Steamboat Sloughs Guidance Structures Evaluation Using ECO-PTM

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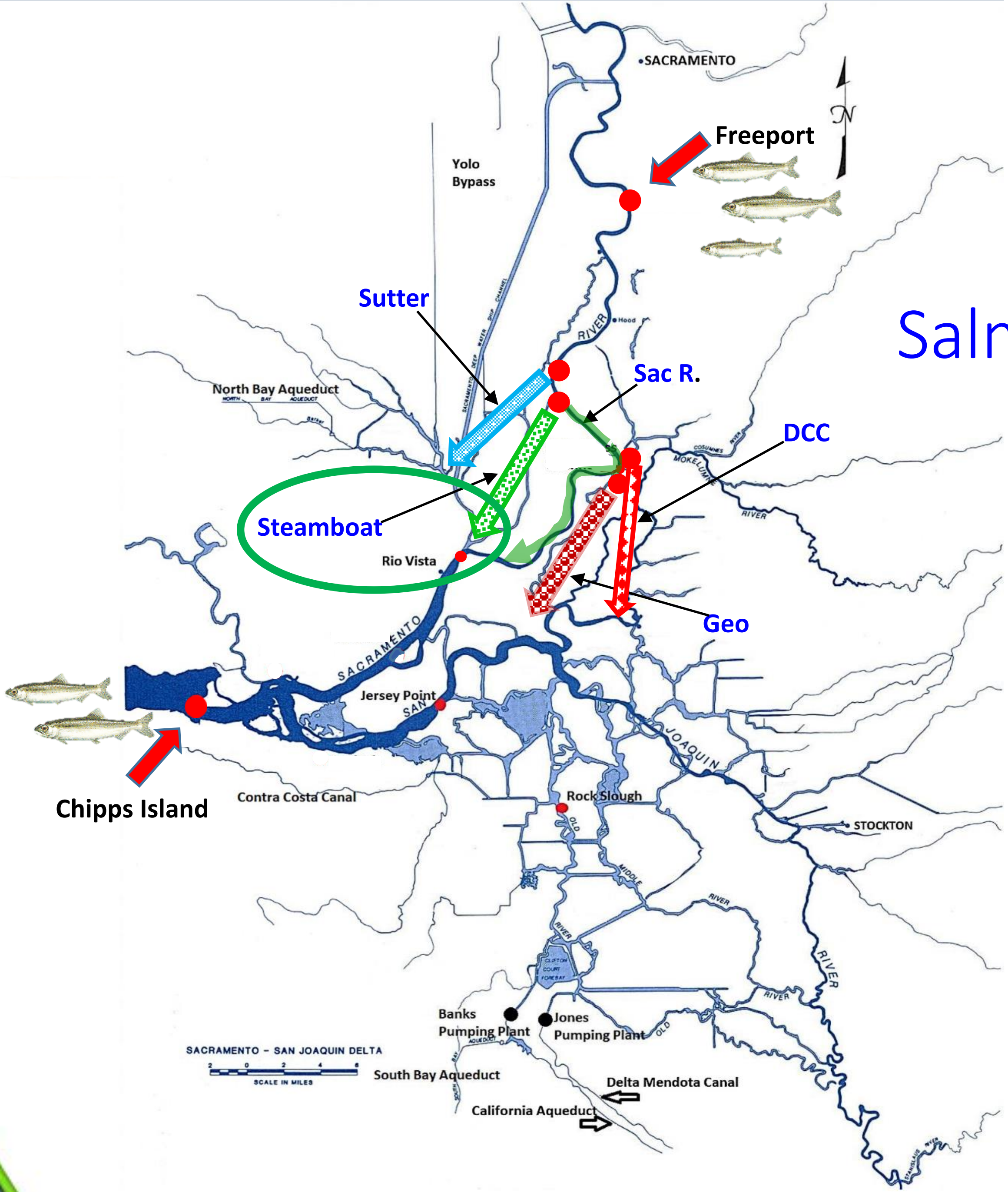
Salmon Migration Routes



STATE WATER PROJECT INCIDENTAL TAKE PERMIT CONDITION OF APPROVAL 8.9.2 (ITP COA 8.9.2)

Evaluate Benefits of Salmonid Guidance Structures at Sutter and Steamboat Sloughs.

Alternatives

Alternative 1

FFGS collector and deflector with a BAFF spanning between

- Full operability assuming the two FFGS can pivot away from the main channel and up against the bank (off mode).
- Highest expected routing efficiency

Alternative 2

FFGS deflector with a BAFF collector

- Full operability assuming FFGS can pivot away from the main channel and up against the bank and BAFF can be turned off.

Alternative 3

BAFF collector

- Full operability as BAFF can be turned off.

FFGS (Floating Fish Guidance Structure)
BAFF (Bio-Acoustic Fish Fence)
Rock Groin

Alternatives

Alternative 4

FFGS deflector

- Full operability assuming FFGS can pivot away from the main channel and up against the bank (off mode).

Alternative 5

Rock groin collector

- Limited to no operability due to the costs and disruption of deployment and removal.

Alternative 6

Rock groin deflector upstream

FFGS (Floating Fish Guidance Structure)
BAFF (Bio-Acoustic Fish Fence)
Rock Groin

Fish Routing (Guidance) and Survival – Analytical Tool Process Sequence

Bay-Delta SCHISM
3D Hydrodynamics and Transport

Eulerian-Lagrangian-agent Method / Evaluating Likely Animal Movement (ELAM)
Engineer Research and Development Center (ERDC)

Ecological Particle Tracking Model (ECO-PTM)
Ecological Particle Tracking Model (ECO-PTM), an individual-based juvenile salmonid migration and survival model

- Simulate changes in hydrodynamic conditions for each alternative

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- Predict fish response to guidance structures (physical and behavioral); net change in routing for alternatives

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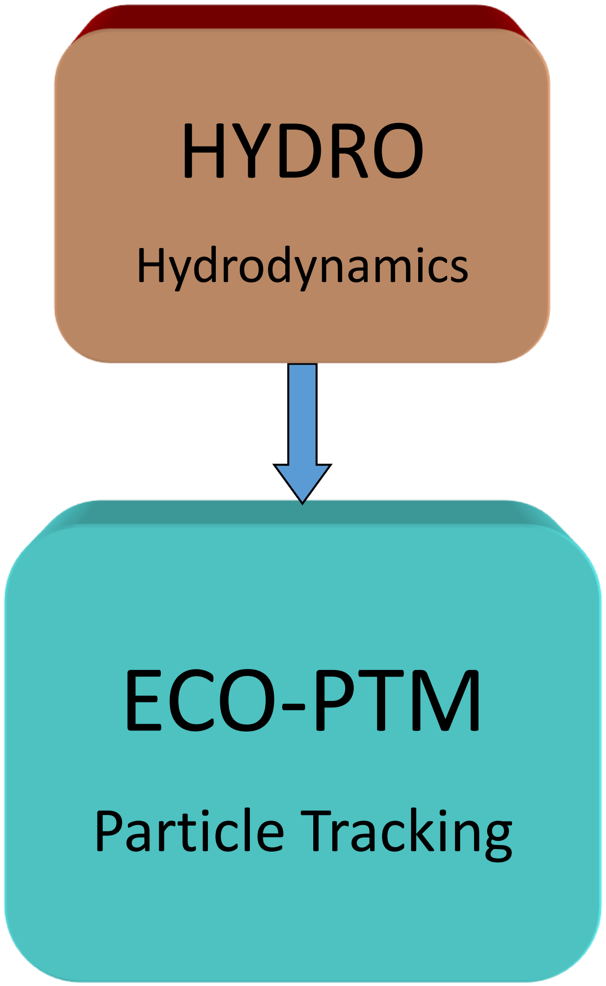
- Predict net change in juvenile salmonid survival though different pathways associated with changes in routing

