BUREAU OF RECLAMATION

Old and Middle River Modeling

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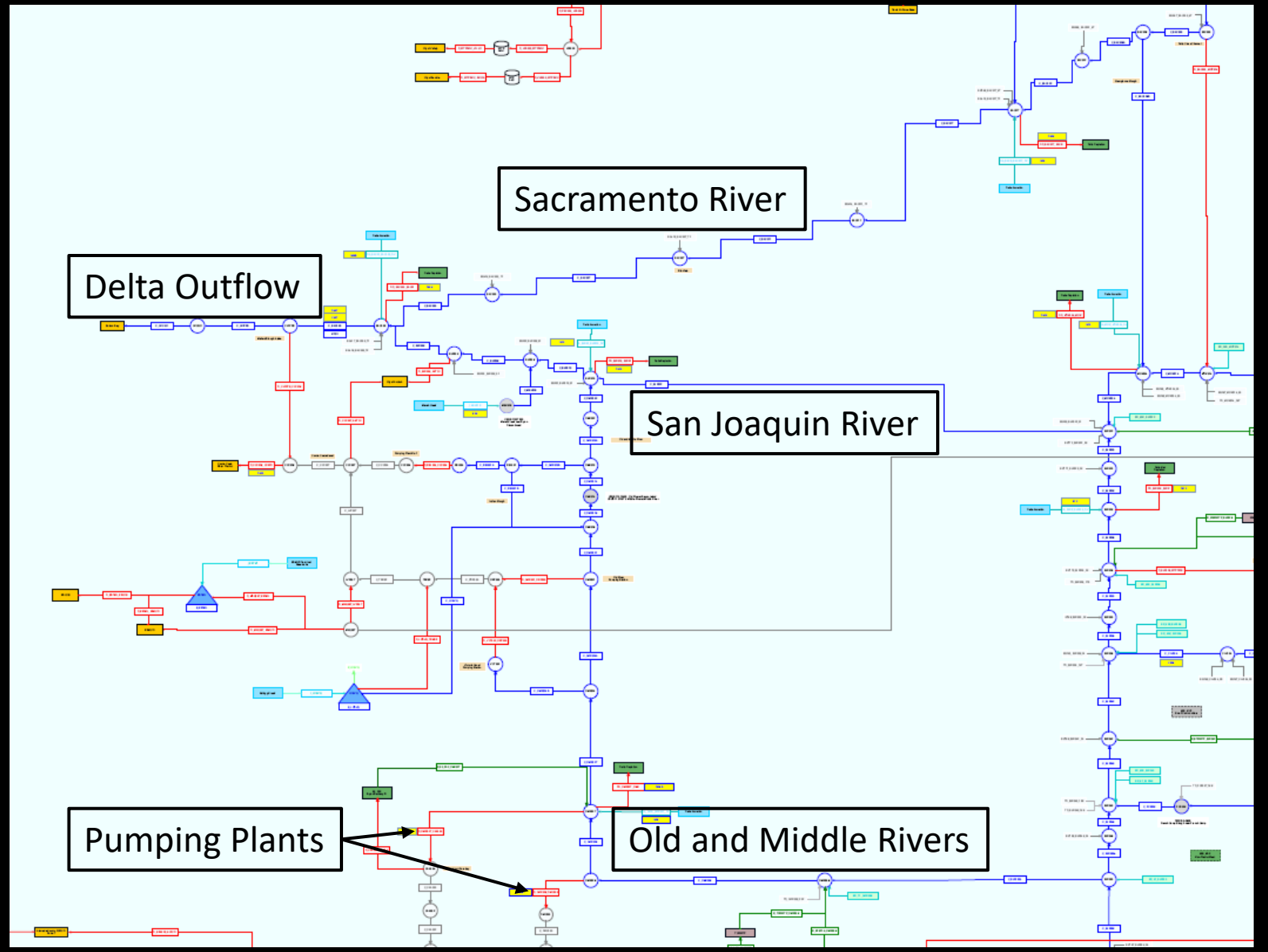
Overview

- Identify different types of models: real time and planning models
- Diagram showing integrated modeling for operations and actions (**Cameron)**
- OMR real time approach- distribution > future distribution, hydrodynamic and PTM modeling. How do we tie information together to make the decisions? **(Bryant)**
- OMR biological models (survival models, salvage and loss) (**Brian Mahardja)**
- What they are, how we use them, what goes into the model, what is predicted. How do we evaluate the action?

