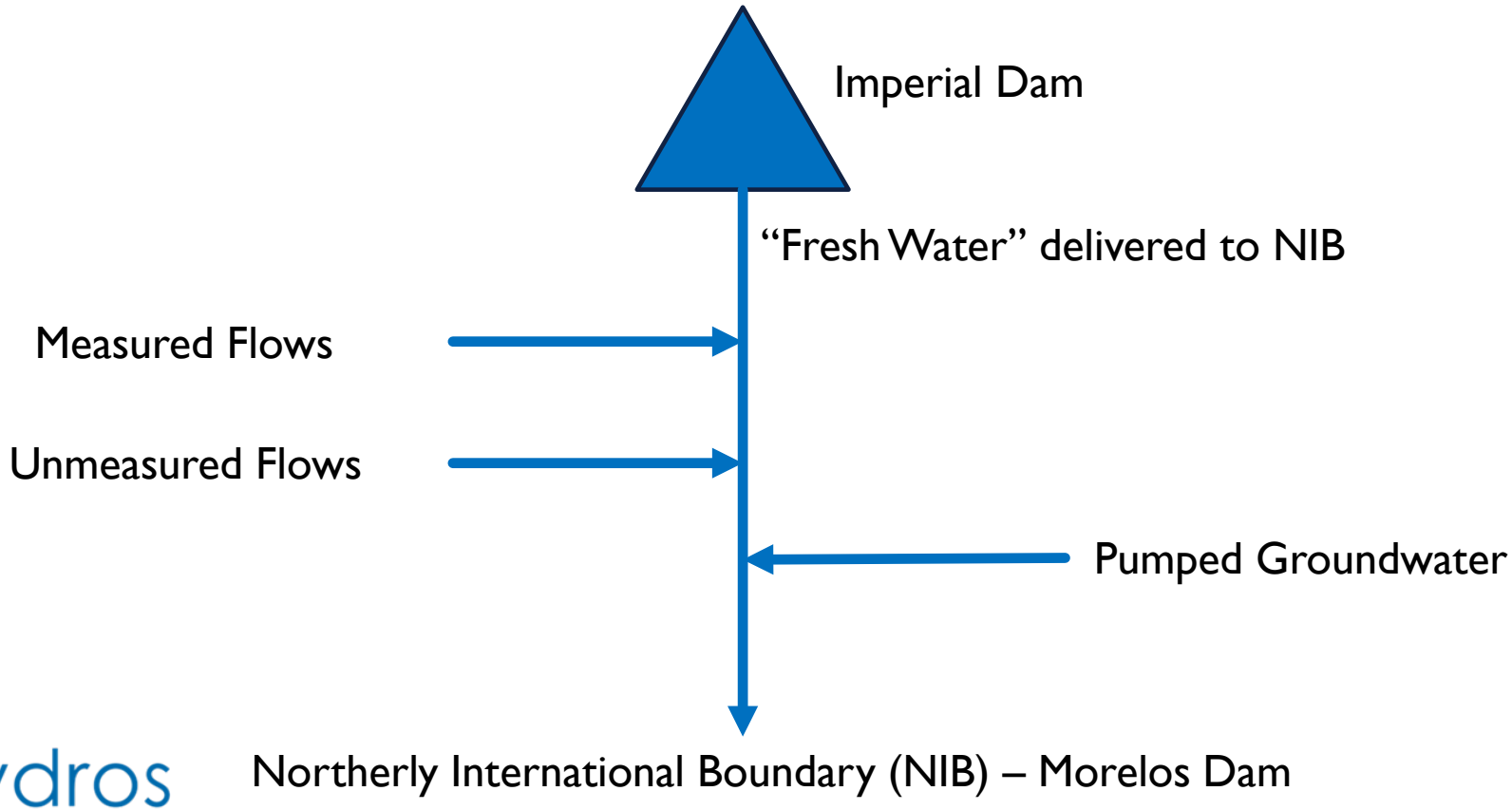
# YUMA AREA OFFICE OPERATIONS RELATED TO MINUTE NO. 242

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# YUMA AREA OFFICE OPERATIONS RELATED TO MINUTE NO. 242

- Groundwater has to be pumped in order to control water table (below the root zone of crops)
- If pumped groundwater can be directed to the river, it counts towards the 1.36 MAF delivery requirement to the NIB
- If pumped groundwater *cannot* be directed to the river, it is sent to the Main Outlet Drain Extension (MODE)
  - US Bypass Water (not in river channel, not diverted/used by Mexico)
  - Does not count toward 1.36 MAF delivery requirement at NIB

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# RIVERWARE SALINITY PROJECTION MODEL

- Objective: Send as much pumped groundwater to the Colorado River (get credit for it) without exceeding the 145 ppm salinity differential (IBWC Minute No. 242)

- RiverWare Salinity Projection Model

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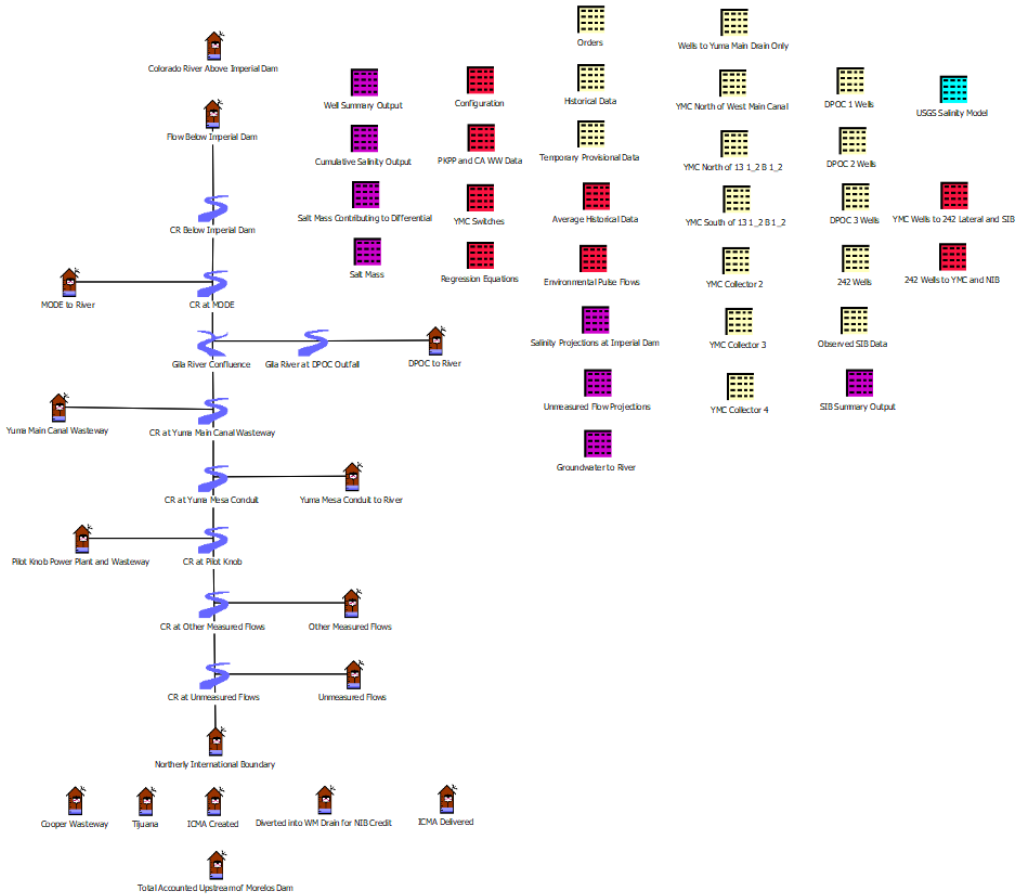
# STUDY DESIGN: RIVERWARE SALINITY PROJECTION MODEL

- Model Extends from Imperial Dam to NIB
- Input Data from Upstream Modeling and User Forecast Modeling
- Operator uses model to test groundwater operations and forecast the year-end salinity differential
- As year progresses, more data is known and the forecast period shortens (uncertainty reduces)

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# RIVERWARE SALINITY PROJECTION MODEL

- Primary Sources of Uncertainty
  - Salinity of water arriving at Imperial Dam
  - Volume and Salinity of Unmeasured Flow (can account for 20% of total salt load at the NIB)
  - Other Measured Flow (less significant that previous two)

- Data for these sources either comes from other models (there is uncertainty associated with that output) or needs to be forecast by the operator
- Using RiverSMART to model uncertainty…