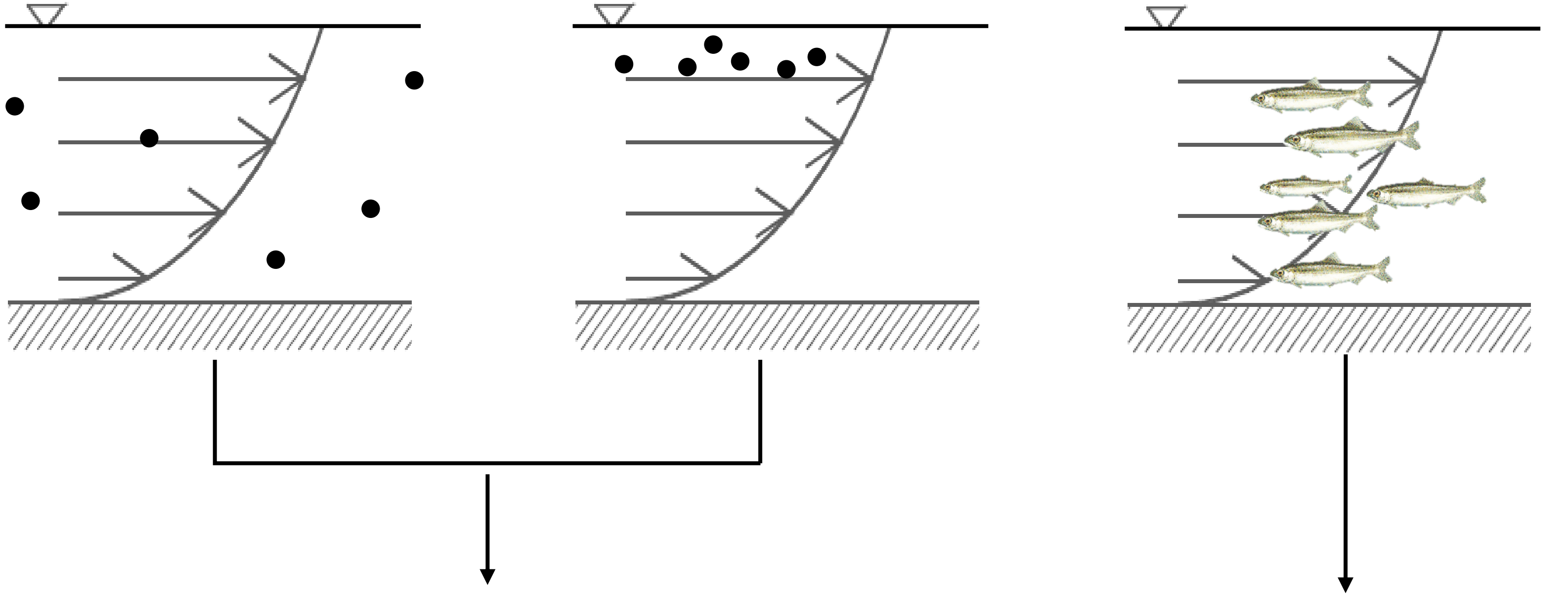
ECO-PTM Overview



ECO-PTM Overview

Type of particles:

Neutrally Buoyant | Position Oriented | Juvenile Salmon



Particle Flux

Fish Survival Rate

ECO-PTM: Salmon Particles

Swimming behavior parameters:

- Swimming velocity
  - ✓ Group mean/SD
  - ✓ Individual mean/SD
  - ✓ Individual instantaneous
- Holding
  - ✓ Flood (STST)
  - ✓ Diel
- Confusion
  - ✓ Flow field Signal/noise

ECO-PTM: Salmon Particles

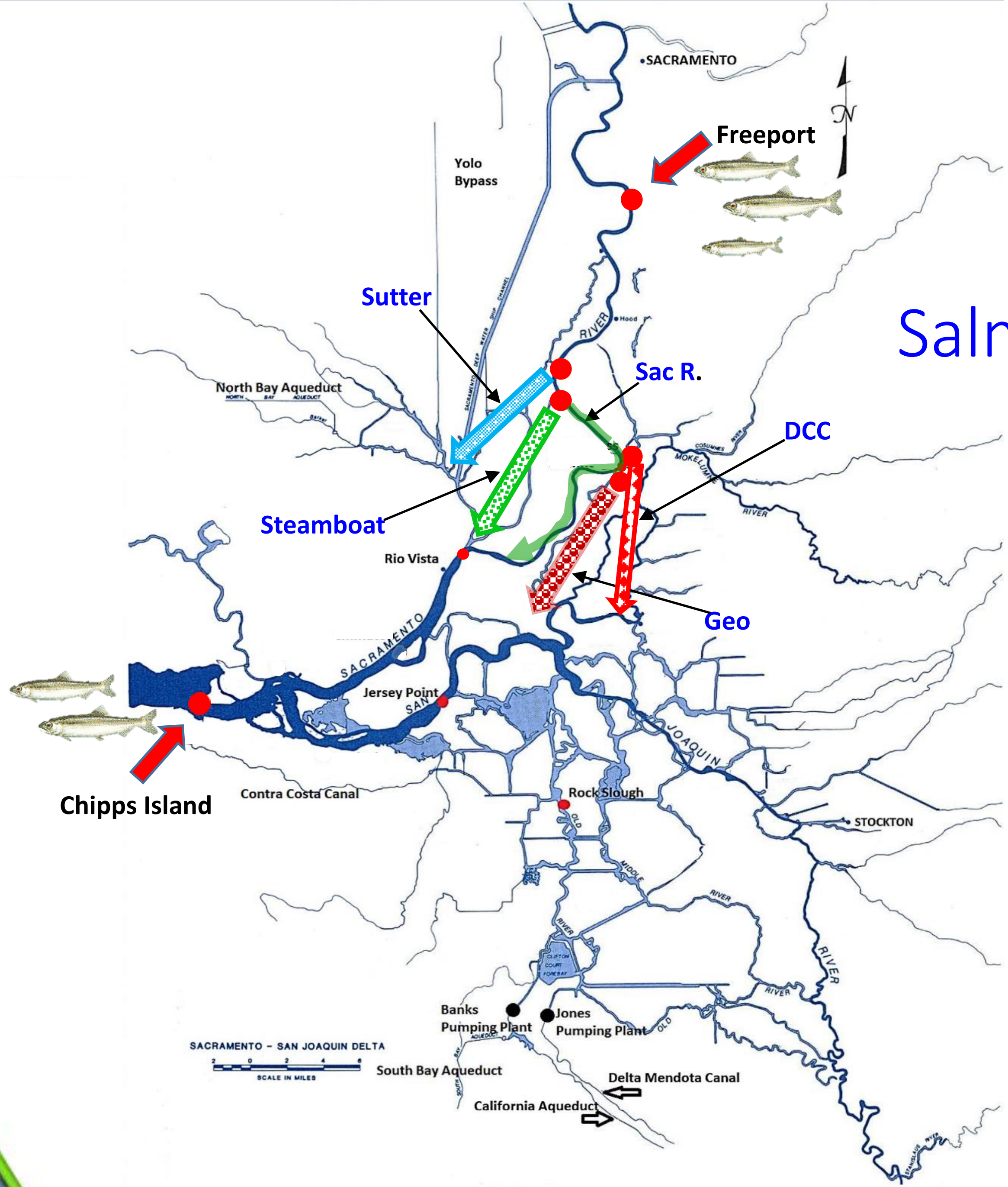
<u>Individual particle routing probability:</u>

- Individual particle routing probability
  - ✓ GLM at 4 junctions:
    Sutter, Steamboat, DCC, GEO
  - ✓ Flow Split