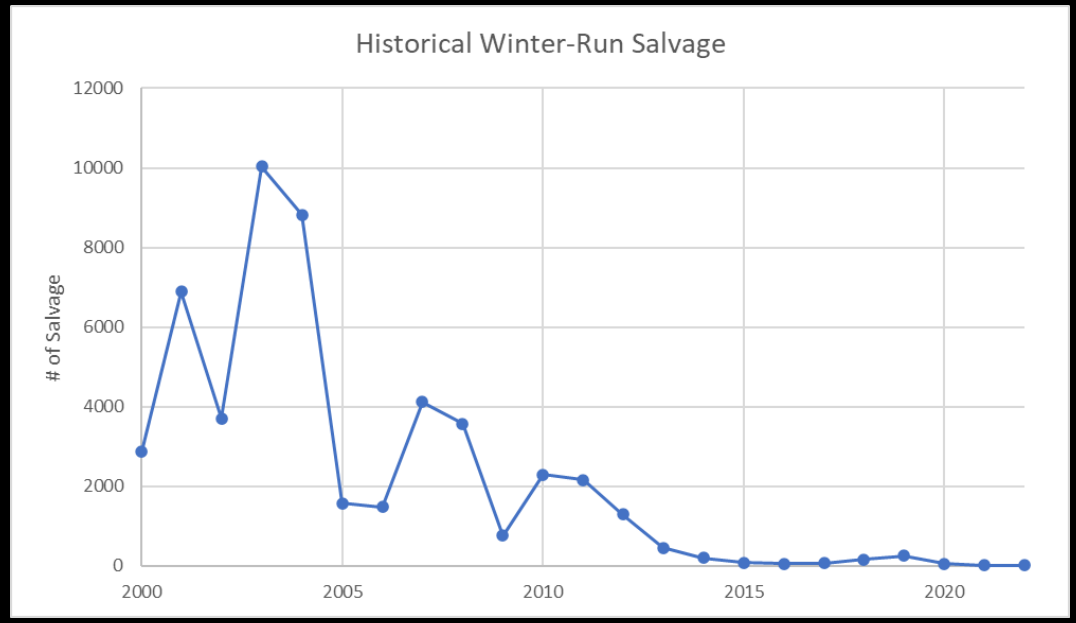
OMR in CalSim3 – Overview

- Planning level model
- Uses linear optimization and weights to replicate operational decision-making
- 100-year study period
- Uses historical or climate adjusted hydrologies from 1921 to 2021
- Monthly Timestep



OMR in CalSim3 – Modeling Challenges

- OMR actions happen as real-time adjustments
- Fish presence, salvage, or temperature are often triggers for OMR actions
- Limited historical dataset
  - 2009 BiOps to 2019 BiOps
  - 2019 BiOps to 2021 LTO
- Holes in the historical dataset
- Regulatory language left open-ended for operational flexibility



"...Reclamation and DWR may determine that OMR restrictions to manage turbidity are infeasible, and will instead implement an OMR target that is deemed protective, based on turbidity, adult Delta Smelt distribution and salvage, but not a more negative OMR than -5,000 cfs."

