Investigating Factors Influencing CESRF Spring Chinook SAR’s

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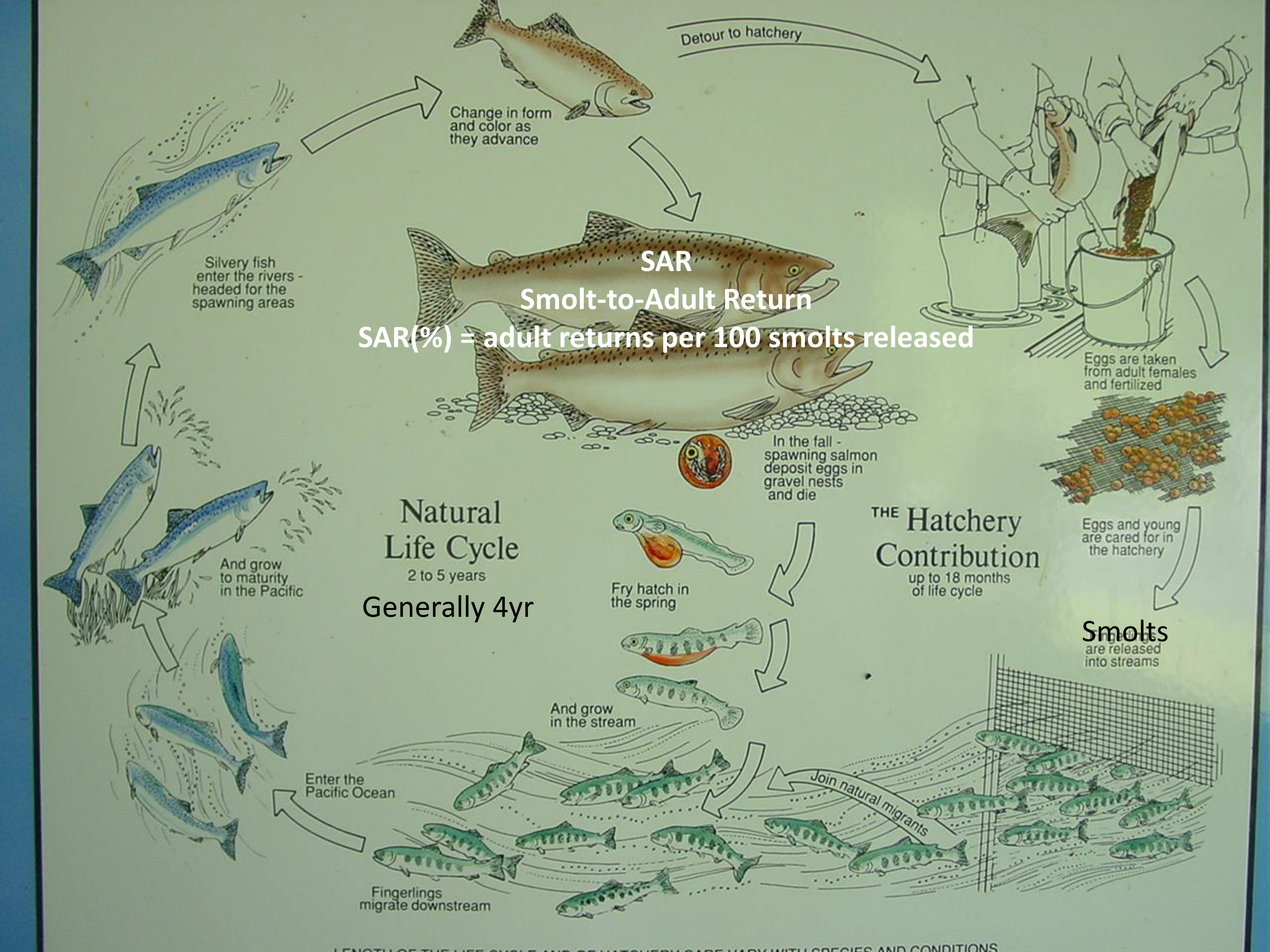
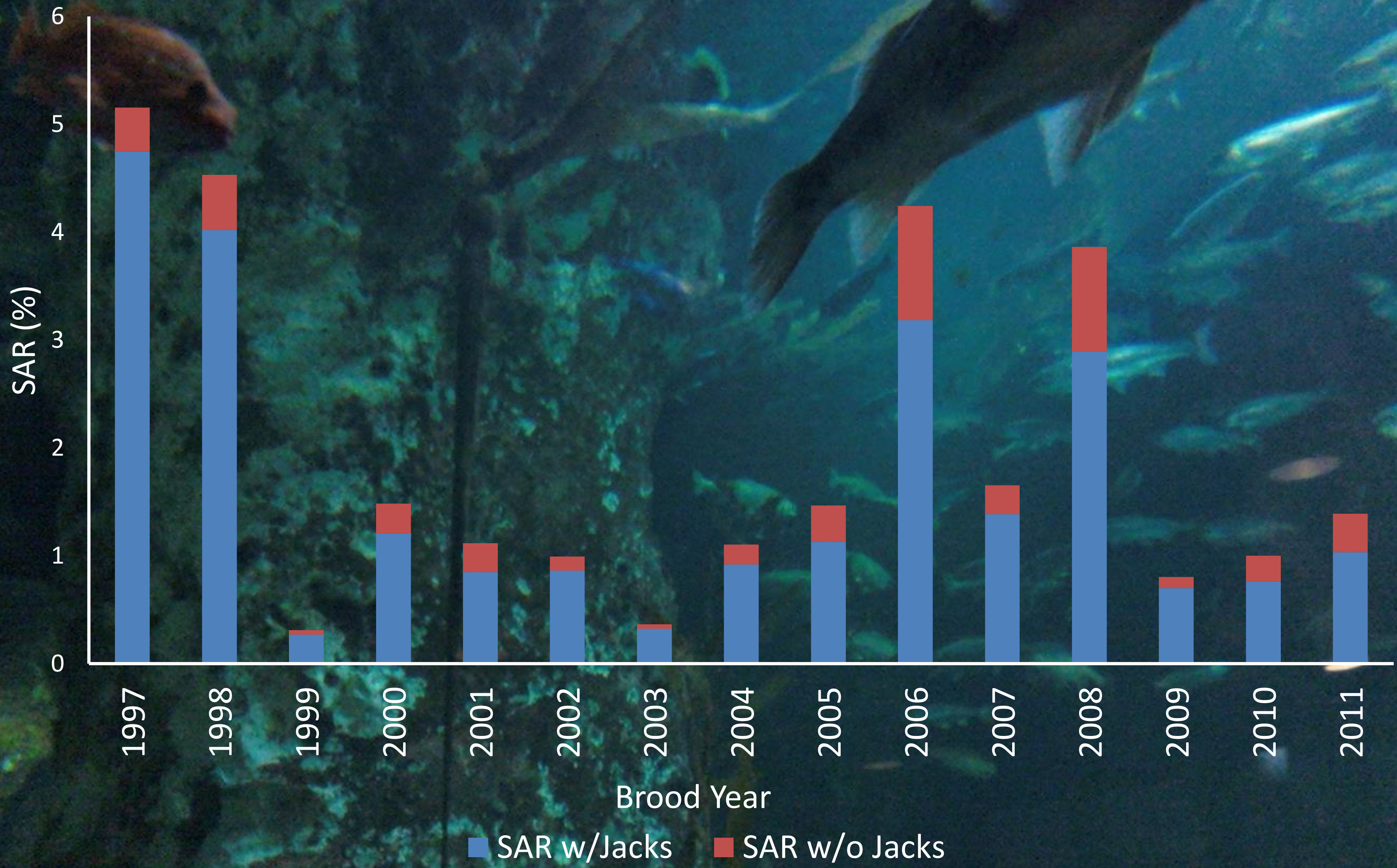