<u>Individual particle survival probability:</u>

- Survival
  - ✓ XT model
  - ➡ Individual survival probability

Salmon Migration Routes



ECO-PTM - Sample of ECO-PTM Simulation Output

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Insertion Date	Scenario	SUT_RATIO	STM_RATIO	SACR_SS_RATIO	SACR_GEO_RATIO	GEO_RATIO	DCC_RATIO	**SUT_SUV**	**STM_SUV**	**SAC_SUV**	**GEO_SUV**	**DCC_SUV**	**Combined_SUV**
2	1/1/2011	stm_3_sP	0.26	0.31	0.43	0.83	0.17		0.61	0.71	0.68	0.42		0.65
3	1/2/2011	stm_3_sP	0.27	0.30	0.43	0.83	0.17		0.61	0.70	0.67	0.35		0.64
4	1/3/2011	stm_3_sP	0.26	0.30	0.44	0.84	0.16		0.59	0.68	0.65	0.31		0.62
5	1/4/2011	stm_3_sP	0.26	0.29	0.45	0.83	0.17		0.59	0.69	0.66	0.33		0.62
6	1/5/2011	stm_3_sP	0.25	0.28	0.47	0.83	0.17		0.57	0.66	0.64	0.32		0.60
7	1/6/2011	stm_3_sP	0.22	0.28	0.50	0.83	0.17		0.52	0.64	0.60	0.30		0.57
8	1/7/2011	stm_3_sP	0.21	0.26	0.52	0.82	0.18		0.52	0.61	0.59	0.32		0.55
9	1/8/2011	stm_3_sP	0.20	0.25	0.55	0.83	0.17		0.47	0.58	0.56	0.29		0.52
10	1/9/2011	stm_3_sP	0.19	0.25	0.56	0.83	0.17		0.47	0.58	0.56	0.25		0.52
11	1/10/2011	stm_3_sP	0.18	0.24	0.58	0.82	0.18		0.44	0.57	0.55	0.28		0.51
12	1/11/2011	stm_3_sP	0.17	0.23	0.60	0.83	0.17		0.44	0.57	0.55	0.24		0.50
13	1/12/2011	stm_3_sP	0.18	0.23	0.60	0.83	0.17		0.45	0.56	0.55	0.31		0.51
14	1/13/2011	stm_3_sP	0.17	0.22	0.61	0.83	0.17		0.51	0.63	0.60	0.28		0.55
15	1/14/2011	stm_3_sP	0.17	0.22	0.61	0.83	0.17		0.50	0.61	0.58	0.24		0.54
16	1/15/2011	stm_3_sP	0.17	0.21	0.62	0.82	0.18		0.51	0.62	0.58	0.29		0.55
17	1/16/2011	stm_3_sP	0.17	0.21	0.62	0.81	0.19		0.55	0.61	0.57	0.23		0.54
18	1/17/2011	stm_3_sP	0.17	0.21	0.62	0.80	0.20		0.52	0.61	0.55	0.22		0.52
19	1/18/2011	stm_3_sP	0.16	0.20	0.64	0.80	0.20		0.49	0.59	0.52	0.28		0.50
20	1/19/2011	stm_3_sP	0.15	0.20	0.65	0.78	0.22		0.50	0.57	0.50	0.26		0.48

ECO-PTM – Scenarios for SS Fish Guidance Structures

- ELAM model predictions (% change in routing) applied to ECO-PTM scenarios to determine subsequent change in survival with different migration pathway
- Results show negligible difference in entrainment for Alts 2, 3, 4, and 6

Scenario / Alt	SS Routing Increase from ELAM	SS Routing Increase Used in ECO-PTM*
Baseline	NA	NA
1	4.6 %	5%
2	0.3 %	0% -- Baseline
3	-0.1 %	0% -- Baseline
4	0.2 %	0% -- Baseline
5a	3.4 %	3%
5c	3.3 %	3%
6a	0.3 %	0% -- Baseline
6c	0.2 %	0% -- Baseline

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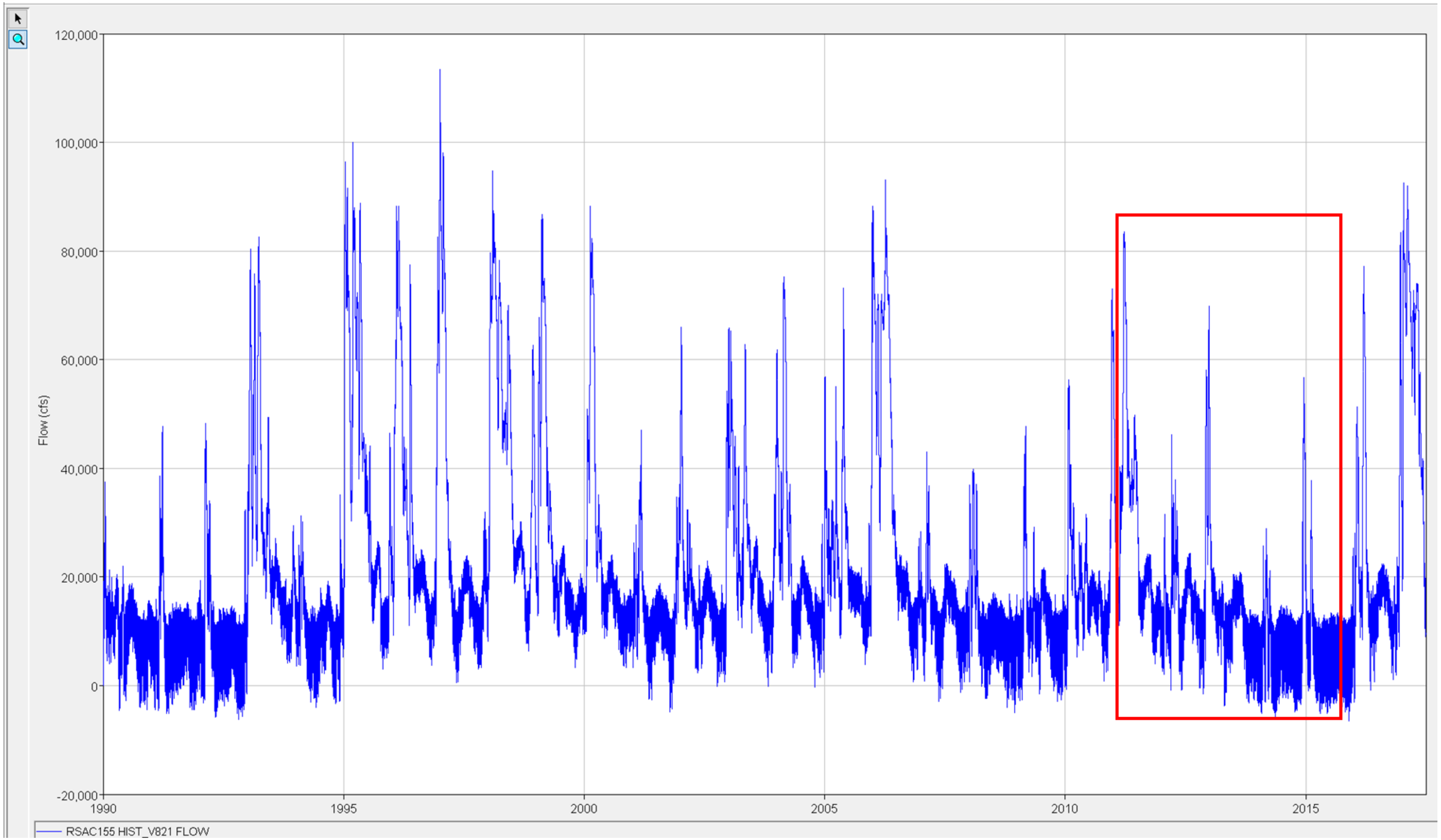
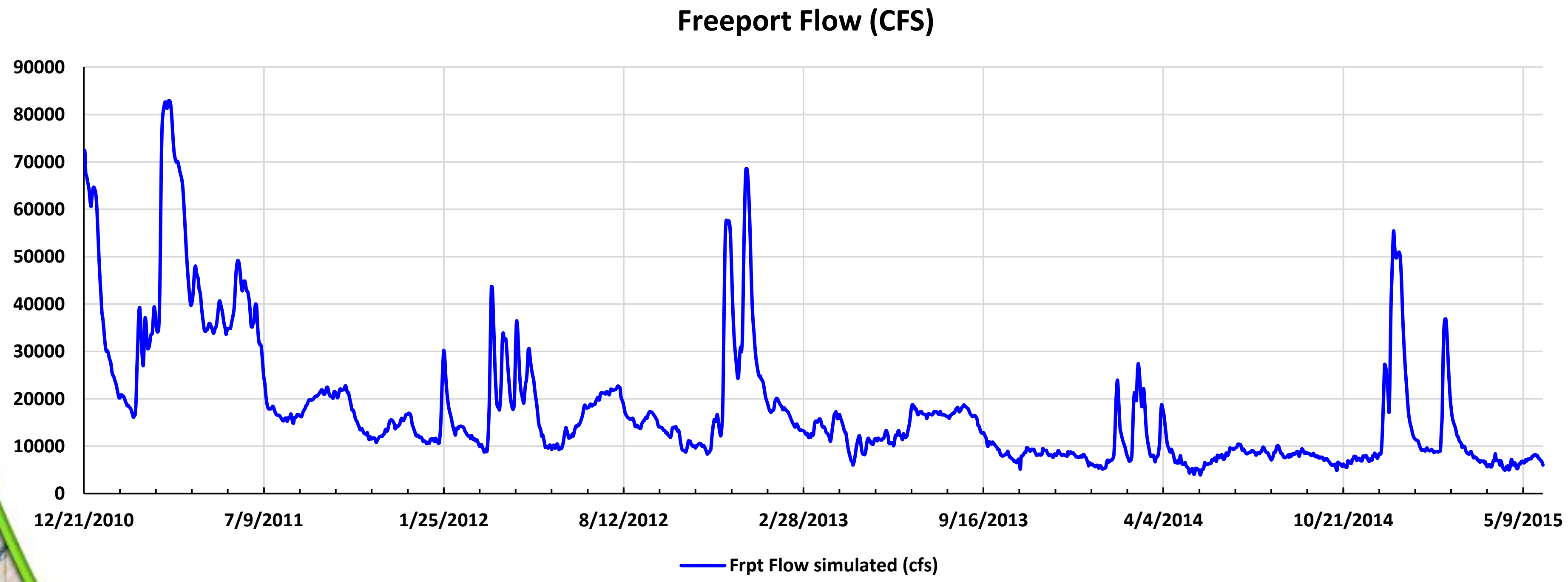
6a		
6c		