OMR in CalSim3 – 2019 BiOps/ITP Actions

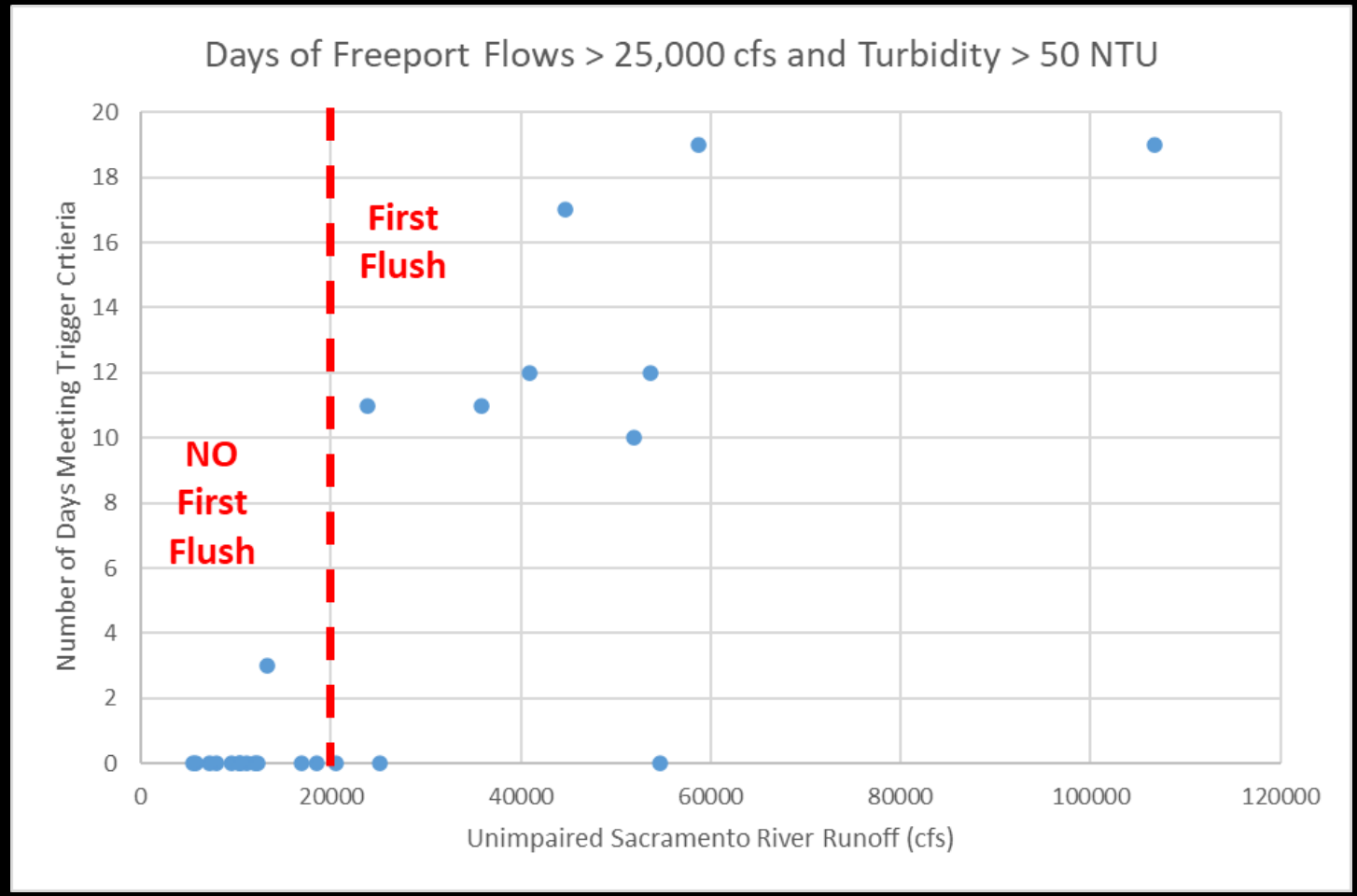
- First, attempt to correlate triggers to flow
- Then, look at the historical timing
- As a last resort, use categorical averages of the historical record