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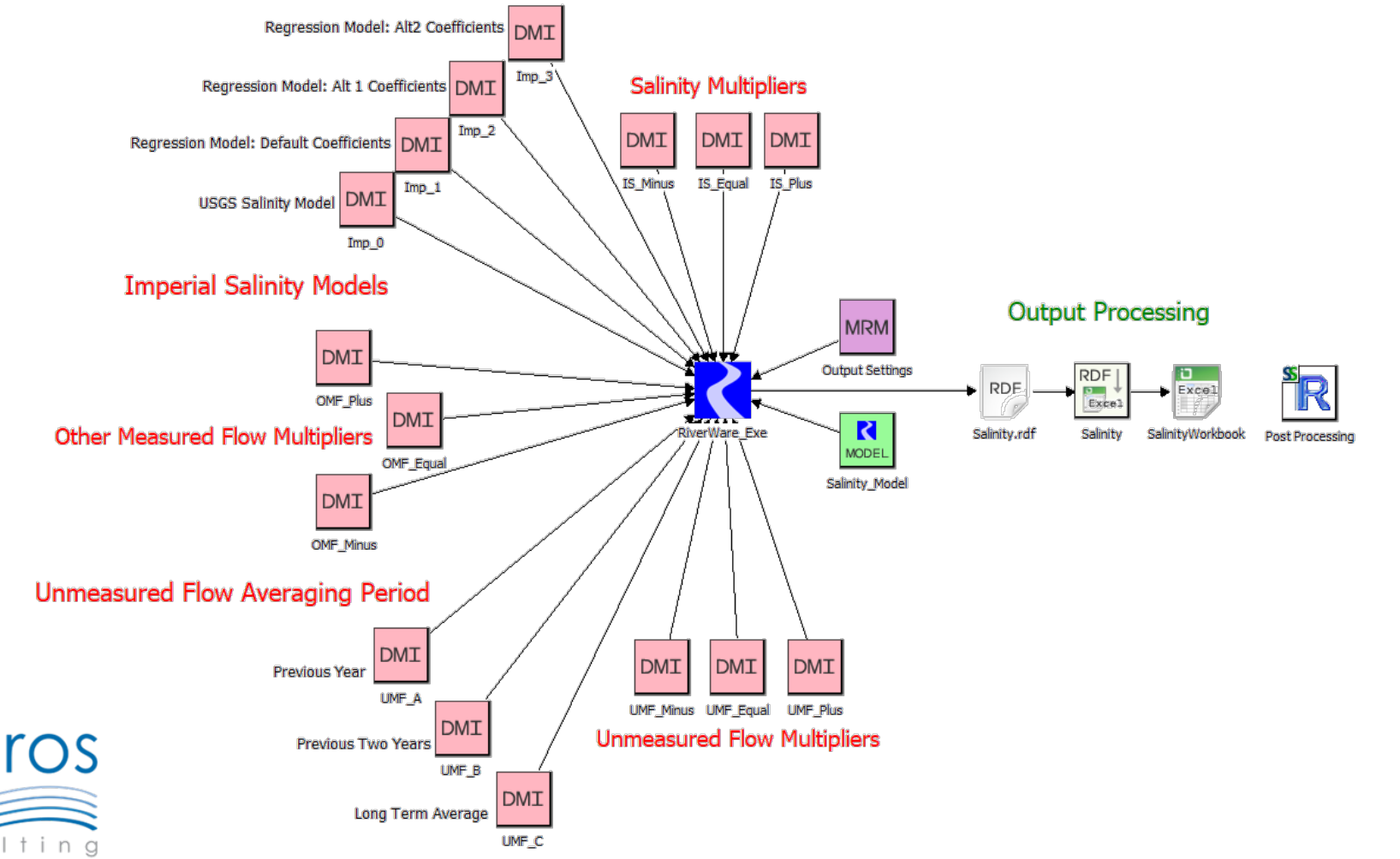
# STUDY DESIGN: RIVERSMART CONFIGURATION

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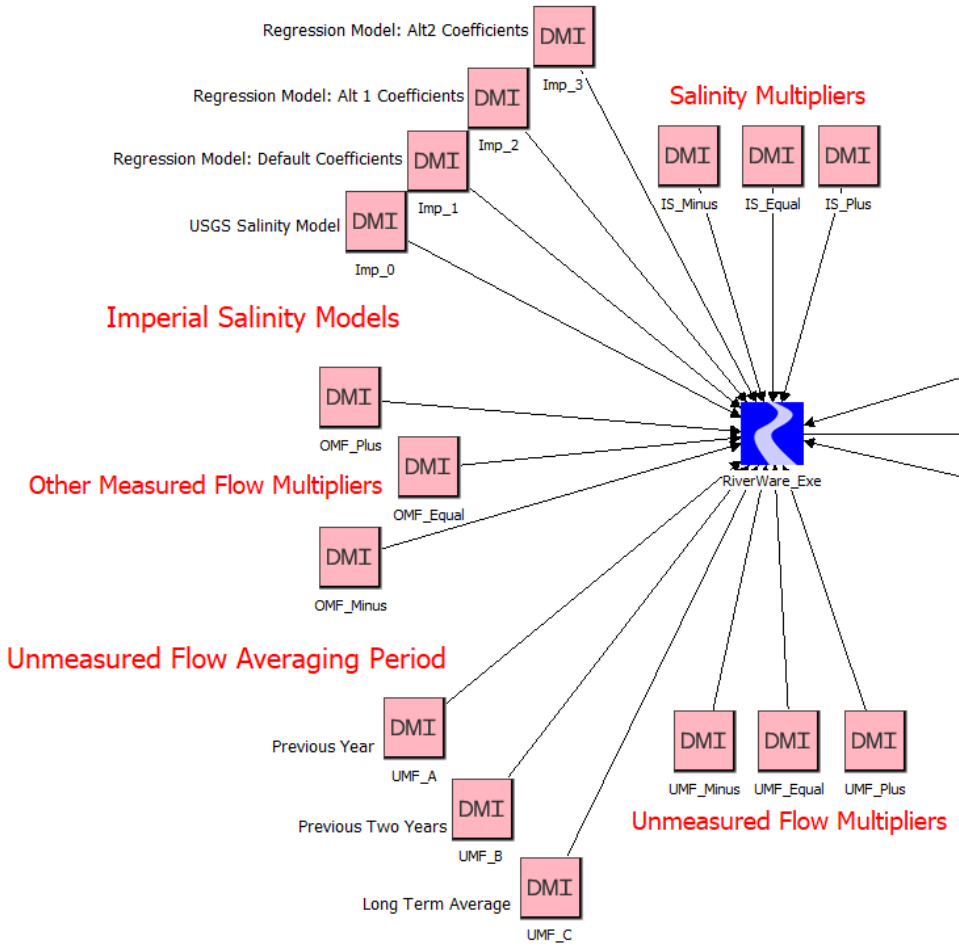
# STUDY DESIGN: RIVERSMART CONFIGURATION

- Five Independent Variables
  - 3 x 4 x 3 x 3 x 3 = 324 Scenarios
- Fast* Simulation Time
  - Less than an hour
- DMI Events Specify Configuration Switches
  - Excel DMIs
  - Sheet Names from RiverSMART
- Post-Processing by Scenario Set
  - R Script Statistically Summarizes Results
  - Analysis of Sensitivity to Each Variable

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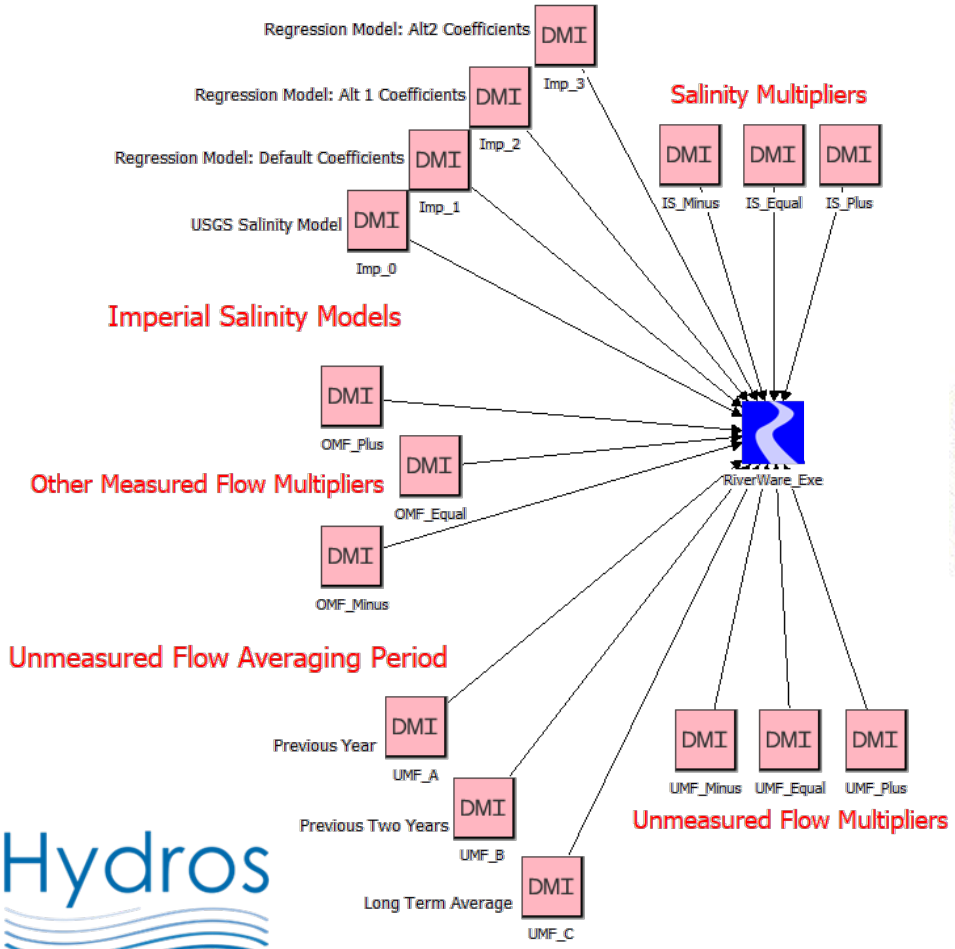
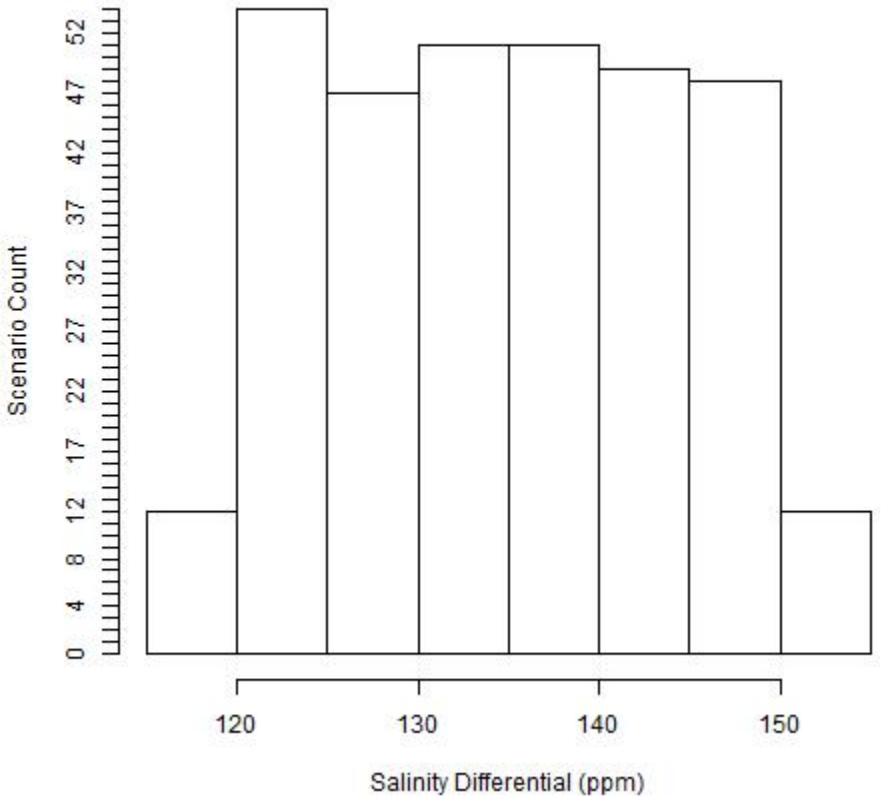
# RESULTS: PROBABILISTIC FORECAST