SAR
Smolt-to-Adult Return
SAR(%) = adult returns per 100 smolts released
Detour to hatchery
Change in form and color as they advance
Silvery fish enter the rivers - headed for the spawning areas
In the fall - spawning salmon deposit eggs in gravel nests and die
Eggs are taken from adult females and fertilized
Natural Life Cycle
2 to 5 years
Generally 4yr
THE Hatchery Contribution
up to 18 months of life cycle
Eggs and young are cared for in the hatchery
Smolts
are released into streams
And grow to maturity in the Pacific
Fry hatch in the spring
And grow in the stream
Join natural migrants
Enter the Pacific Ocean
Fingerlings migrate downstream

CESRF Smolt-to-Adult Returns



Sampson et al. 2016

r to hatchery
Silver
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Nat
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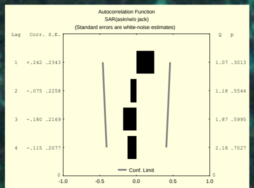
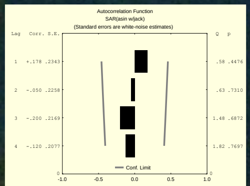
RESEARCH

Factors that may influence survival from release to return:

1. Proportion of fish that fail to migrate following release
2. River discharge during outmigration ($\overline{X}$ and SD-Kiona, March-June)
3. McNary Pool Inflow ($\overline{X}$ and SD during May and June)
4. John Day Pool Temperatures ($\overline{X}$ and SD, May - July)
5. Bonneville Dam Temperatures ($\overline{X}$ and SD, May - July)
6. Travel time ($\overline{X}$ and SD of days from release to Bonneville)
7. Ocean Index (PDO May through September for year of entry from NOAA)
8. NOAA's ocean indicator principal component 1 and 2 scores
9. River environment upon return ($\overline{X}$ May-June below Bonn. & Kiona)
10. Response variable is SAR (ASIN √ transformed)
    a) Verified the SAR time series was not autocorrelated