Correlated to Flow	Historical Timing	Historical Triggers
First Flush	Onset of OMR Management	Larval and Juvenile Delta Smelt Action
Onset of OMR Management	End of OMR Management	Salmonid Cumulative Loss Threshold
Turbidity Bridge Avoidance	Turbidity Bridge Avoidance Offramp	Salmonid Single-Year Loss Threshold
Storm-Flex		

OMR in CalSim3 – Correlation to Flow

First Flush:

- Running 3-day average of the daily flows at Freeport is greater than 25,000 cfs, and
- Running 3-day average of the daily turbidity at Freeport is 50 NTU or greater



OMR in CalSim3 – Historical Timing

End of OMR Management for Salmonids:

- when more than 95 percent of salmonids have migrated past Chipps Island, as determined by their monitoring working group, or
- after daily average water temperatures at Mossdale exceed 71.6°F for 7 days during June (the 7 days do not have to be consecutive).

	Mossdale		Salmonids 95% passage at Chipps Island		
Water Year	**First Date**	**Day 7**	**WR LAD**	**SR LAD**	**Steelhead**
2010	Data NA	Data NA	21-Apr	**14-May**	12-May
2011	24-Jun	Not Met	20-Apr	11-May	**13-May**
2012	1-Jun	14-Jun	27-Apr	**14-May**	13-Apr
2013	31-May	6-Jun	12-Apr	**17-May**	10-May
2014	24-May	2-Jun	9-Apr	8-May	**22-May**
2015	29-Apr	**5-May**	15-Apr	27-Apr	18-Feb
2016	30-May	**5-Jun**	8-Apr	2-May	30-Dec
2017	20-Jun	Not Met	27-Apr	15-May	**27-May**
2018	14-Jun	22-Jun	17-Apr	29-Apr	**14-May**
2019	6-Jul	15-Jul	21-Apr	10-May	**14-May**
2020	26-May	24-Jun	10-Apr	8-May	**22-May**
2021	28-May	**3-Jun**	25-Apr	10-May	17-Nov

OMR in CalSim3 – Historical Triggers

Single-Year Loss Threshold for Salmonids:

- Natural Winter-Run Chinook Salmon (loss = 1.17% of JPE)
- Hatchery Winter-Run Chinook Salmon (loss = 0.12% of JPE)
- Natural Central Valley Steelhead from December through March (Loss = 1,414)
- Natural Central Valley Steelhead from April through June 15 (loss = 1,552)