ECO-PTM - DSM2 HYDRO Historical Simulation 1990-2017, Flow @ Freeport

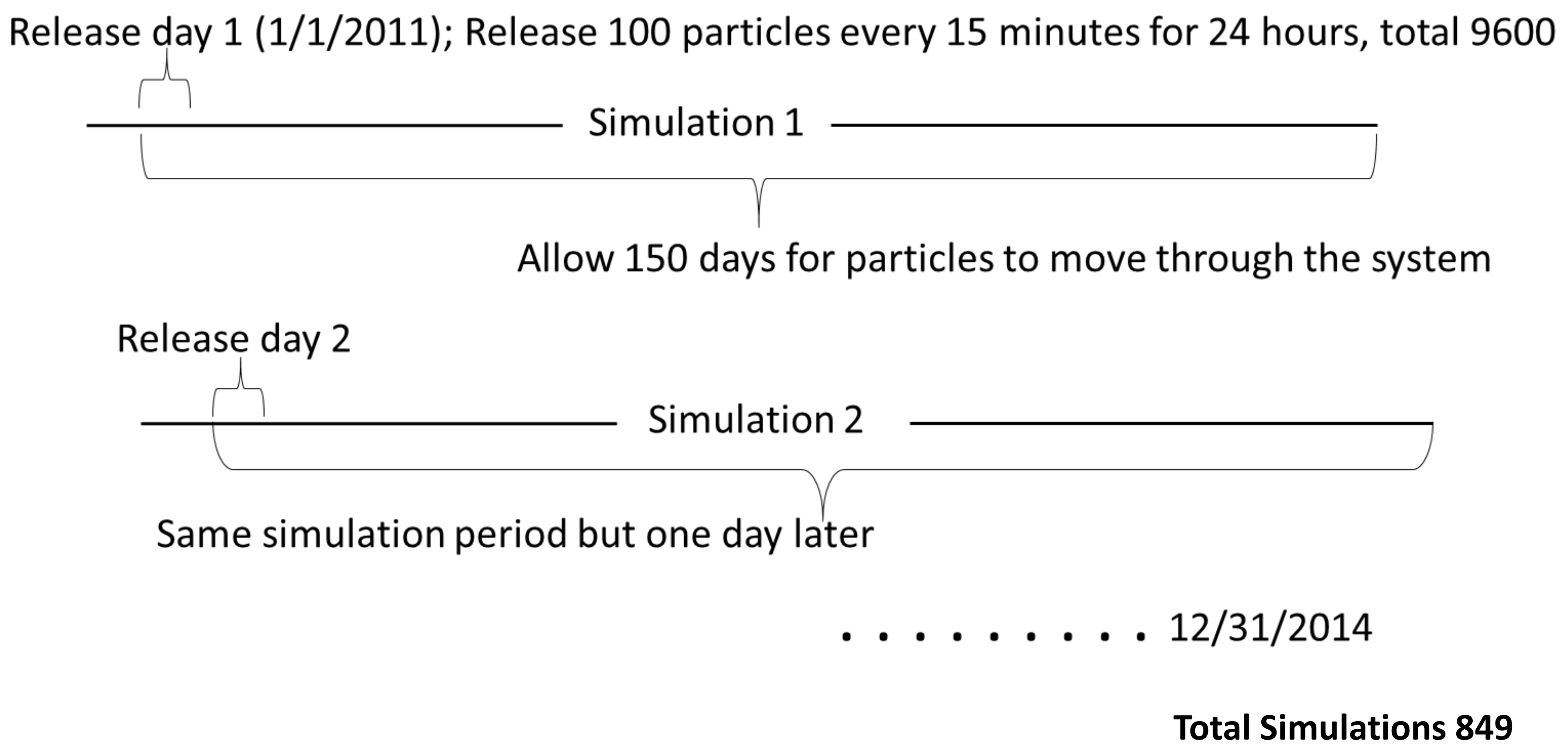


ECO-PTM – Simulation Period and Flow Condition

- Particle Insertion Period: 1/1/2011 – 12/31/2014
- Migration Months: November -- May