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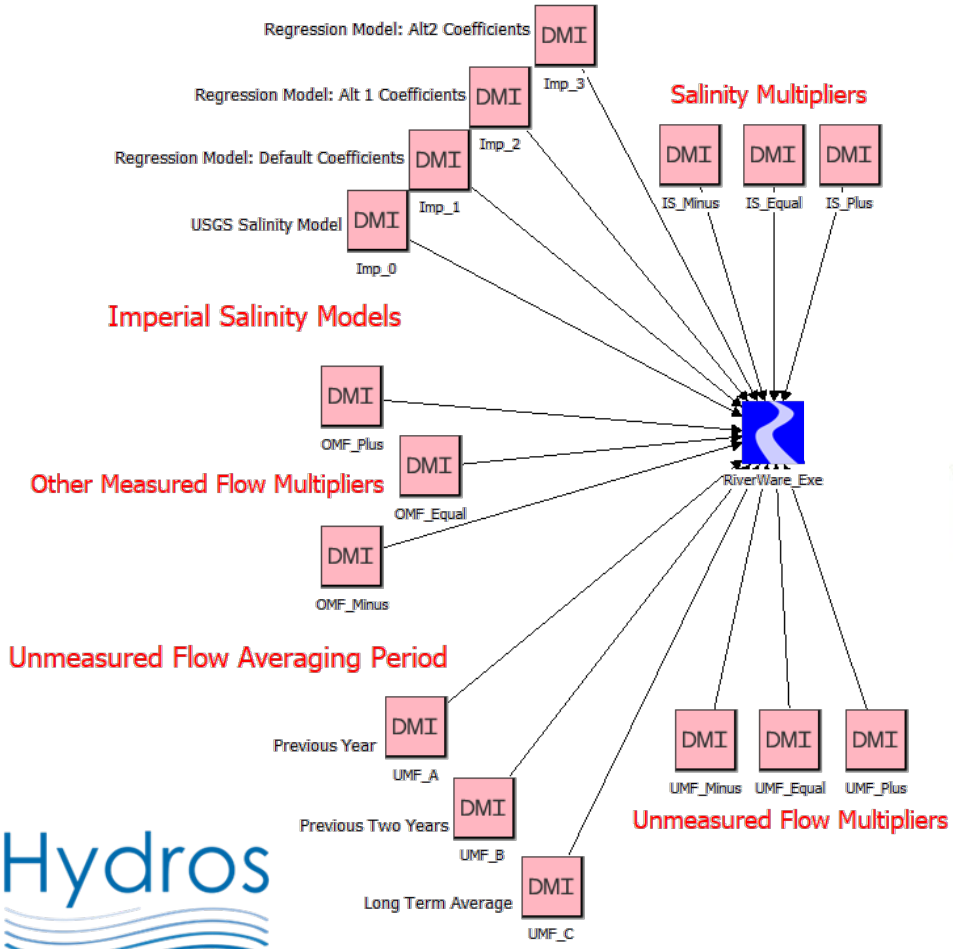


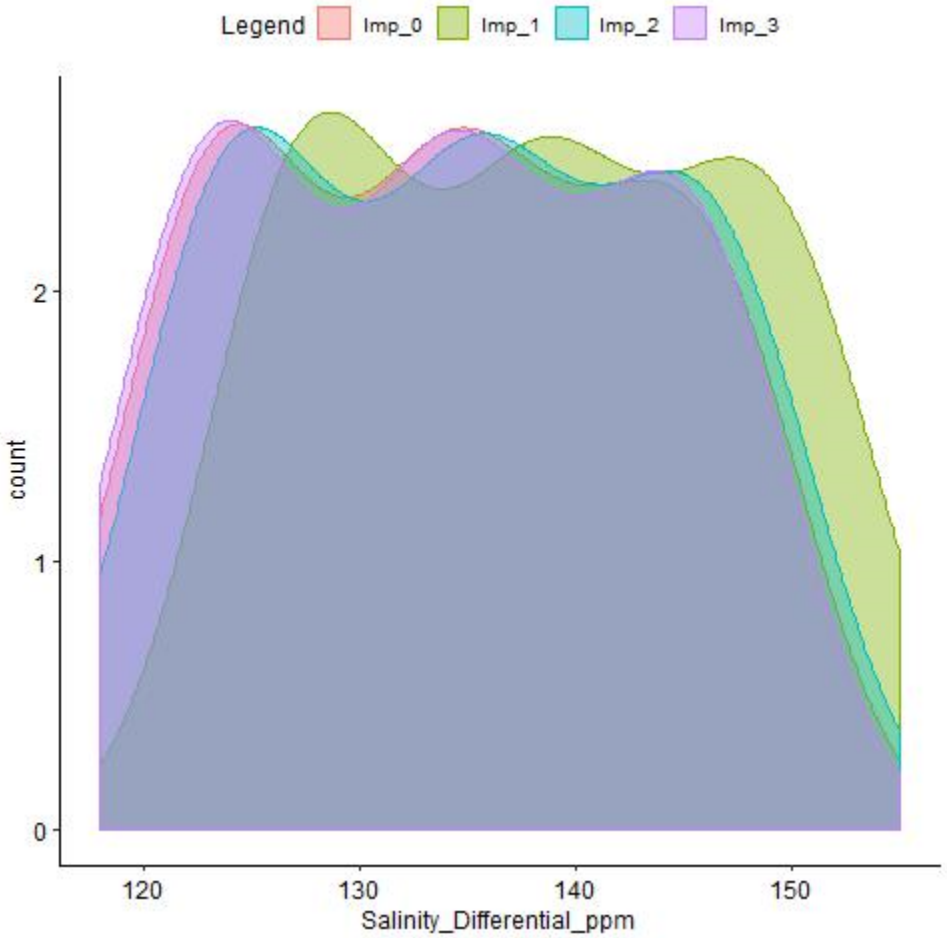


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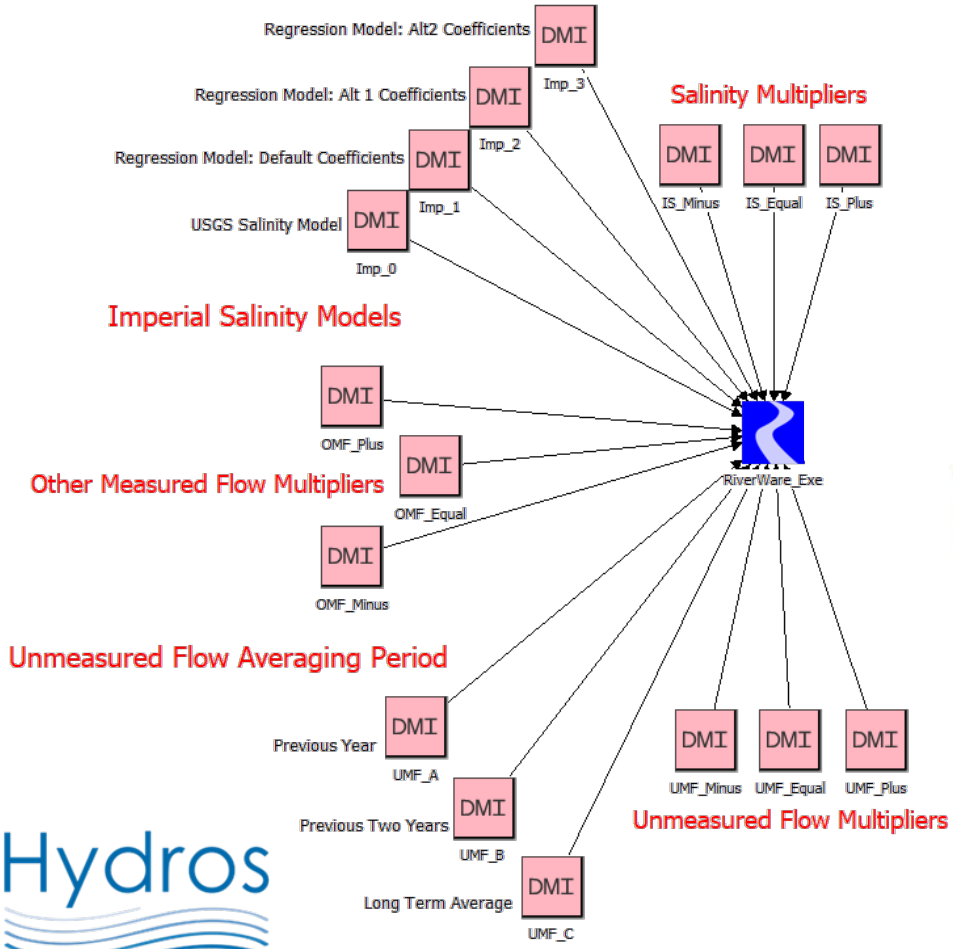