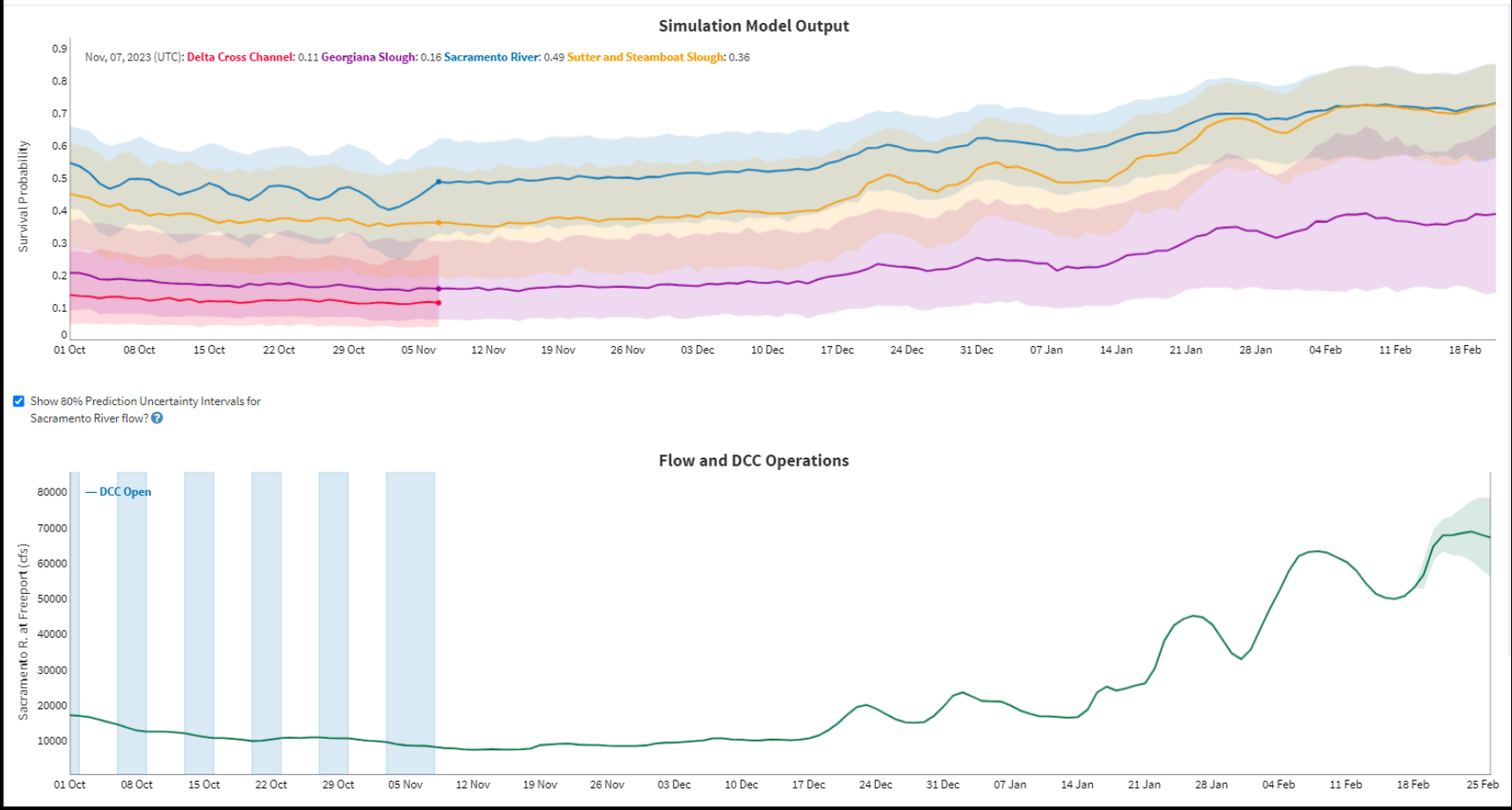
Sac River WYT	Count (2010 - 2021)	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg
Crtically Dry	4	0%	3%	25%	19%	13%
Dry	3	0%	12%	71%	56%	50%
Below Normal	4	0%	25%	100%	88%	81%
Above Normal	0	0%	35%	100%	77%	82%
Wet	3	0%	0%	100%	67%	83%

Biological Models used for real-time OMR operations

- STARS model (survival and routing of Chinook Salmon)
- Boosted Regression Trees for Steelhead and winter-run Chinook Salmon
- Machine Learning model for winter-run Chinook Salmon

Survival, Travel Time, and Routing Simulation (STARS; Perry et al. 2018, Hance et al. 2021) Model

- Predicts survival, travel time, and routing of juvenile salmon migrating through the Sacramento–San Joaquin River Delta