ECO-PTM Simulations



ECO-PTM - Sample of ECO-PTM Simulation Output

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
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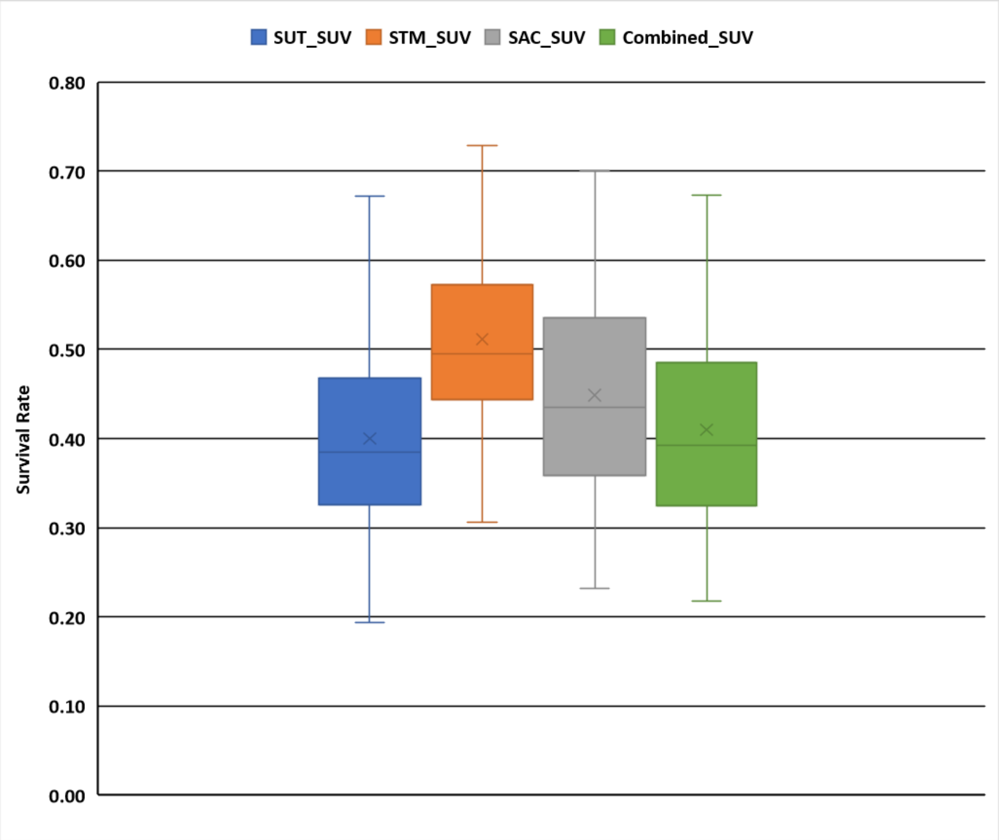
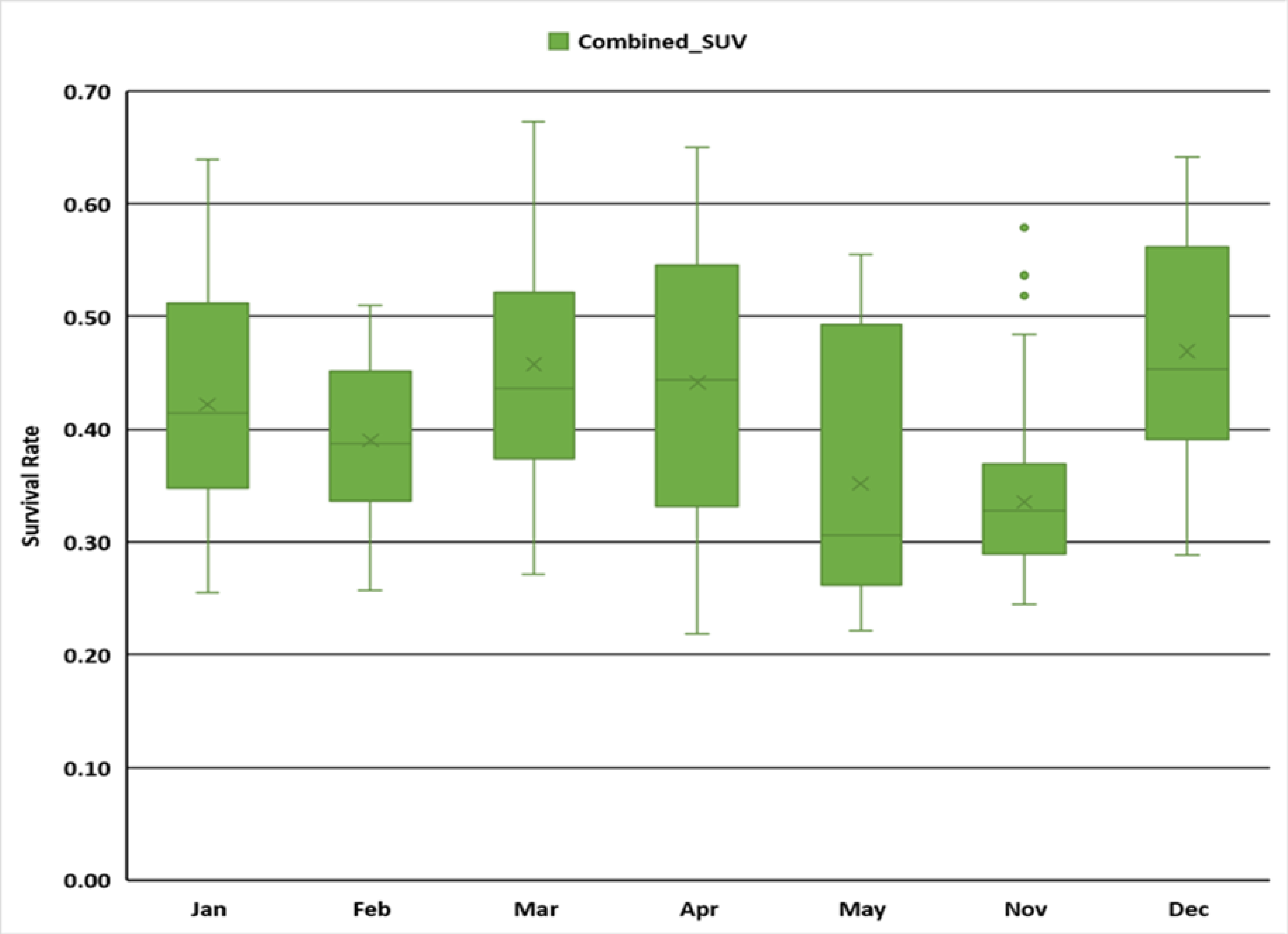
20	1/19/2011	stm_3_sP	0.15	0.20	0.65	0.78	0.22		0.50	0.57	0.50	0.26		0.48

ECO-PTM – Baseline Survival Rates for Various Routes



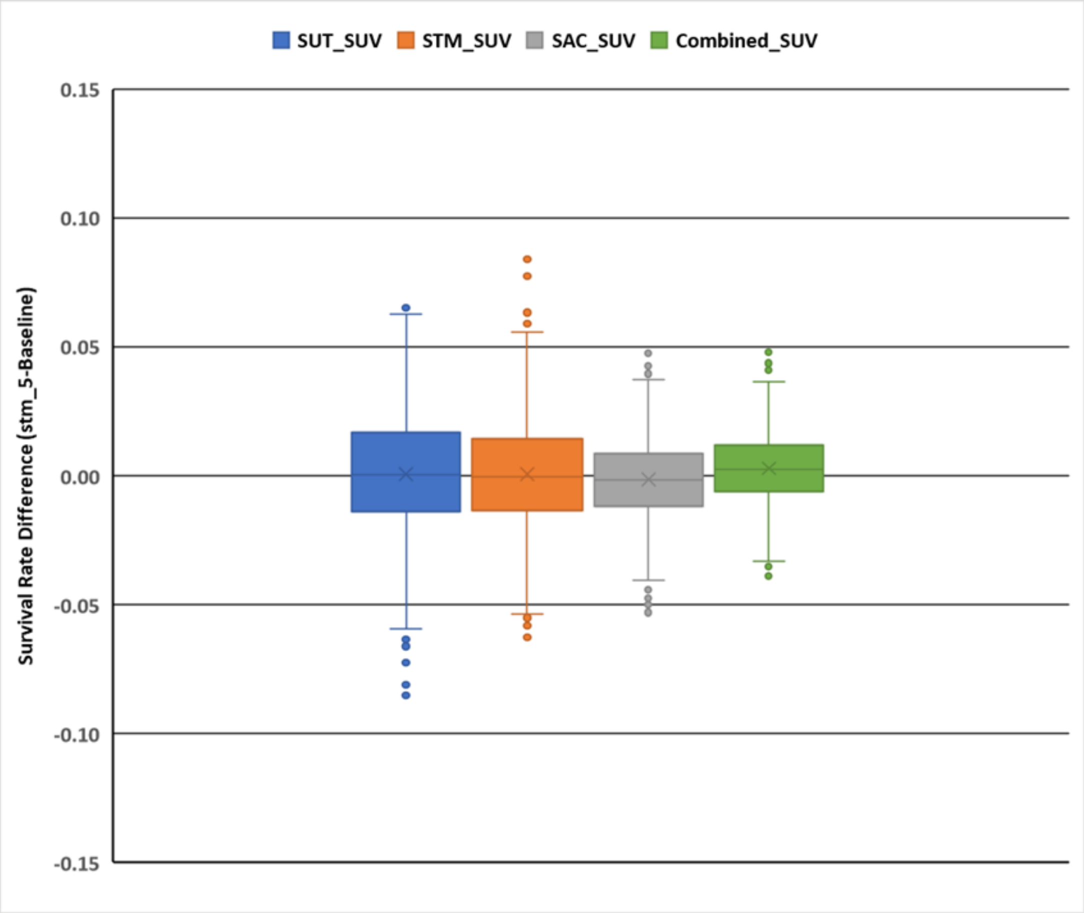
	SUT_RATIO	STM_RATIO	SACR_SS_RATIO	SUT_SUV	STM_SUV	SAC_SUV	GEO_SUV	Combined_SUV
Median	0.11	0.10	0.79	0.39	0.49	0.44	0.21	0.39
Mean	0.13	0.13	0.74	0.40	0.51	0.45	0.22	0.41