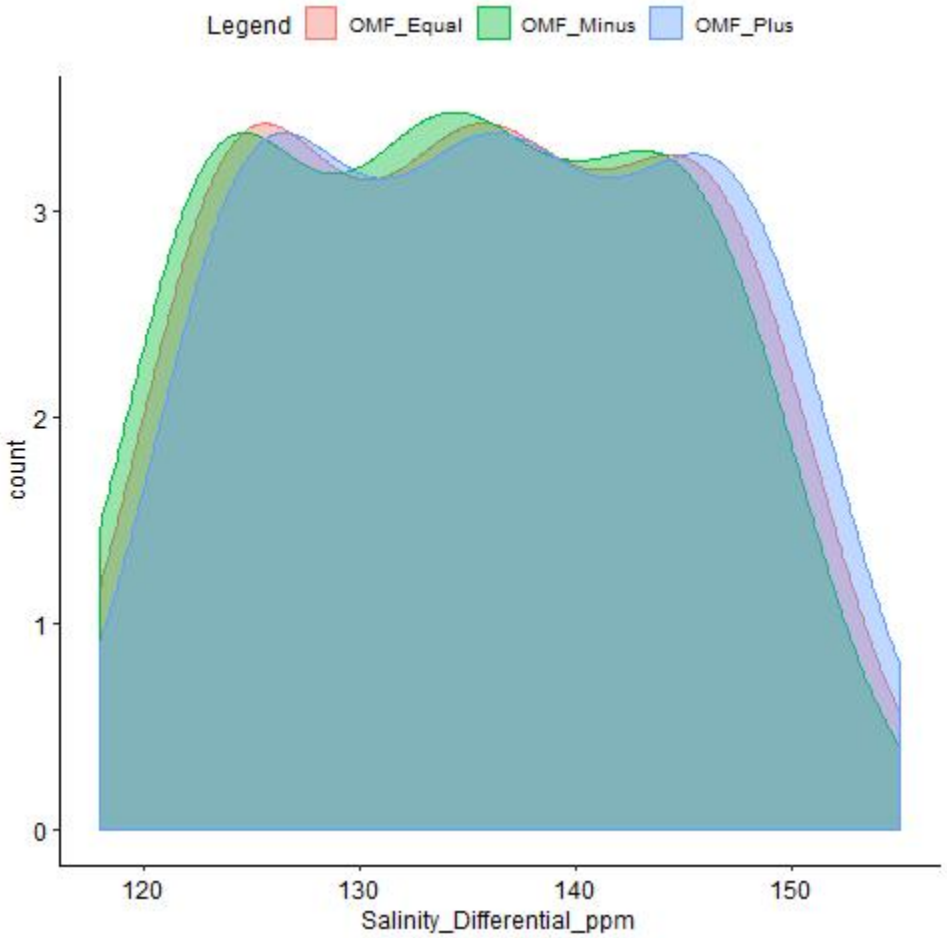


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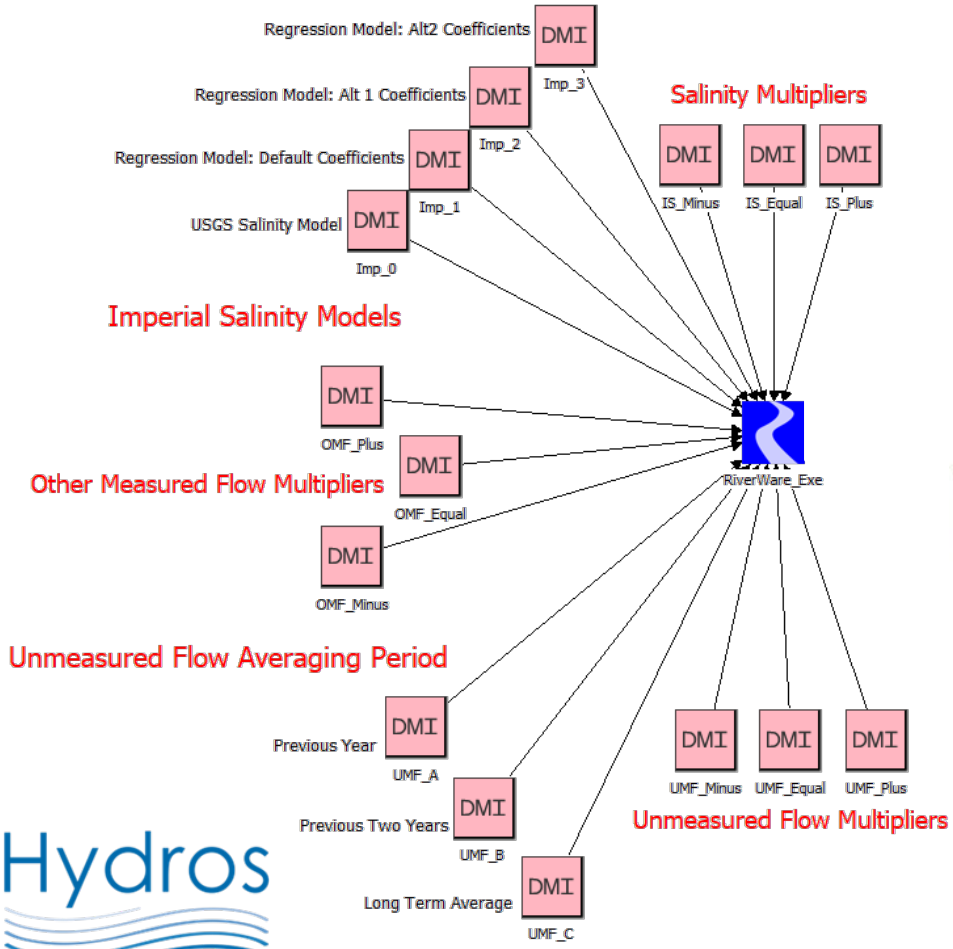