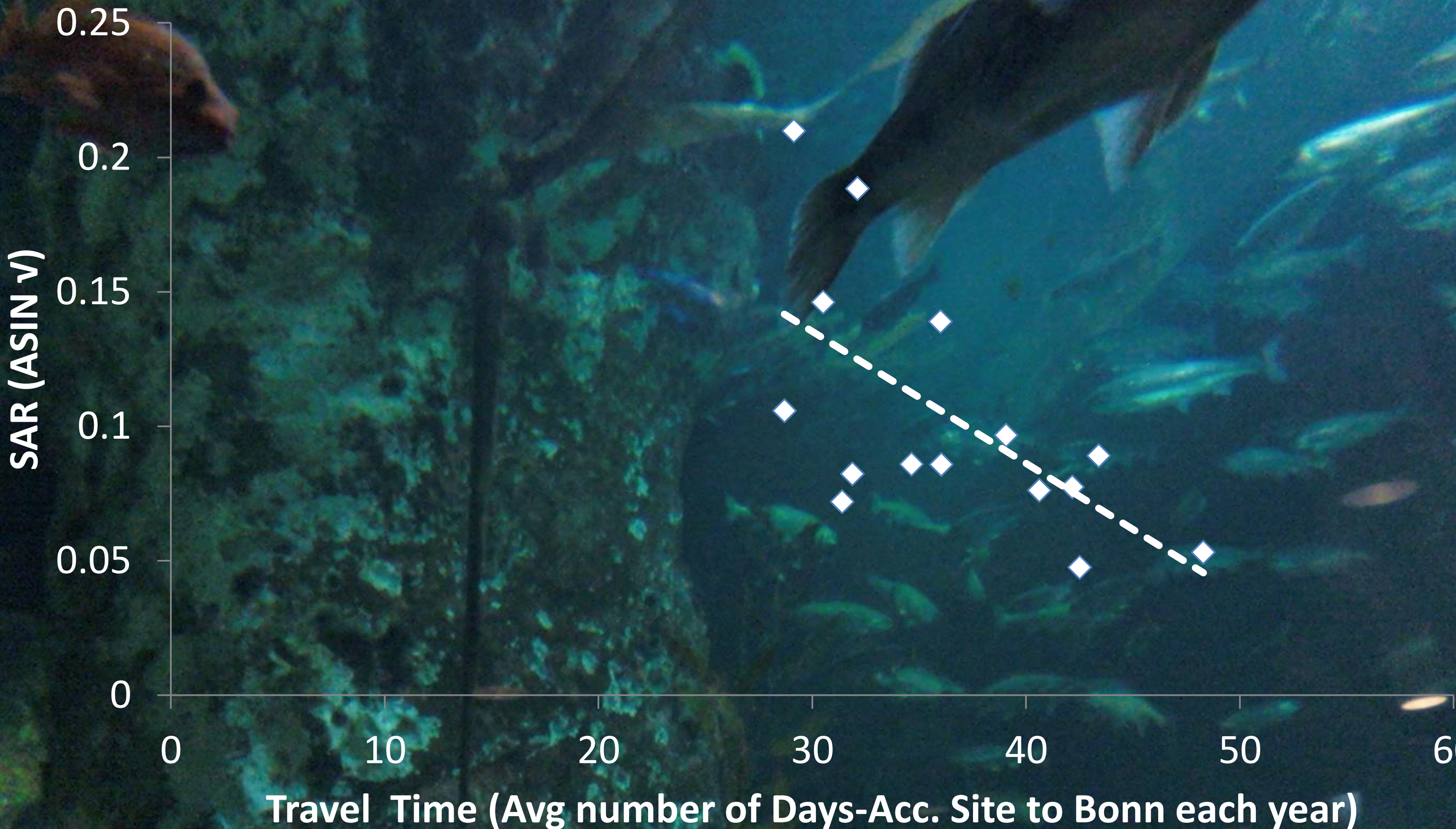


Step 1:

- Construct simple correlation matrix to see if any individual factor explains significant amounts of variation in SAR's

Factor	r and p		Factor	r and p
HSPC night runs	-.3950 p=.145		Travel Time Days (ACC Site detection to Bonneville)	-.6231 p=.013
Kiona $\bar{X}$ March-June	.3199 p=.245		SDev Travel Time	-.1998 p=.475
Kiona Flow variation (SDev) March-June	.1466 p=.602		PDO (Sum May-Sept)	-.3592 p=.189
MCNary inflow $\bar{X}$ May-June	.1801 p=.521		NOAA PC1 (1st year ocean)	-.3897 p=.151
McNary SDev of May-June inflow	.1561 p=.579		NOAA PC2 (1st year ocean)	-.2124 p=.447
Jday $\bar{X}$ pool temp May, June, July	-.3208 p=.244		NOAA PC1 (2nd year ocean)	-.2647 p=.340
Jday pool SDev temps May, Jun, Jul	-.0082 p=.977		NOAA PC2 (2nd year ocean)	-.0224 p=.937
Bonn $\bar{X}$ temp May, Jun, July	-.381 9 p=.160		Bonn$\bar{X}$ Discharge for adults	-.3462 p=.206
Bonn SDev temps May, Jun, Jul	-.005 5 p=.985		NOAA PC2 (1st year ocean)	-.1607 p=.567

Travel Time vs. SAR (no Jacks)

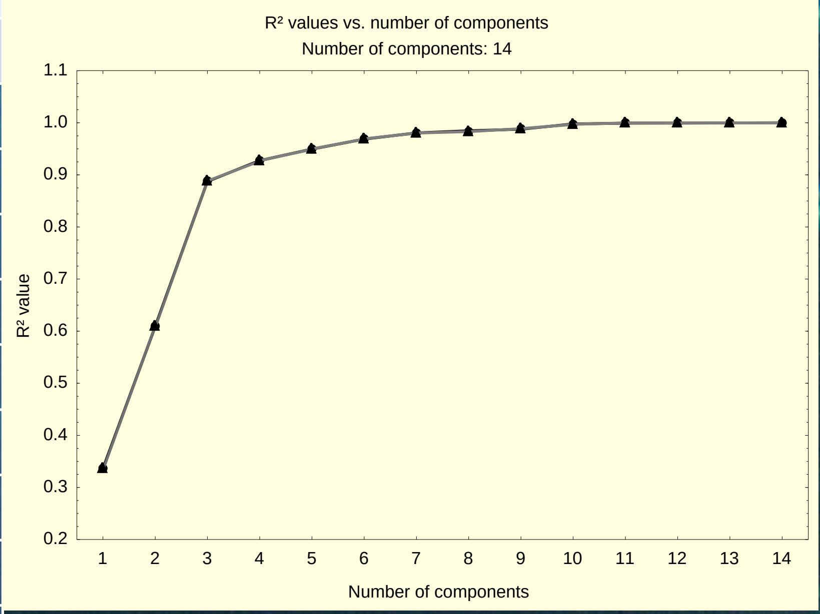


Step 2

- Submit factors to multiple regression to see if incorporating additional factors improved explanatory power
- Consider multicollinearity
- Use a Partial Least Squares Multiple Regression

Step 2
Partial Least Squares Multiple Regression

Component Number	Increase in R^2 of Y
Component 1	0.335776
Component 2	0.272947
Component 3	0.278582
Component 4	0.039971
Component 5	0.022071
Component 6	0.019203
Component 7	0.011922
Component 8	0.003957
Component 9	0.003256
Component 10	0.009894
Component 11	0.001509
Component 12	0.000228
Component 13	0.000326
Component 14	0.000359