ECO-PTM – Baseline Combined Survival Rates for Different Months

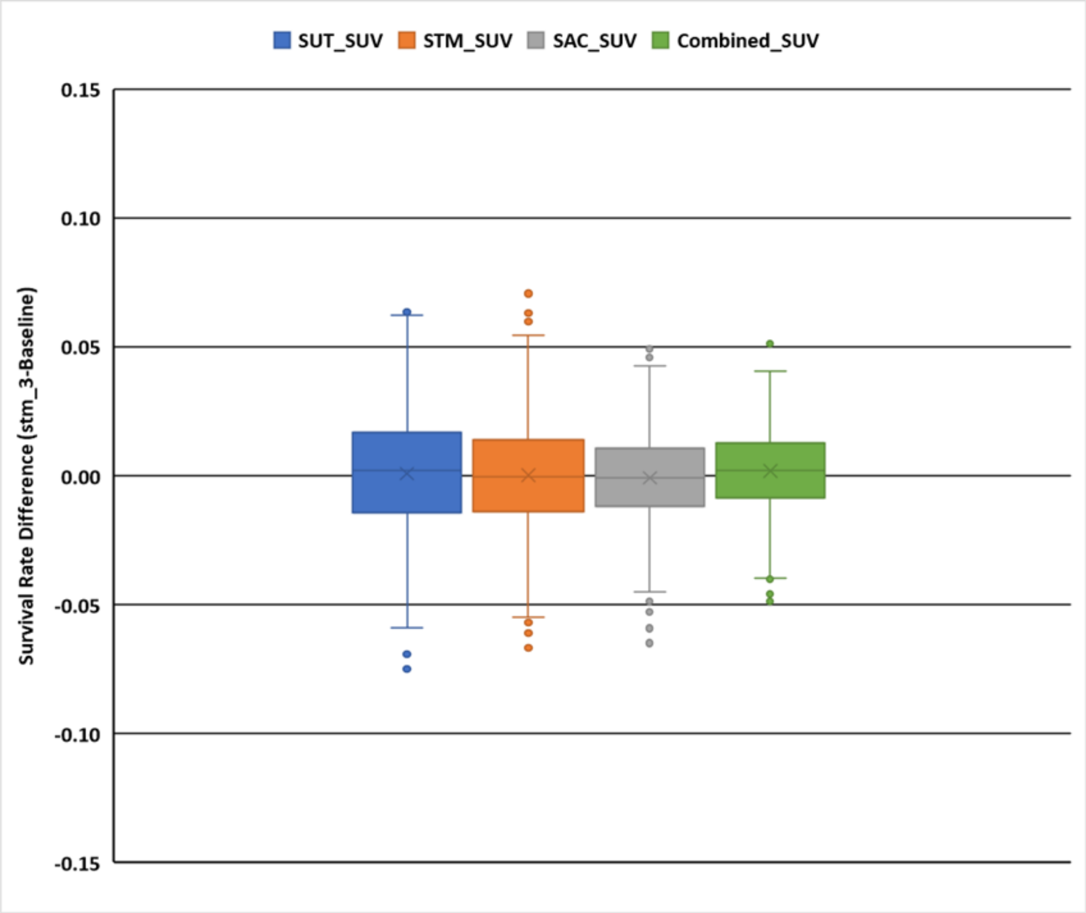


	Jan	Feb	Mar	Apr	May	Nov	Dec	All
Median	0.41	0.39	0.44	0.44	0.31	0.33	0.45	0.39
Mean	0.42	0.39	0.46	0.44	0.35	0.34	0.47	0.41