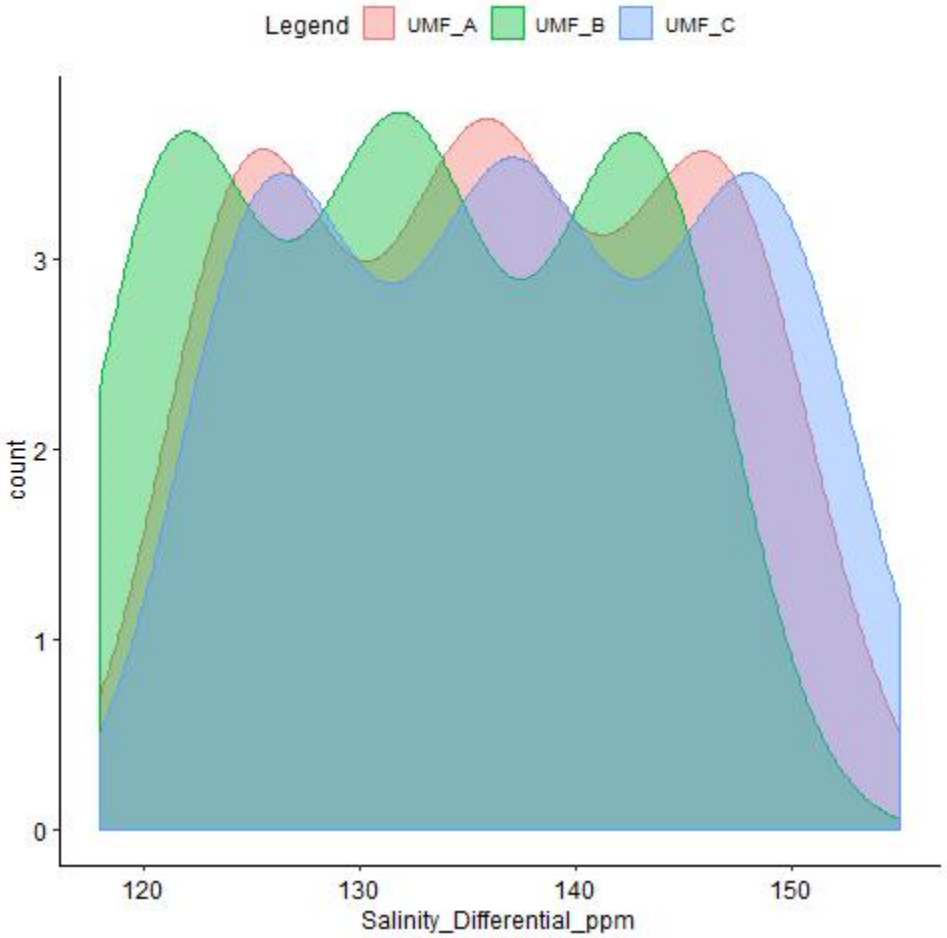


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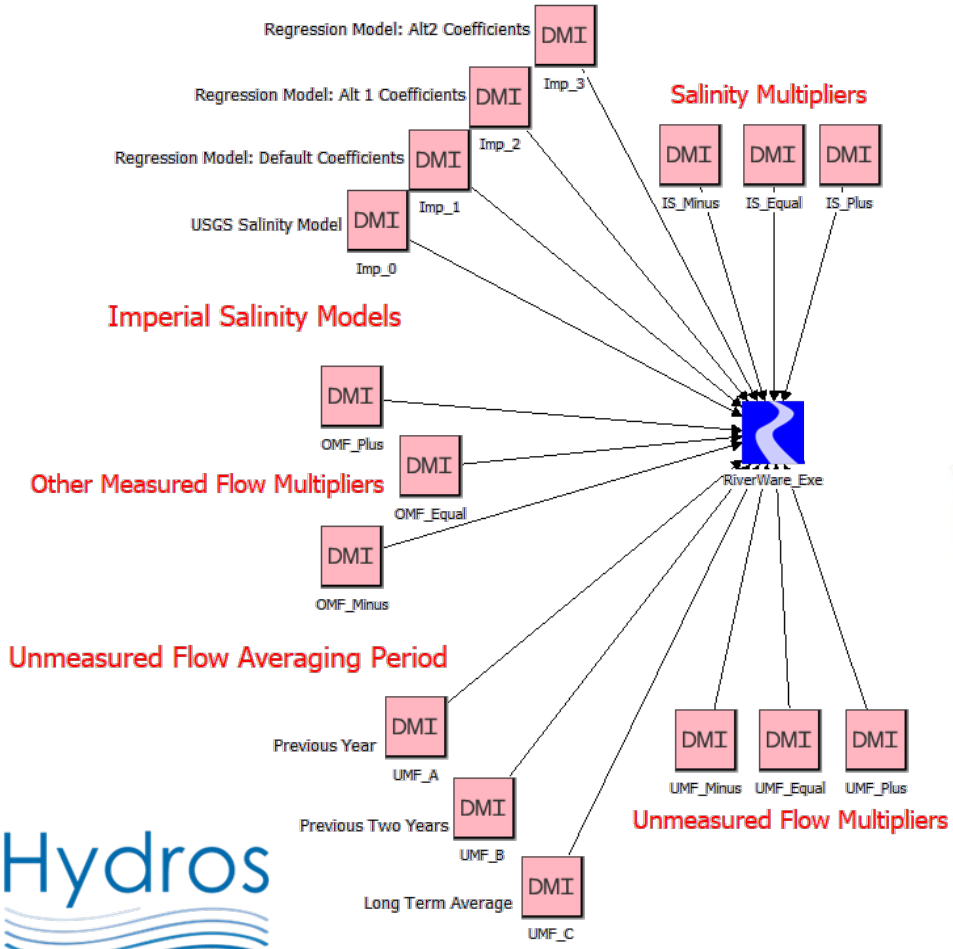


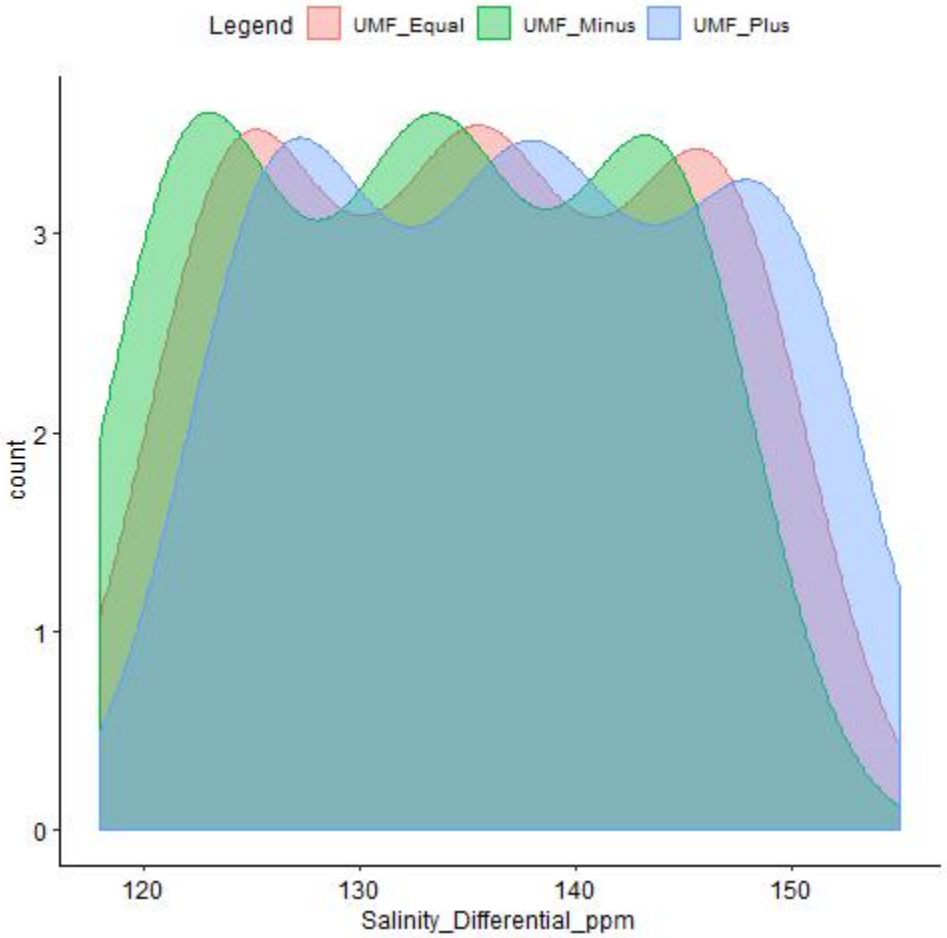


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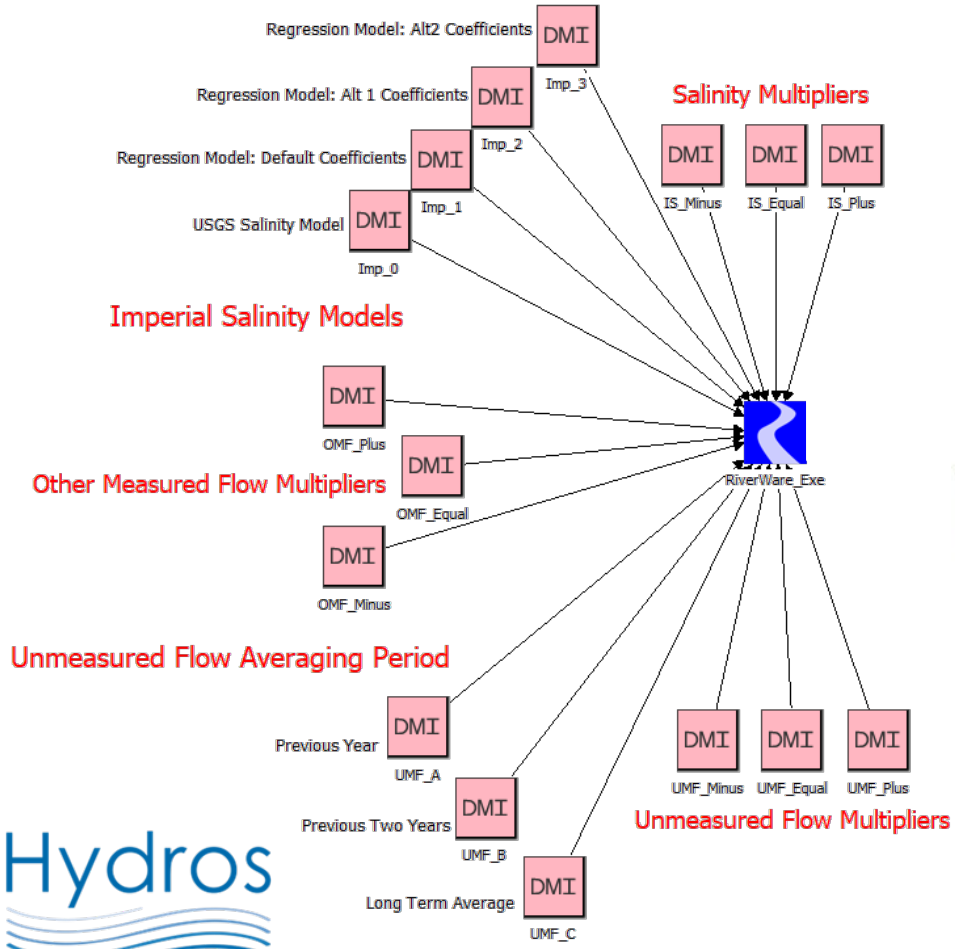