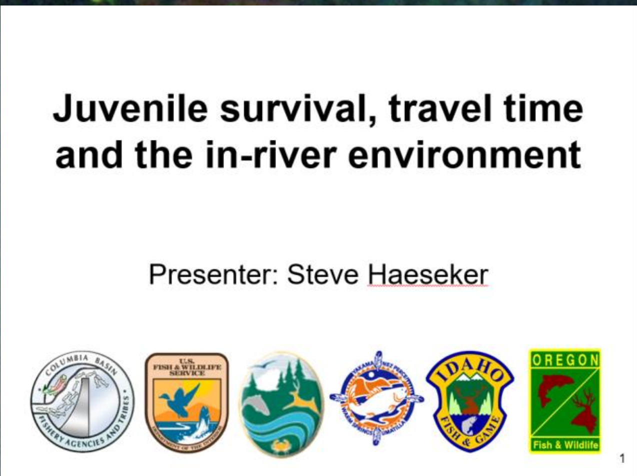
Component	HSPC Abundance	Kiona Mean March-June	kiona Flow variation(SD) March-June	MCNary inflow avg mayjune	McNarySDof may june inflow	Jday AVG pool temp may jun july	Jday pool SDev temps May Jun Jul	Bonn AVG temp may jun july	Bonn SD temps may jun jul	Travel Time Days	SD Days Travel	PDO (Sum May-Sept)	noaa pc1 (First Year in Ocean)	noaa pc2 (first year in ocean)	noaa pc1 (Second Year in Ocean)	noaa pc2 (Second year in ocean)	Bonn. Discharge during Adult Return	Kiona Discharge during adult return
1	-0.32	0.26	0.12	0.14	0.13	-0.26	-0.01	-0.31	0.00	-0.50	-0.16	-0.29	-0.31	-0.17	-0.21	-0.02	-0.28	-0.13
2	-0.36	-0.09	-0.31	-0.31	-0.16	0.12	0.17	0.03	0.12	-0.64	-0.10	0.00	-0.05	-0.18	-0.10	-0.17	-0.28	-0.12
3	-0.47	-0.05	-0.33	-0.27	0.02	-0.03	-0.06	-0.11	-0.13	-0.54	-0.18	0.00	0.24	0.19	-0.20	-0.21	0.05	0.25
4	-0.53	-0.13	-0.25	-0.18	0.44	-0.09	0.05	-0.18	-0.02	0.02	-0.08	0.22	0.34	0.17	-0.09	-0.06	-0.38	-0.10
5	0.15	-0.12	-0.16	-0.40	0.42	0.04	0.03	-0.13	-0.13	0.06	-0.31	-0.01	0.00	0.34	-0.25	-0.25	-0.48	-0.03
6	0.16	-0.05	0.00	-0.28	0.54	0.07	0.34	-0.07	0.16	-0.11	-0.21	0.03	-0.01	0.46	-0.11	-0.13	-0.35	0.18
7	0.20	-0.09	-0.13	-0.21	0.44	0.06	0.19	-0.07	0.02	-0.14	0.43	-0.13	-0.02	0.33	-0.23	0.00	-0.43	0.30
8	0.19	0.23	-0.08	-0.20	-0.01	0.01	0.06	-0.10	-0.07	-0.20	0.30	-0.01	0.09	0.60	0.03	0.27	-0.53	0.08
9	0.09	0.40	0.08	-0.40	-0.24	-0.17	0.12	-0.33	0.12	0.09	0.29	0.20	0.05	0.21	-0.05	-0.09	-0.40	0.31
10	0.18	0.29	-0.07	-0.49	-0.14	-0.27	0.09	-0.44	0.11	0.06	0.19	0.15	0.02	0.05	0.15	0.11	-0.33	0.35
11	-0.22	0.38	-0.21	-0.26	0.08	0.19	-0.09	-0.13	-0.05	0.18	0.16	0.08	-0.51	0.14	0.42	-0.09	-0.13	0.29
12	-0.17	0.56	-0.21	-0.28	0.13	0.43	-0.04	0.00	0.04	0.23	-0.04	0.04	-0.23	-0.10	-0.16	0.36	0.00	0.22
13	0.19	0.56	-0.34	0.06	0.24	0.47	-0.17	-0.32	0.21	-0.04	0.07	0.05	0.15	-0.12	0.03	-0.12	0.10	-0.10
14	-0.08	-0.01	0.17	-0.08	-0.01	0.56	-0.37	-0.36	0.40	0.06	-0.02	-0.37	0.21	-0.02	0.13	0.00	-0.09	0.07

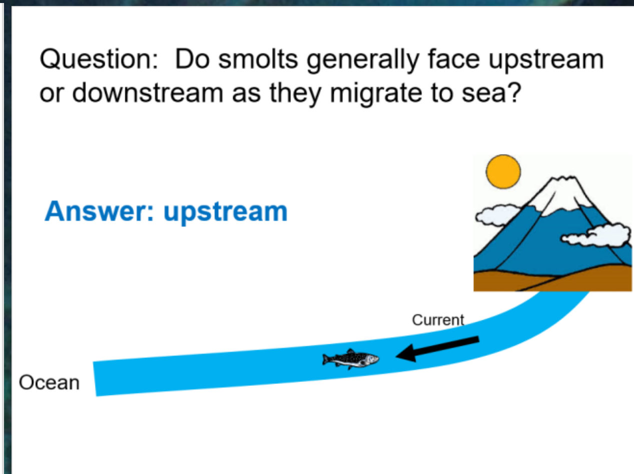
Similar Observations

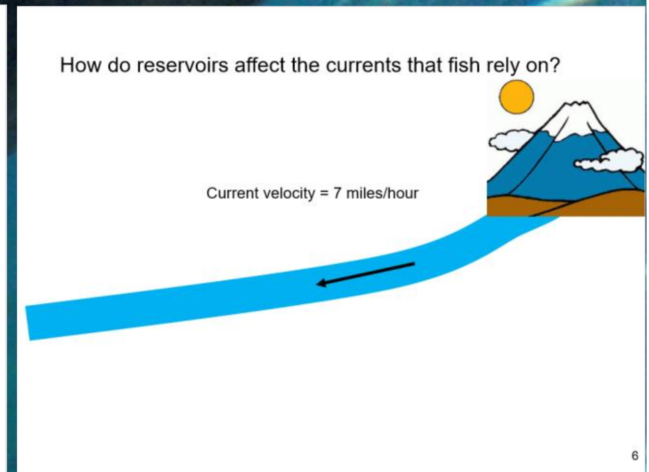
- Weight of evidence suggests getting fish to migrate, and their travel time through the hydro system is important