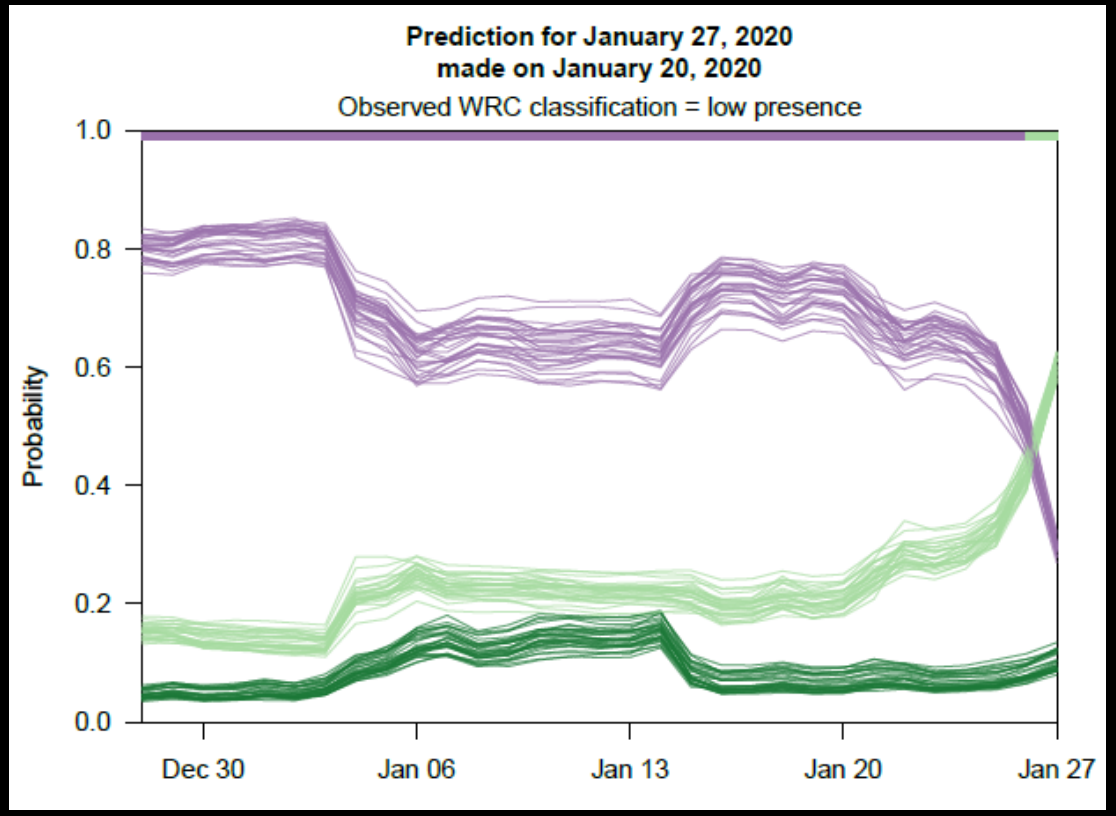
- https://oceanview.pfeg.noaa.gov/shiny/FED/CalFishTrack/
- https://www.cbr.washington.edu/shiny/STARS/
- Link to papers on website

Steelhead and Winter-run Loss and Salvage Predictor

- Boosted regression tree models (Tillotson et al. 2022)
- Provides a loss prediction one week in advance for winter-run and steelhead
- Winter-run prediction is for length-at-date winter-run (i.e., may not be true winter-run)
- https://www.cbr.washington.edu/sacramento/lossandsalvage/

Week	20	21
	Model	
Steelhead.Low	24	23
Steelhead.Median	**243**	**141**
Steelhead.High	527	284
Winter.Run.Low	17	5
Winter.Run.Median	**142**	**107**
Winter.Run.High	729	456
	Data	
Steelhead.Observed.loss	239	NA
Winter.Run.Observed.loss	97	NA
Steelhead.Cumulative.loss	889	889
Winter.Run.Cumulative.loss	661	661

Winter-run Chinook Salmon Machine Learning Model for predicting salvage



Model predicted probability over time. Lines represent the 30 model runs. Purple = absence, light green = low presence, dark green = high presence.