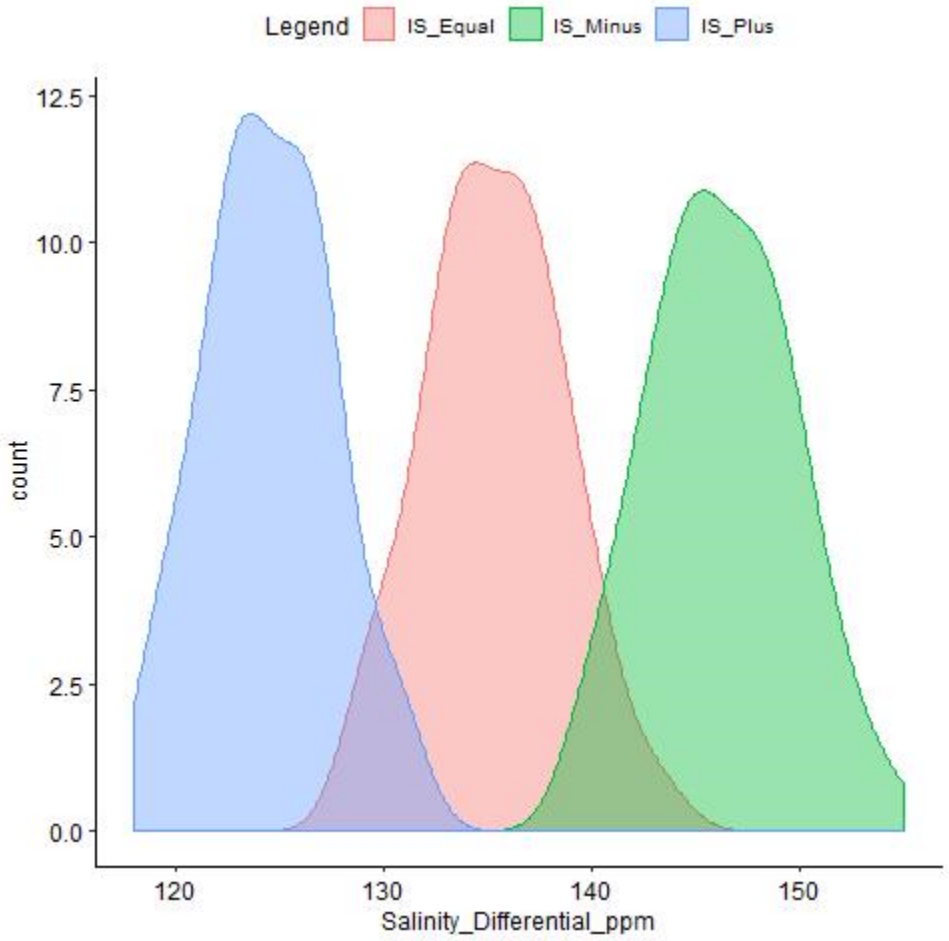


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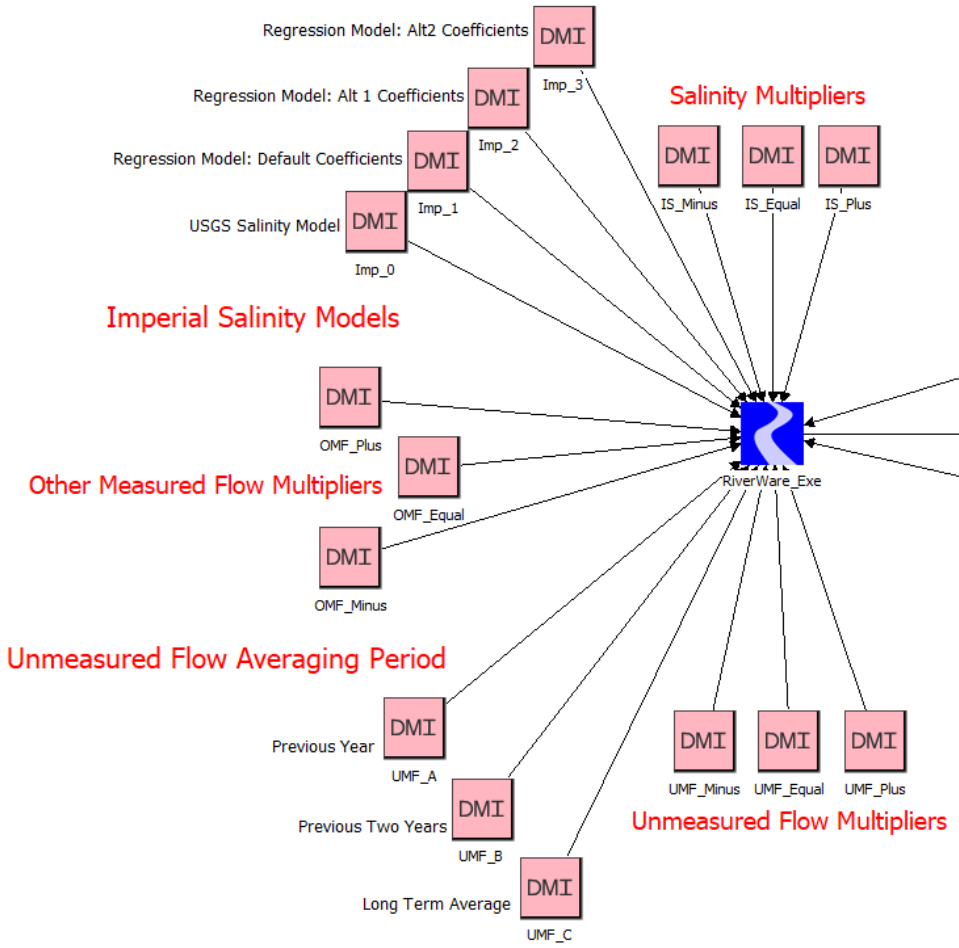
# RESULTS: RIVERSMART ADJUSTMENTS

- Post-Processing Script Reads Selected Scenarios
- Change the Selected Set and Reprocess
  - Takes Less Than One Minute
  - User Interface Through RiverSMART
- Limit Processing to One Value for Most Sensitive Variable to Analyze Impact of Others
  - Choosing Salinity Multiplier = 1.0 (IS_Equal)

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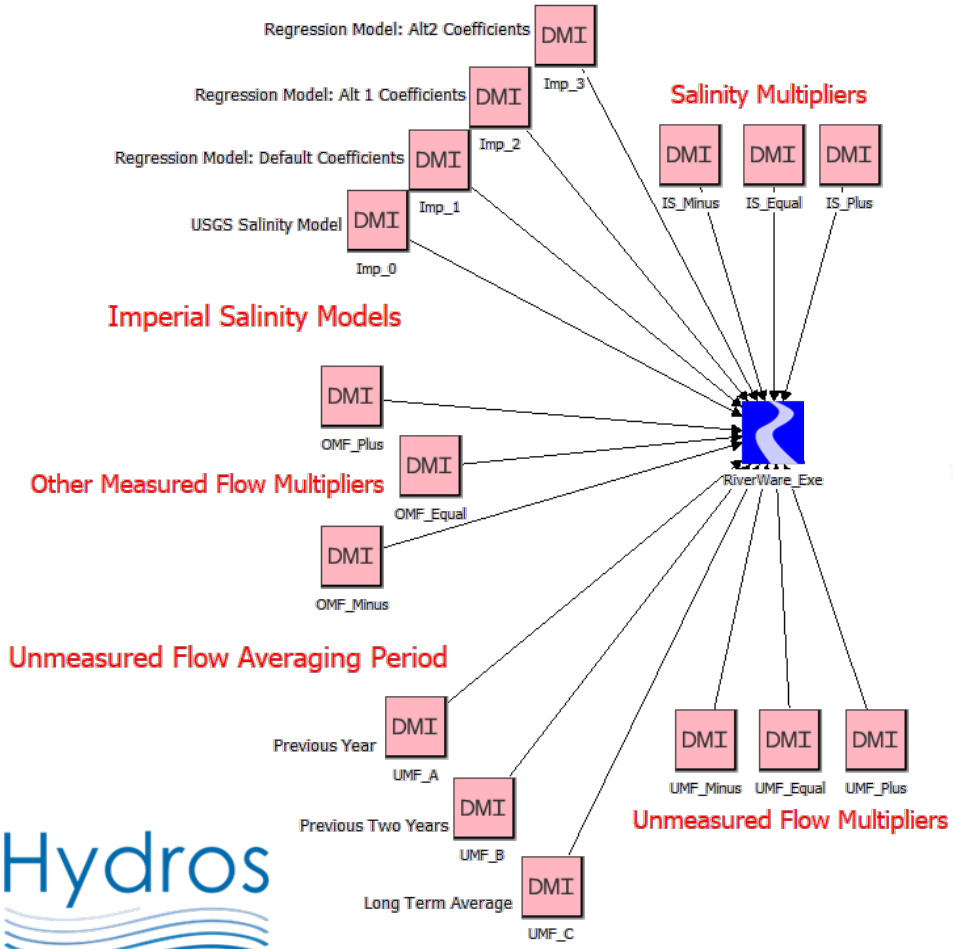