ECO-PTM – Survival Rate Difference for Various Scenarios

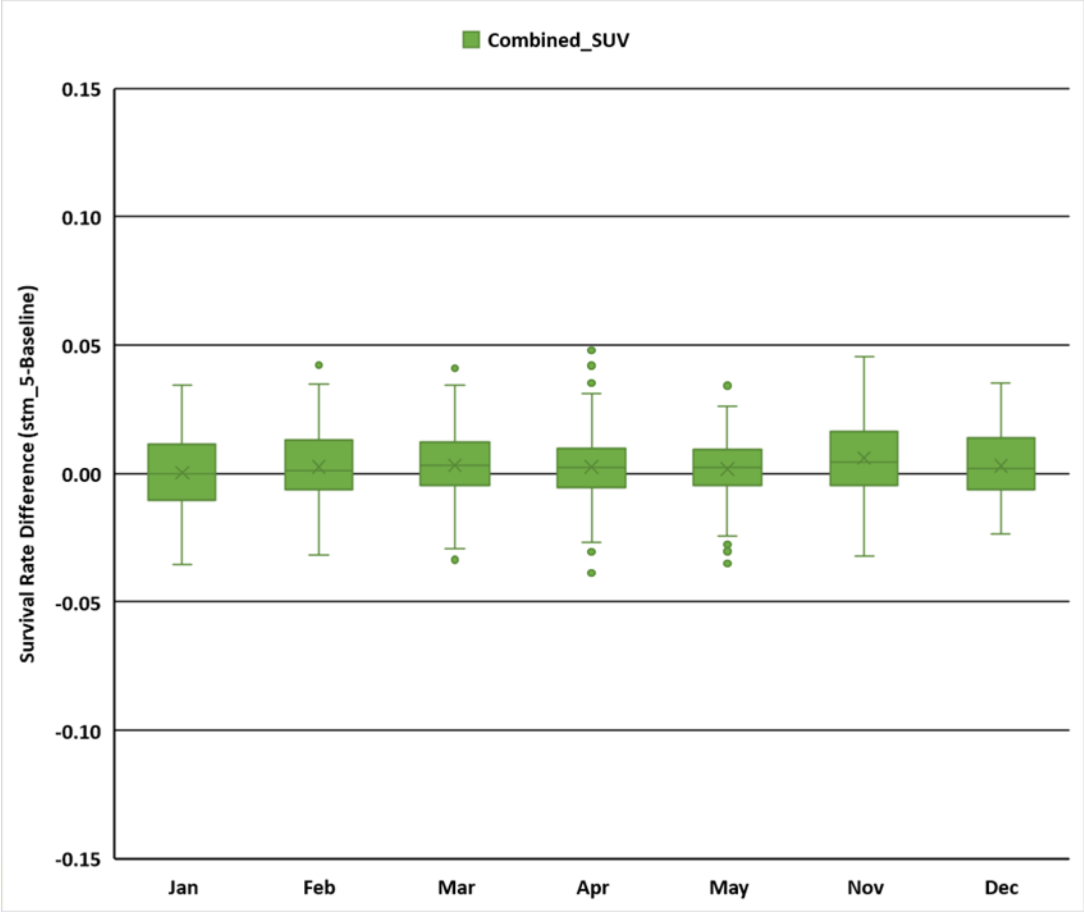


Scenario 1: 5% Entrainment Increase

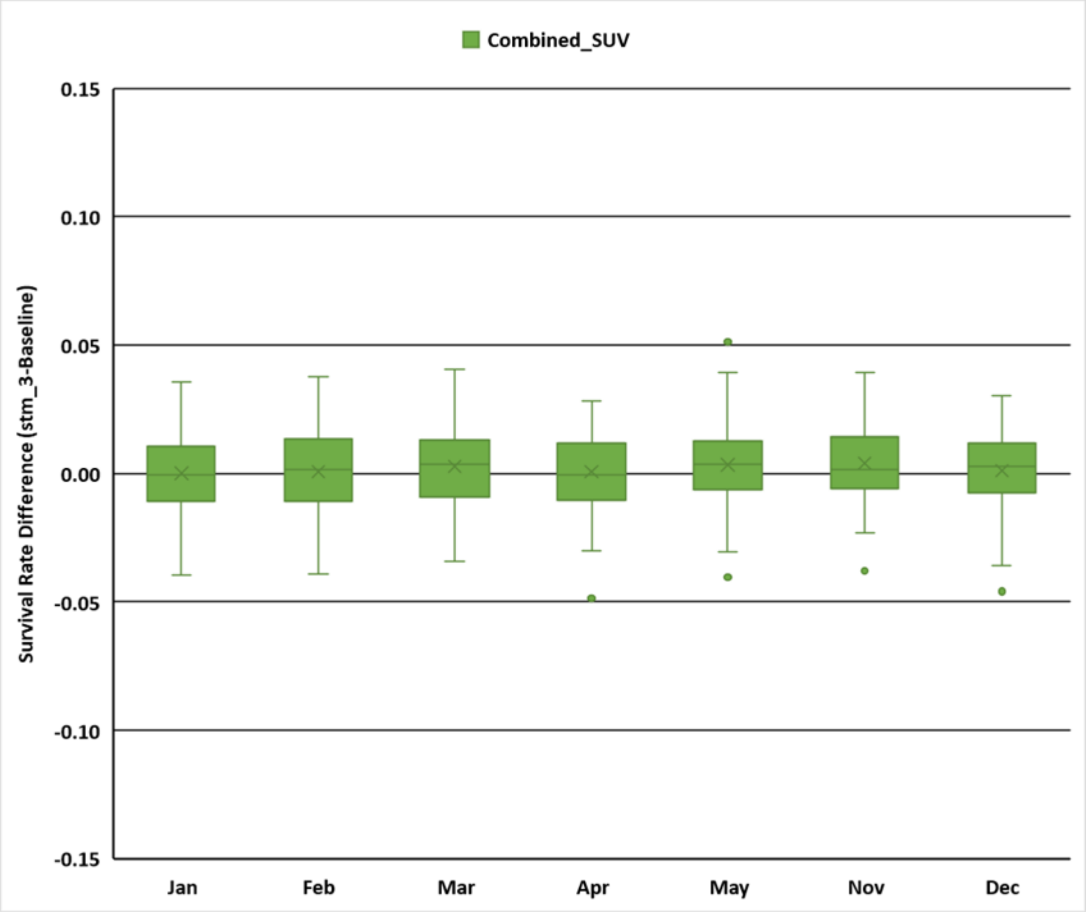


Scenario 5: 3% Entrainment Increase

ECO-PTM – Survival Rate Difference for Different Months



Scenario 1: 5% Entrainment Increase



Scenario 5: 3% Entrainment Increase

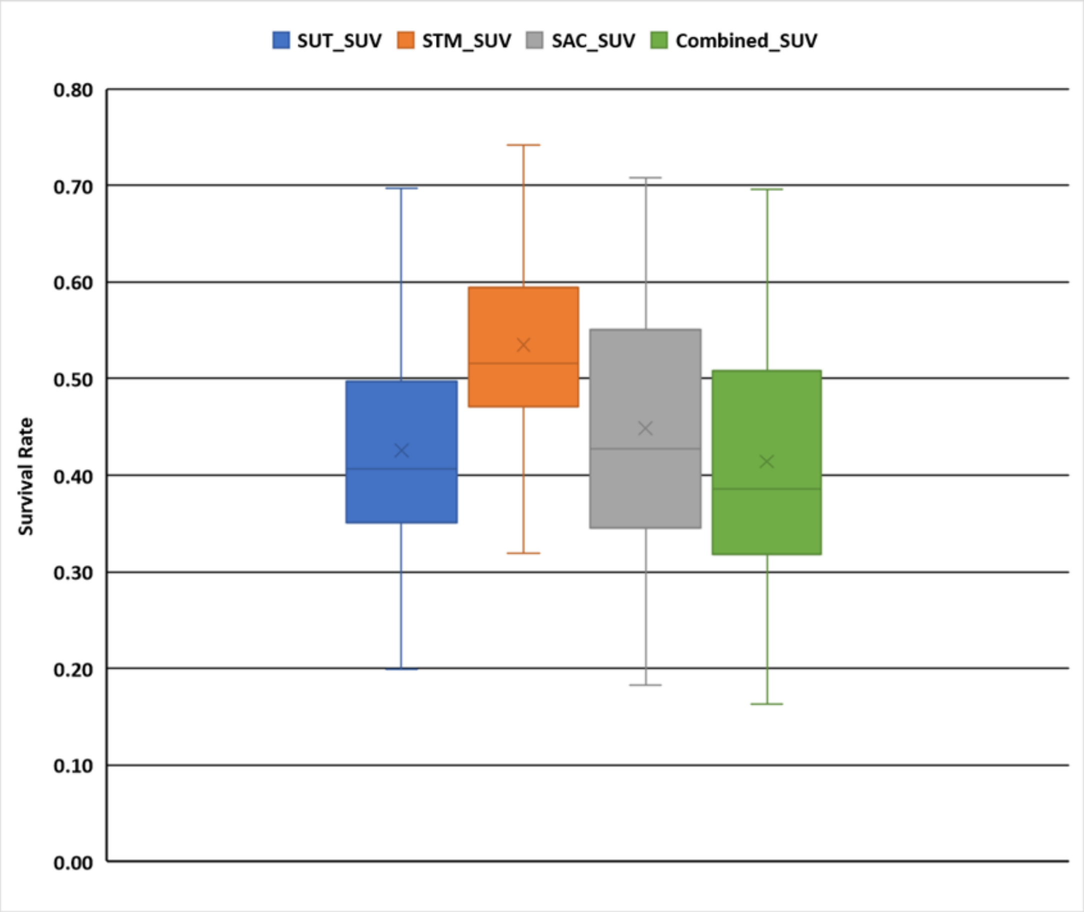
ECO-PTM – Simulation Results for All Scenarios

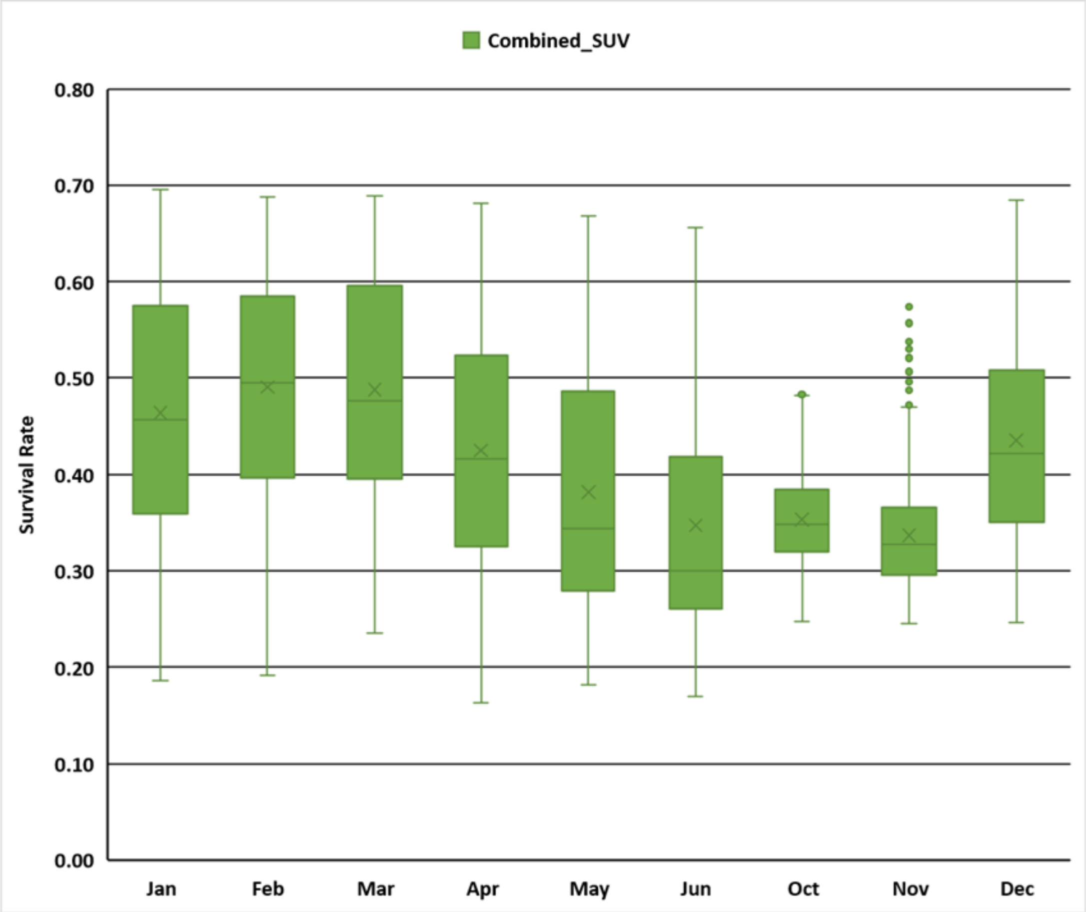
Scenario / Alt	SS Routing Increase from ELAM	SS Routing Increase Used in ECO-PTM*	Survival Difference (Scenario – Baseline)
Baseline			
1	4.6 %	5%	0.00231 (Median), 0.00279 (Mean)
2			
3			
4			
5a	3.4 %	3%	0.00199 (Median), 0.00186 (Mean)
5c			
6a			
6c			