- Extreme gradient boosting with dropout additive regression trees
- Consists of 30 separate models
- Provide prediction of expanded salvage for the following week
- Categorical variables:
  - High Presence (>4.29 winter-run expanded salvage; median for non-zero values)
  - Low Presence(≤ 4.29 winter-run expanded salvage)
  - Absence (no salmon)
- Also predicts length-at-date winter run

For more information: Jereme Gaeta (jereme.gaeta@wildlife.ca.gov)

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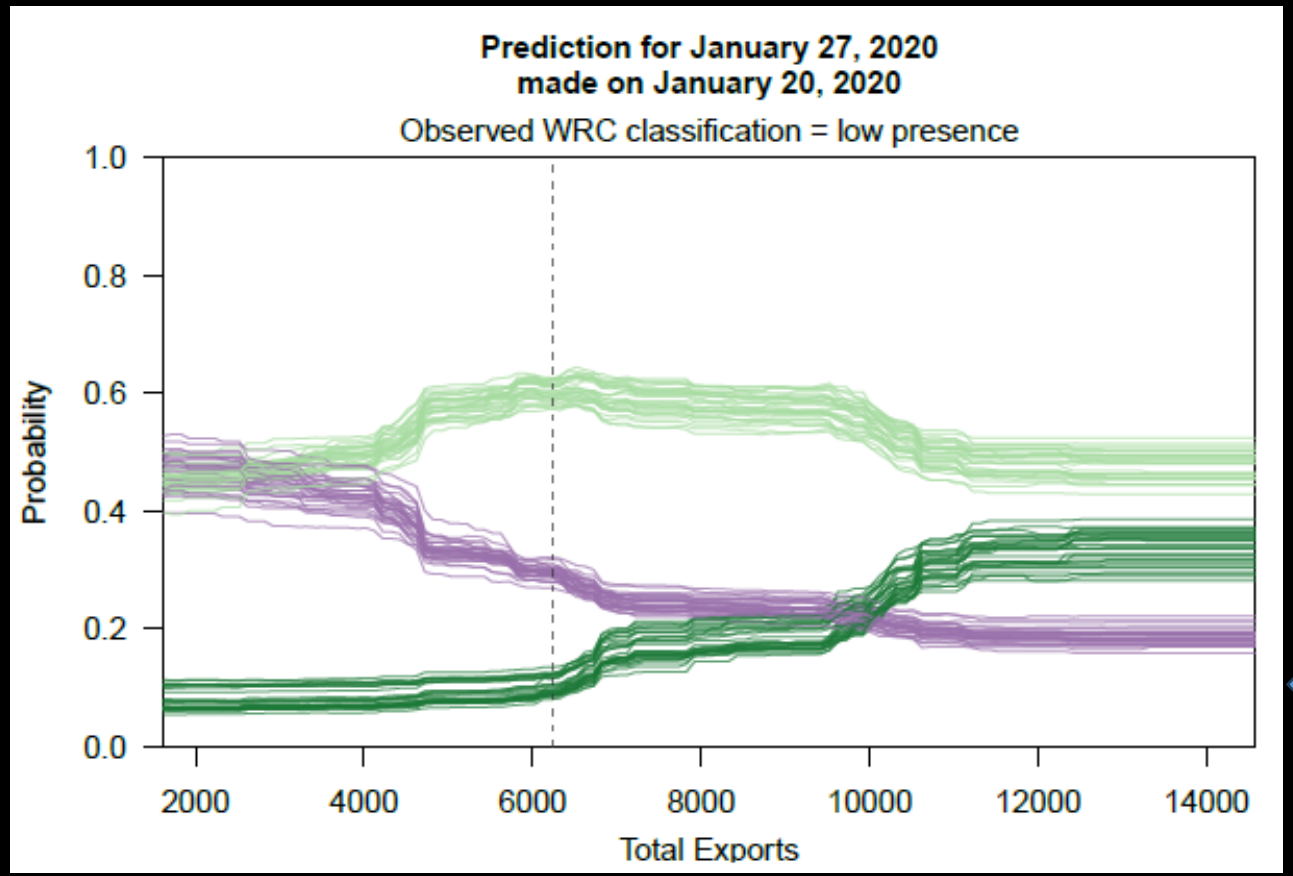

- Can evaluate effect of export on predictions
- Not online yet, but draft report available

Model predicted probability for the next week based on different Delta export values. Vertical dashed line indicate export value for the day of prediction. Purple = absence, light green = low presence, dark green = high presence.