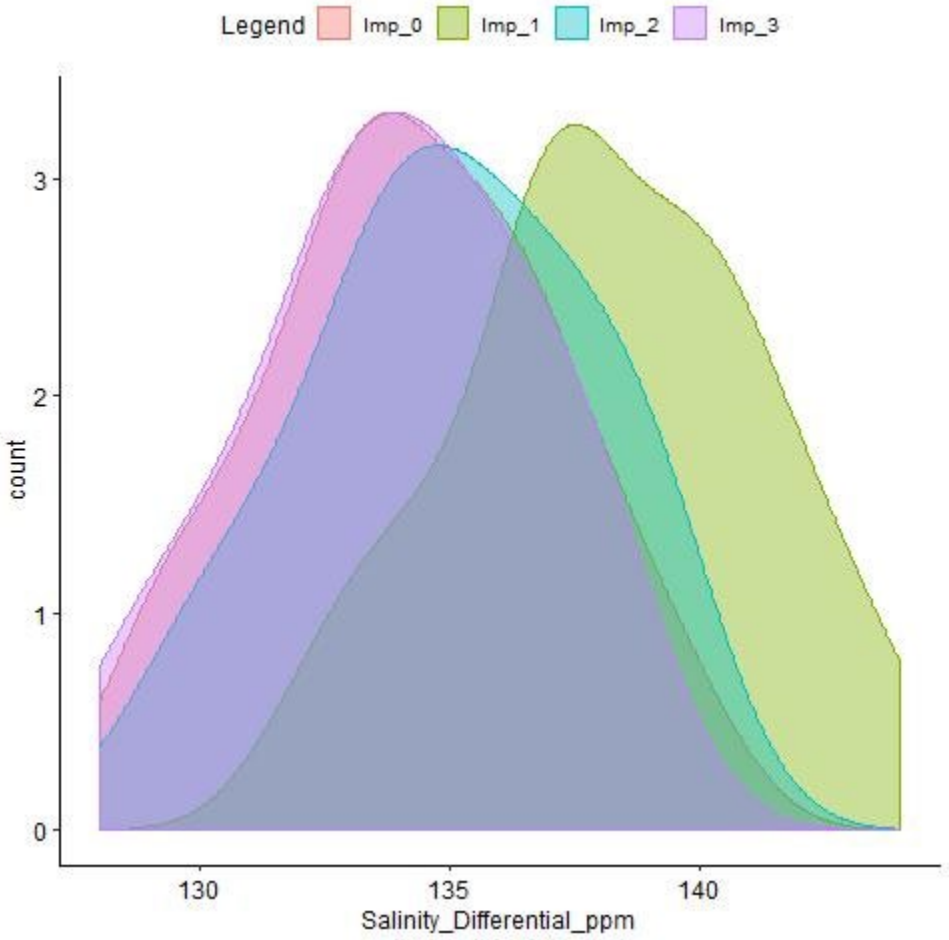


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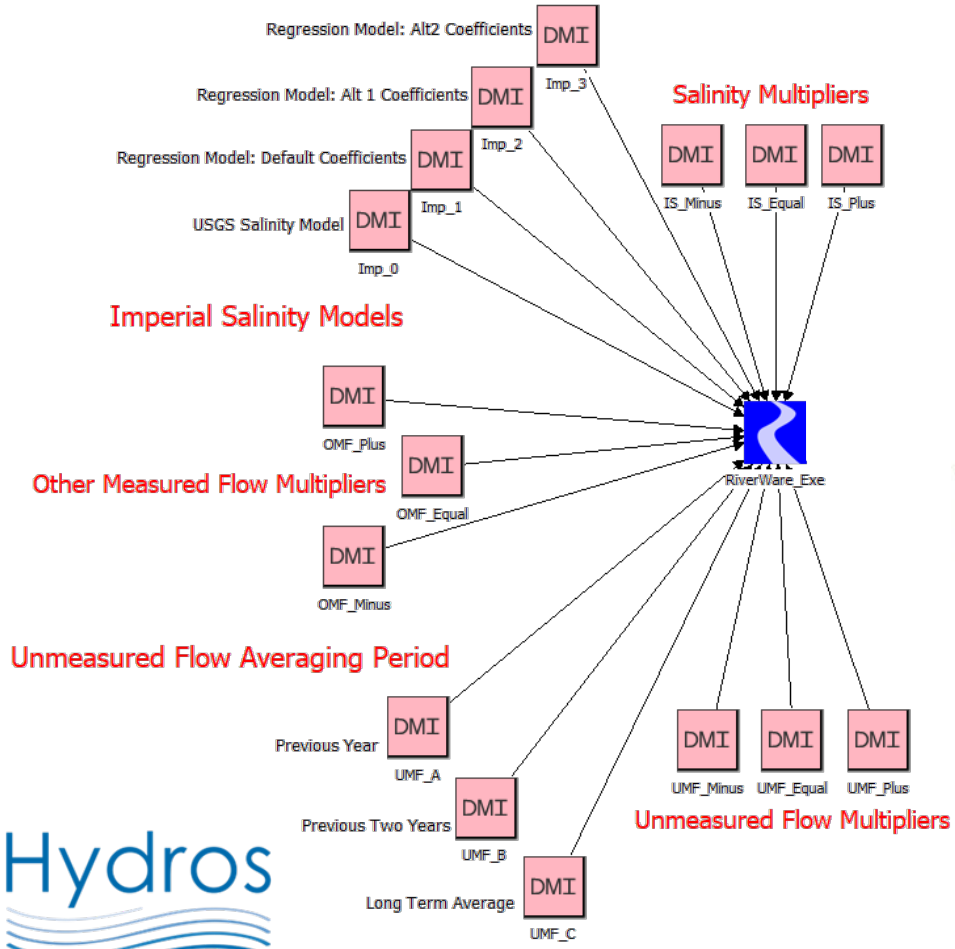


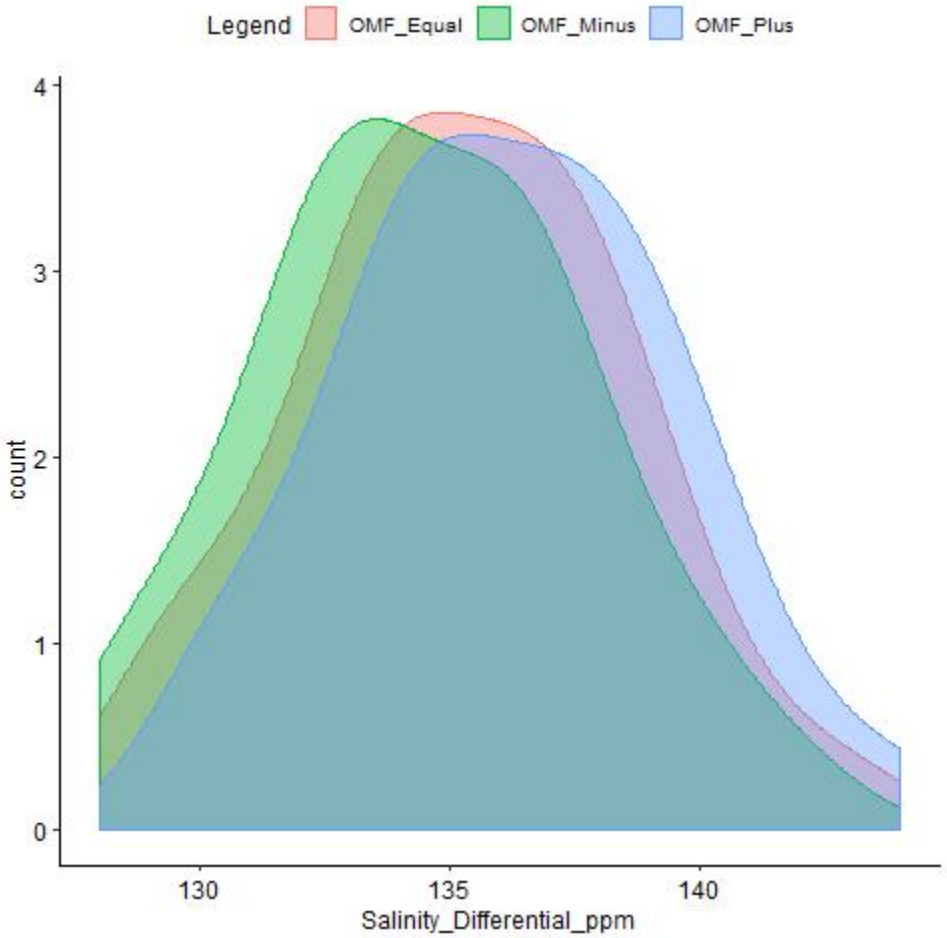


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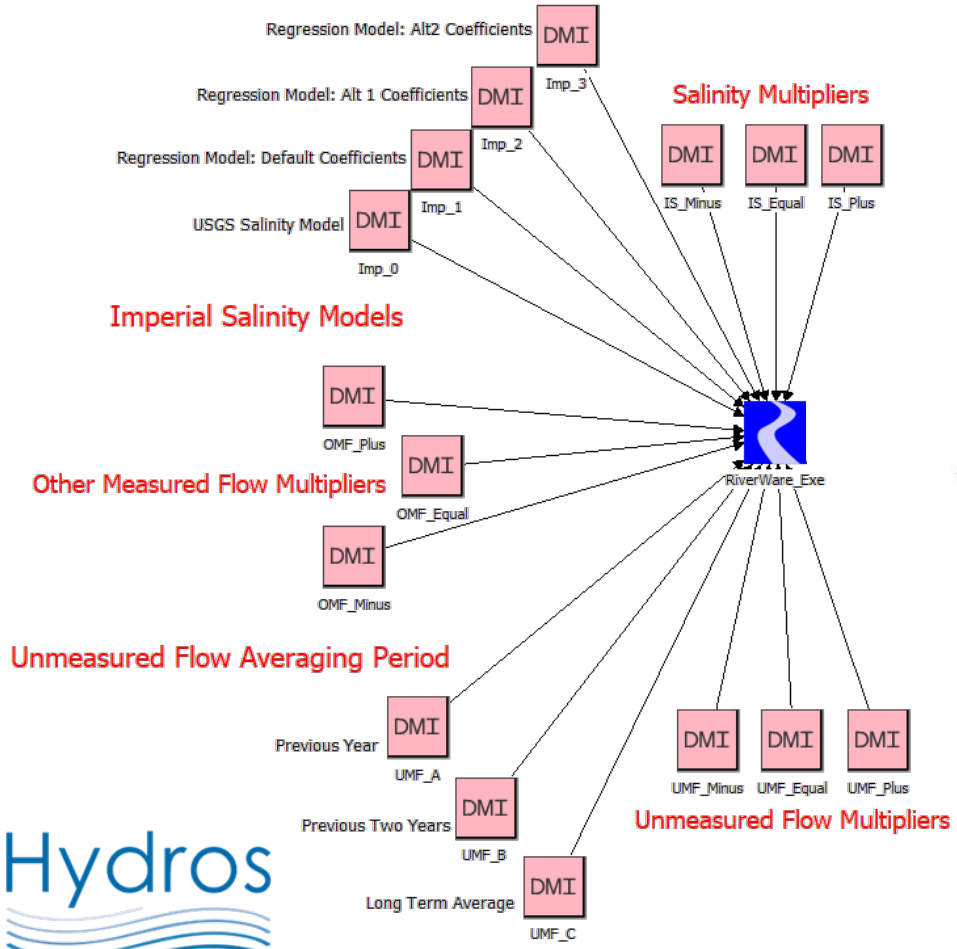