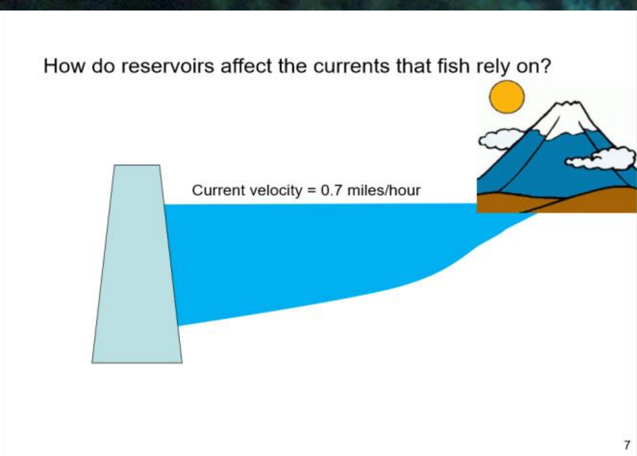
- Scheuerell et al. 2009 – Earlier juvenile outmigrants produce better adult returns
  - Suggest possible management objective-speeding estuary arrival by increasing spring river flow
- Beckman et al. 2017 – Smolt quality (e.g. size) and migration rate are influential on SARs
- Larsen et al. 2004 – Notes that high incidence of precocious male maturation may result in reduced anadromous adult returns
- Meeting with Jennifer Gosselin and Brian Burke
  - Hydro passage-barging vs run of the river fish survival
  - Take home for me was travel time is important