ECO-PTM Sensitivity Study

- Purpose: What level of routing probability increase would be required to change survival
- Simulation: 1/1/1991 – 6/1/2016, total 6,984 simulations
- Scenario: Increased 30% of Steamboat Slough routing probability

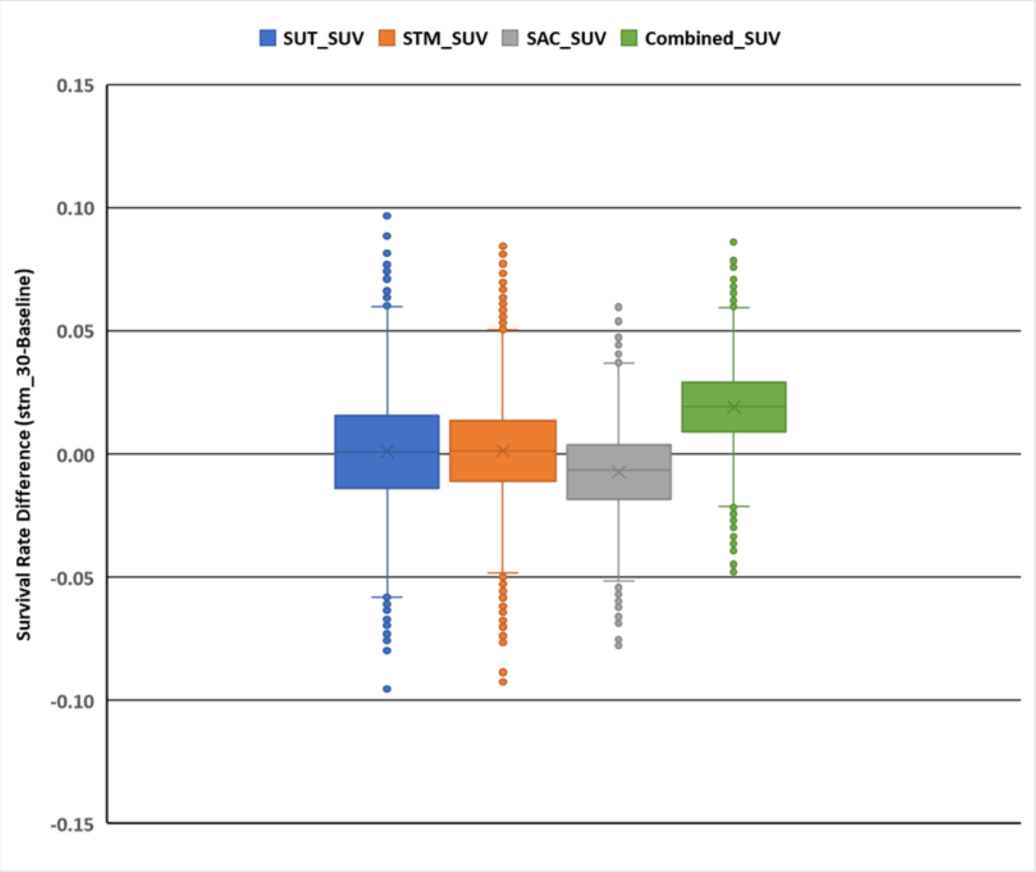
ECO-PTM – Sensitivity Study: 1991 – 2016 Baseline Survival Rate

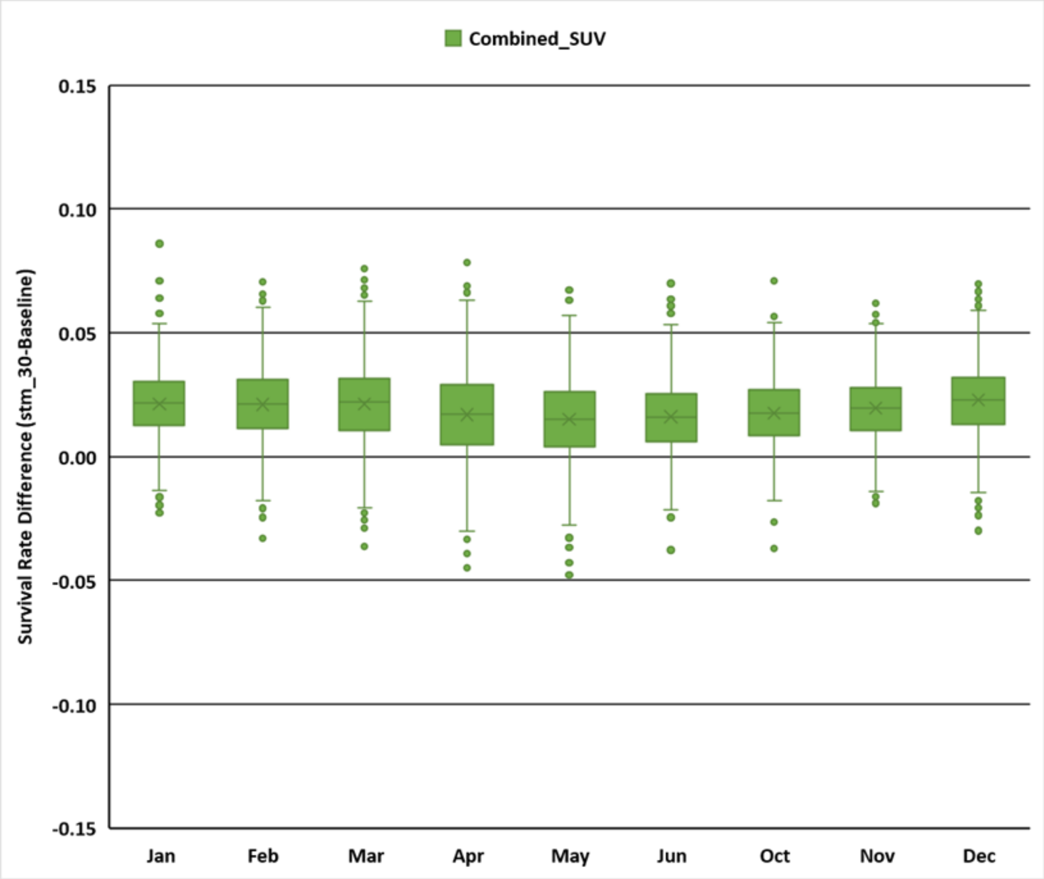




ECO-PTM – Sensitivity Study: Survival Rate Difference

30% increase in routing probability - baseline





	Jan	Feb	Mar	Apr	May	June	Oct	Nov	Dec	All
Median	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mean	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02

Discussion

- Ecological modeling tools can offer valuable insights to effective decision making
- For all scenarios/alternatives, modeling results indicate changes in mean routing rates were low
- When using mean routing changes from ELAM, survival benefits simulated are negligible for all alternatives
- To change survival, a significant increase in Steamboat Slough routing probability (e.g., 30%) is needed

Acknowledgement

ITP COA 8.9 Working Group

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Andy Goodwin

ESA:

Chris Fitzer, Bill Eisenstein

And other working group members and staff

USGS: Russ Perry, Adam Pope

ECO-PTM Zones for Survival Calculation