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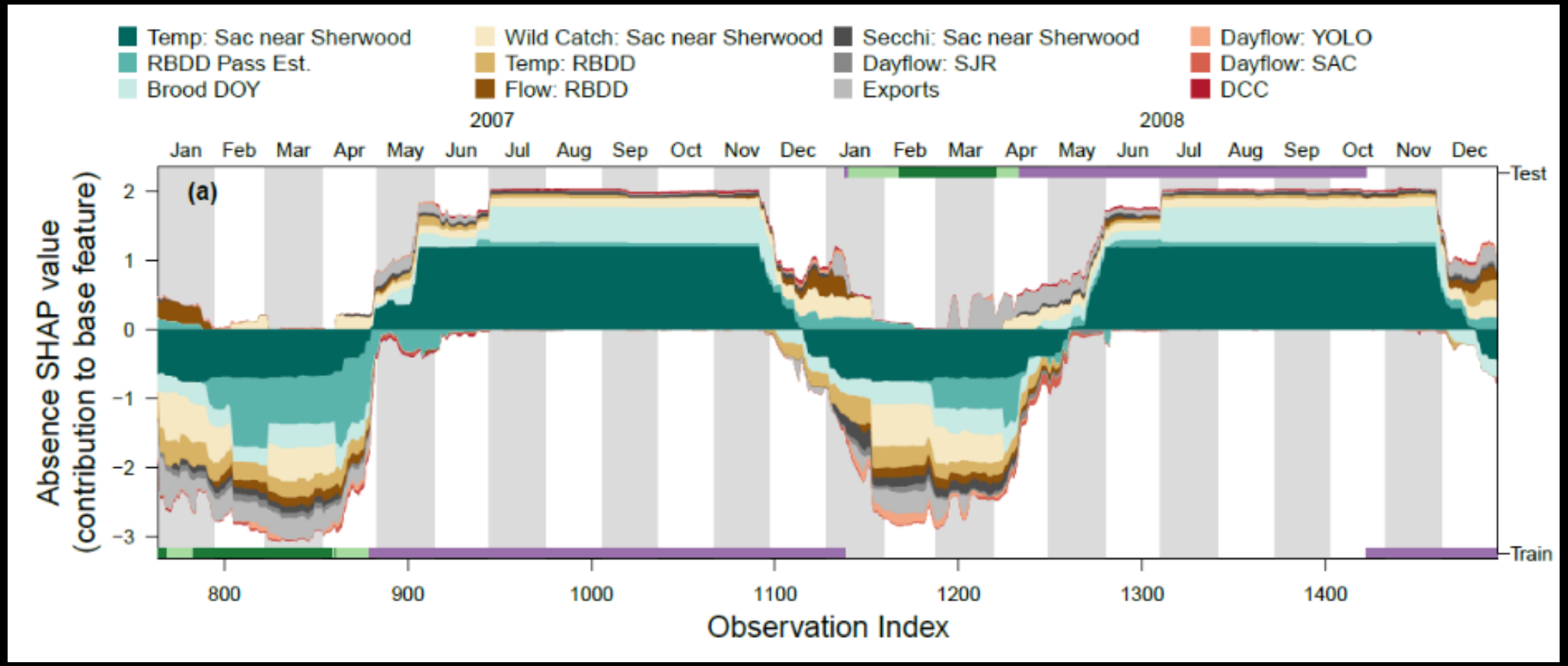
SHapley Additive exPlanations (SHAP) values

- Contribution of parameter towards a prediction



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