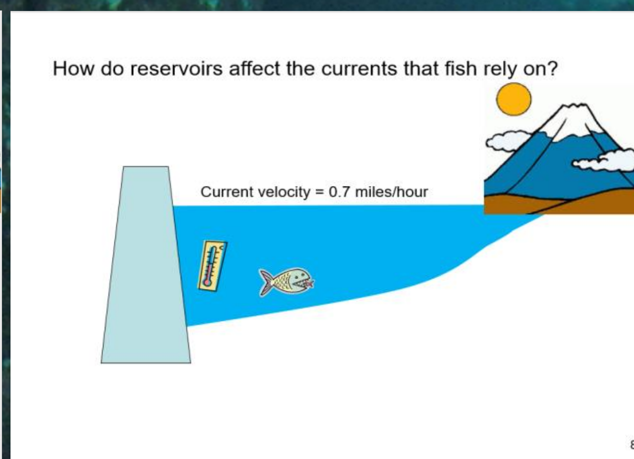
Some Considerations of Travel Time

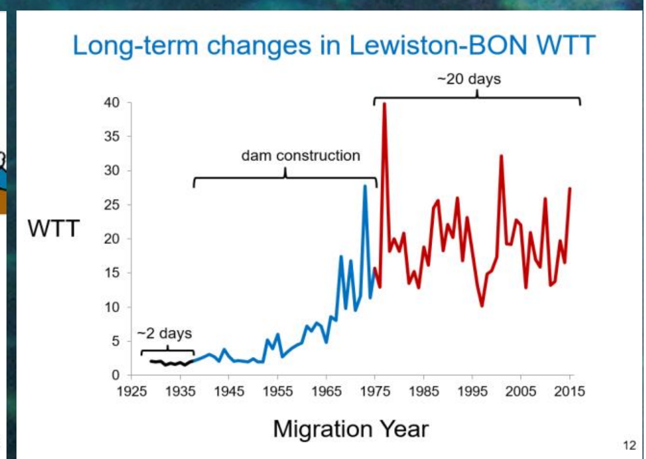






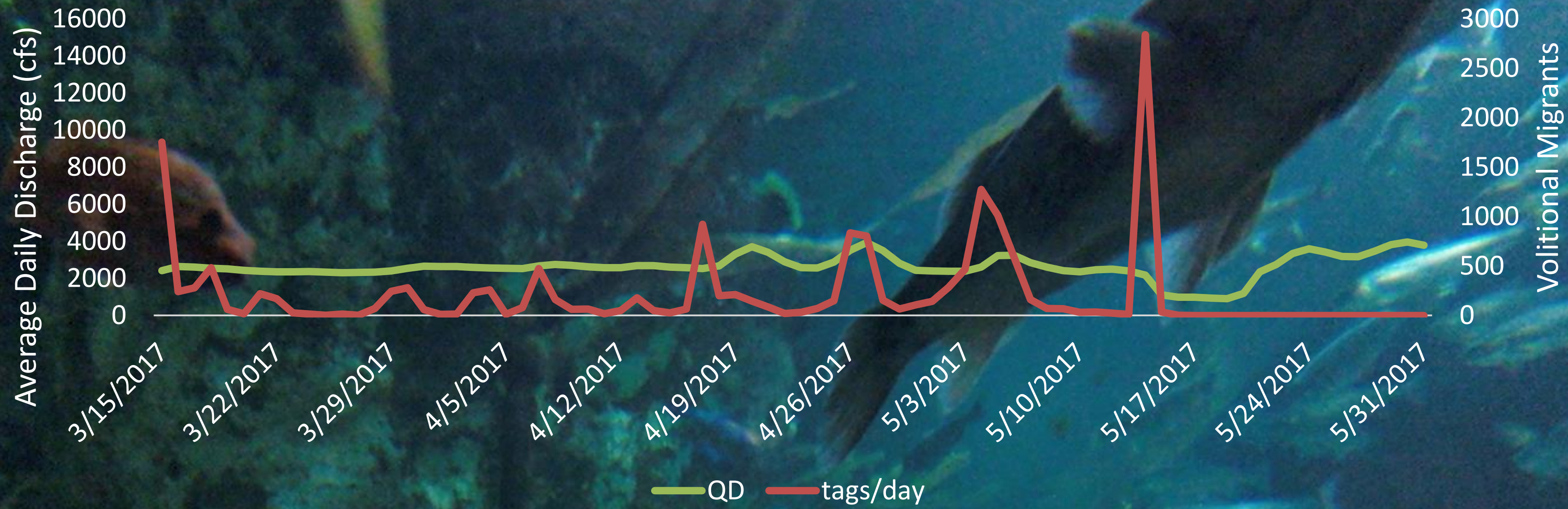




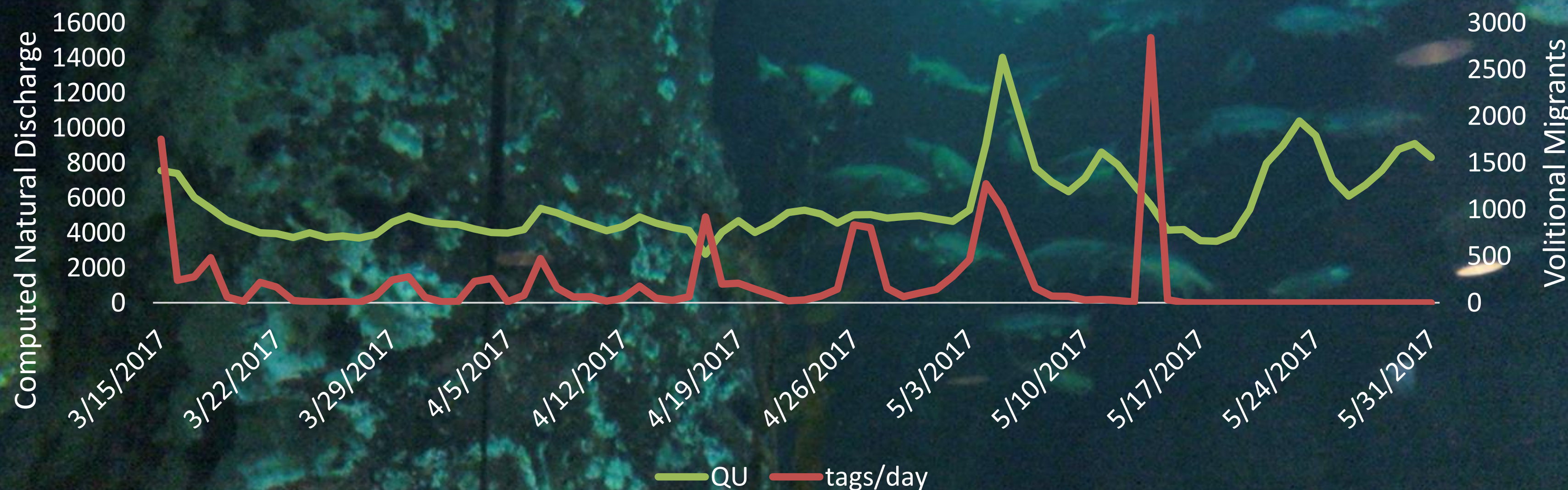


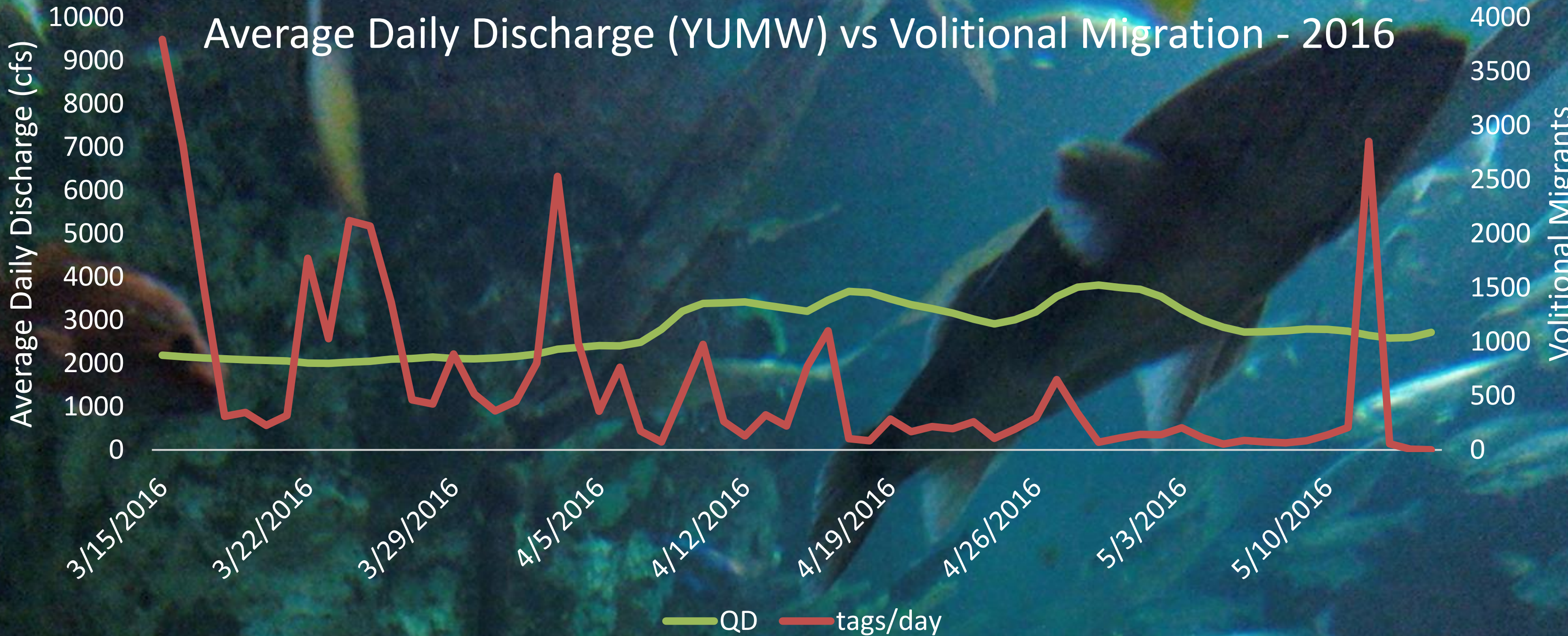
Comparative Survival Study (CSS): Used with Permission