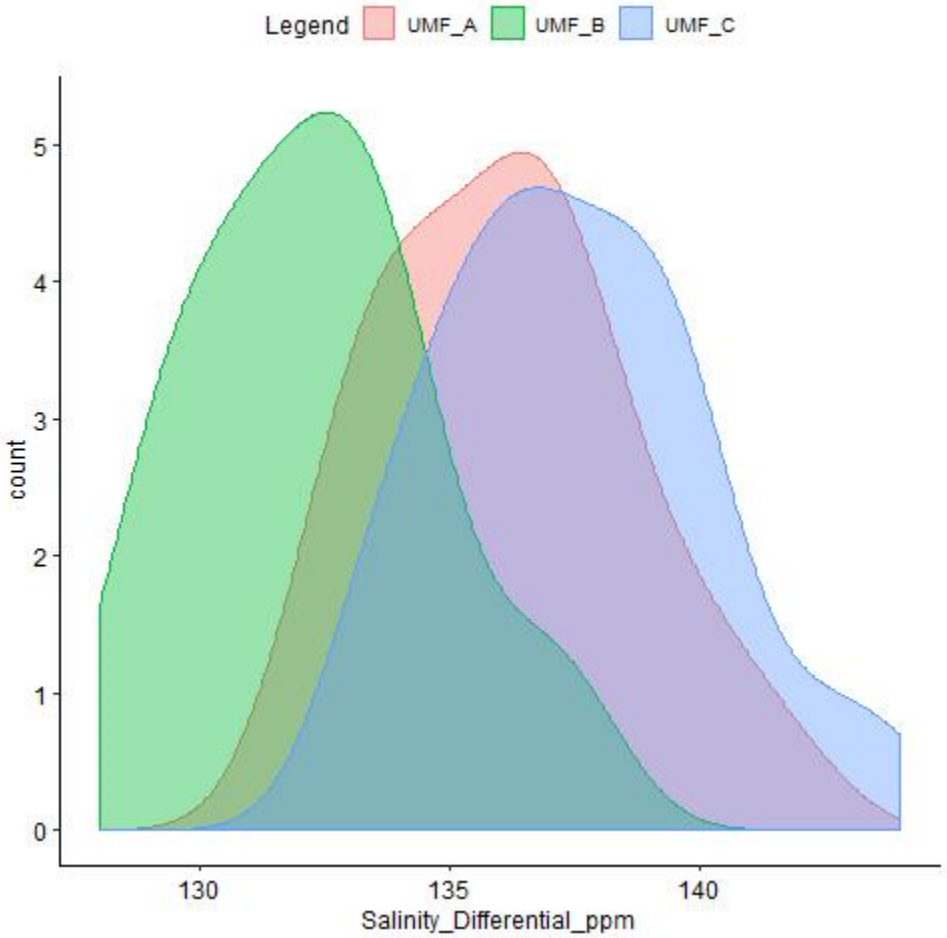


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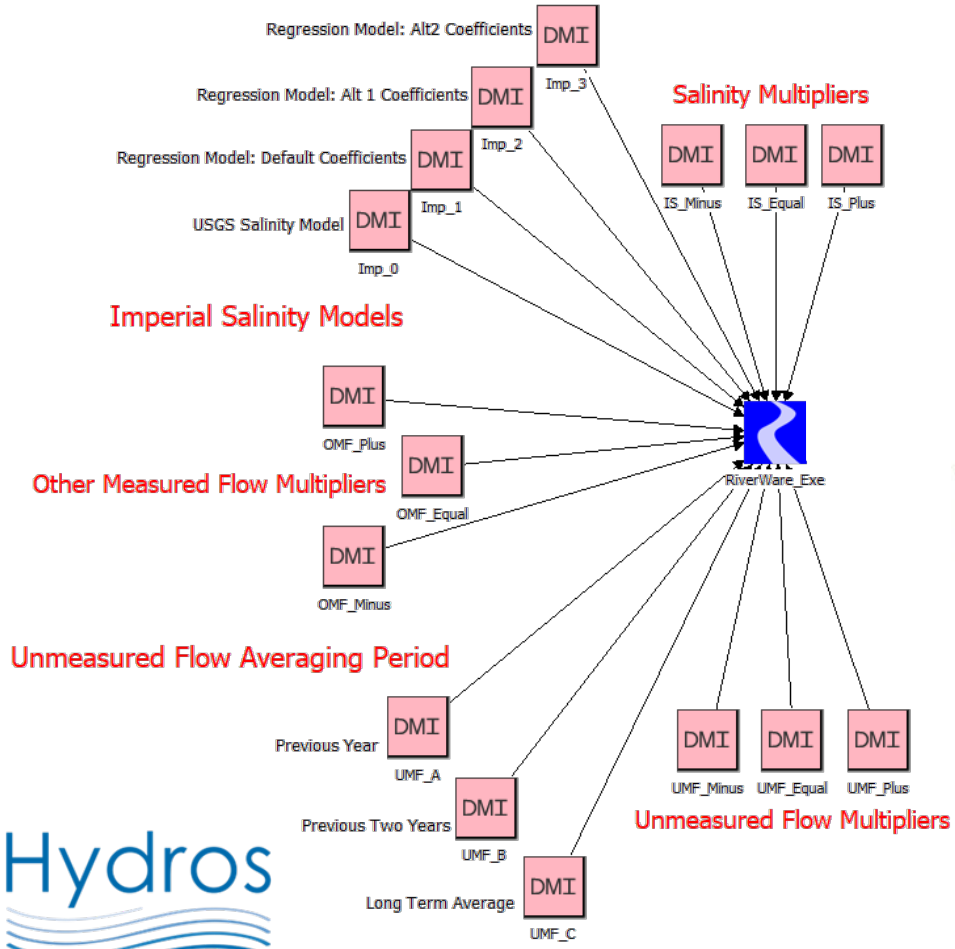


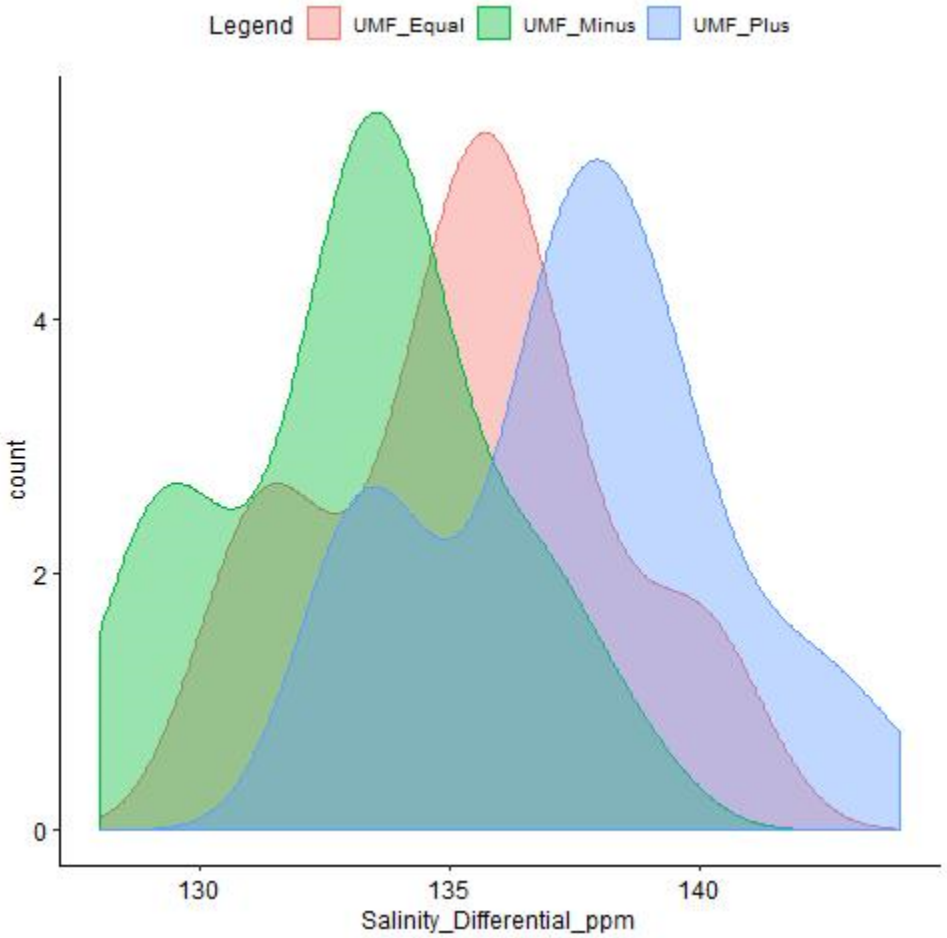


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# SUMMARY

- New feature, not yet incorporated into Yuma Area Office operations
- Looking forward to working with YAO Water Operations Staff to implement for 2020 projections

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# THANK YOU

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