Average Daily Discharge (YUMW) vs. Volitional Migration - 2017



Computed Natural Discharge vs. Volitional Migration - 2017




Average Daily Discharge (YUMW) vs Volitional Migration - 2016
Average Daily Discharge (cfs)
Volitional Migrants
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
4000
3500
3000
2500
2000
1500
1000
500
0
3/15/2016
3/22/2016
3/29/2016
4/5/2016
4/12/2016
4/19/2016
4/26/2016
5/3/2016
5/10/2016
QD
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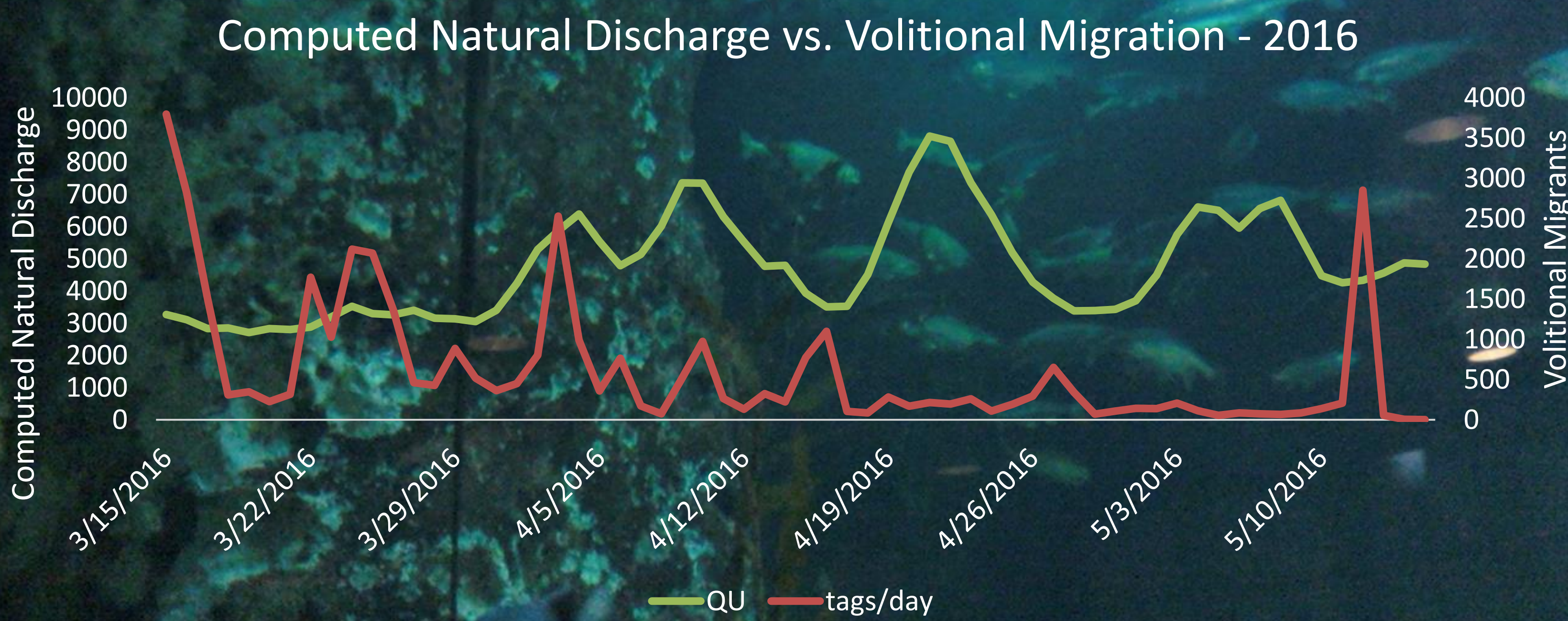
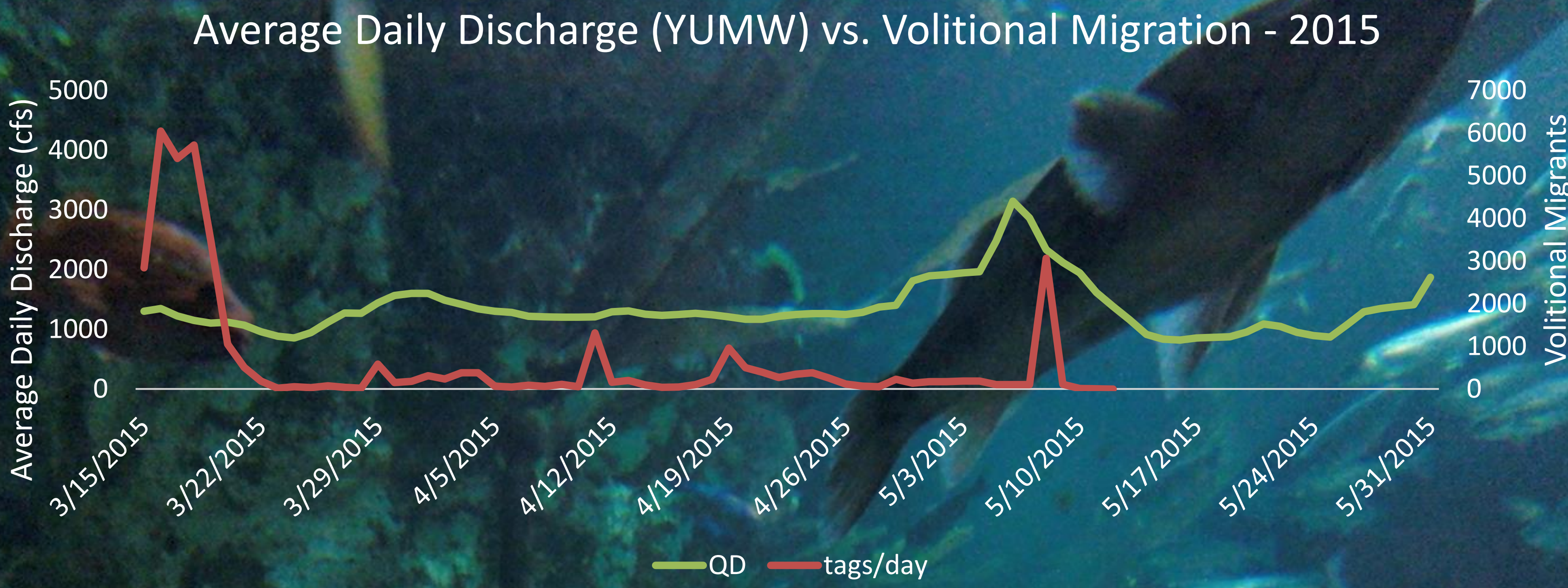
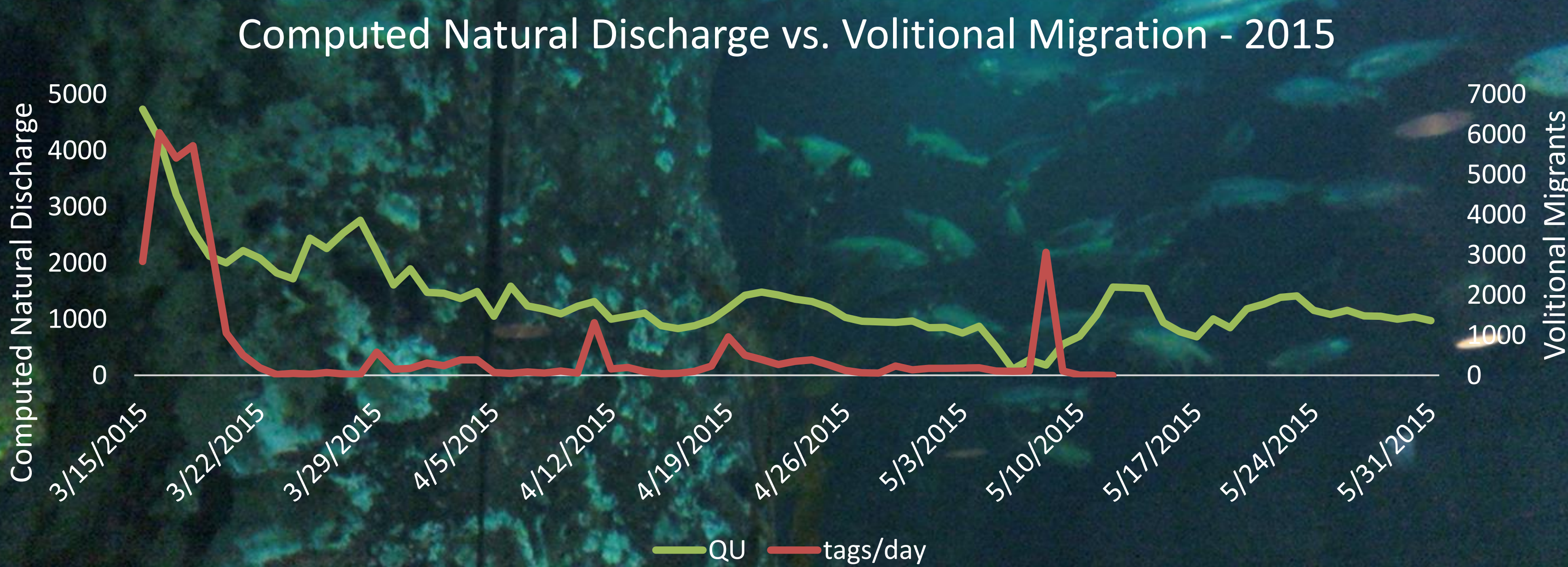

Computed Natural Discharge vs. Volitional Migration - 2016
Computed Natural Discharge
Volitional Migrants
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
4000
3500
3000
2500
2000
1500
1000
500
0
3/15/2016
3/22/2016
3/29/2016
4/5/2016
4/12/2016
4/19/2016
4/26/2016
5/3/2016
5/10/2016
QU
tags/day


Average Daily Discharge (YUMW) vs. Volitional Migration - 2015
Average Daily Discharge (cfs)
5000
4000
3000
2000
1000
0
7000
6000
5000
4000
3000
2000
1000
0
Volitional Migrants
3/15/2015
3/22/2015
3/29/2015
4/5/2015
4/12/2015
4/19/2015
4/26/2015
5/3/2015
5/10/2015
5/17/2015
5/24/2015
5/31/2015
QD
tags/day


Computed Natural Discharge vs. Volitional Migration - 2015
Computed Natural Discharge
5000
4000
3000
2000
1000
0
7000
6000
5000
4000
3000
2000
1000
0
Volitional Migrants
3/15/2015
3/22/2015
3/29/2015
4/5/2015
4/12/2015
4/19/2015
4/26/2015
5/3/2015
5/10/2015
5/17/2015
5/24/2015
5/31/2015
QU
tags/day

Looking Forward

- Minimize the number of fish that fail to migrate
  - Which is kind of what is done already e.g., Don/Charlie
- Target water releases (pulsed flows) during periods when lots of smolts are ready
  - Also which is kind of what is done already e.g., MJ/JE
- Many other (apparently less influential) factors are probably out of our control
  - e.g., Columbia River temperature and flow, ocean environment

Food for Thought

- Admit these results not very satisfying
- May be some opportunity to speed migration out of the Yakima via water releases that mimic natural runoff during the outmigration, particularly during drought years
- Power analysis suggests we would have to make pretty some pretty big improvements in SAR's to detect them within a few years
- Continue to investigate things we can manipulate that could lead to increased survival