Northwest **Power** and **Conservation** Council

February 6, 2018

MEMORANDUM

TO: **Council Members**

FROM: **Laura Robinson, Program Liaison Coordinator**

SUBJECT: **Presentation on survival of adult spring/summer Chinook salmon through the estuary and lower Columbia River amid a rapidly changing predator population**

BACKGROUND:

Presenter: Dr. Michelle Wargo Rub, NOAA Northwest Fisheries Science Center

Summary: Dr. Wargo Rub is a Fisheries Biologist for NOAA's Northwest Fisheries Science Center. Much of Dr. Wargo Rub's research is focused on salmon run timing and the effects marine mammal predation has on it. At the February Council meeting, Dr. Wargo Rub will present to the Council members the latest findings of her research on marine mammal predation on Chinook salmon in the estuary and lower Columbia River.

Relevance: Preserving program effectiveness by supporting expanded management of predators is a priority of the Council's 2014 Fish and Wildlife Program.

Background: A NOAA research group led by Dr. Wargo Rub has been studying the annual spring Chinook run since 2010 and has captured, marked and released several thousand fish, tracking their progress as they move up the river to spawn. NOAA contracts with commercial fishers to catch spring Chinook in the estuary around river mile 28, near Tongue Point east of Astoria. Researchers insert tags into the fish and release them back into the river. Sea lions also are tagged in the Astoria area so their

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movements in the river can be monitored. According to Dr. Wargo Rub, most stay in that area, but a small percentage travel all the way to Bonneville where up to half of the predation on spring Chinook occurs.

Eight years of research has shown year-to-year variations on Chinook survival and run timing in the lower river and estuary. Of particular interest is a peak in Chinook mortality in 2014. Many reasons, such as flow variations, could account for annual differences in Chinook mortality, but Dr. Wargo Rub feels confident that pinniped predation plays a large role.

More Info: Attached is Dr. Wargo Rub's December 2017 presentation to the ISAB.

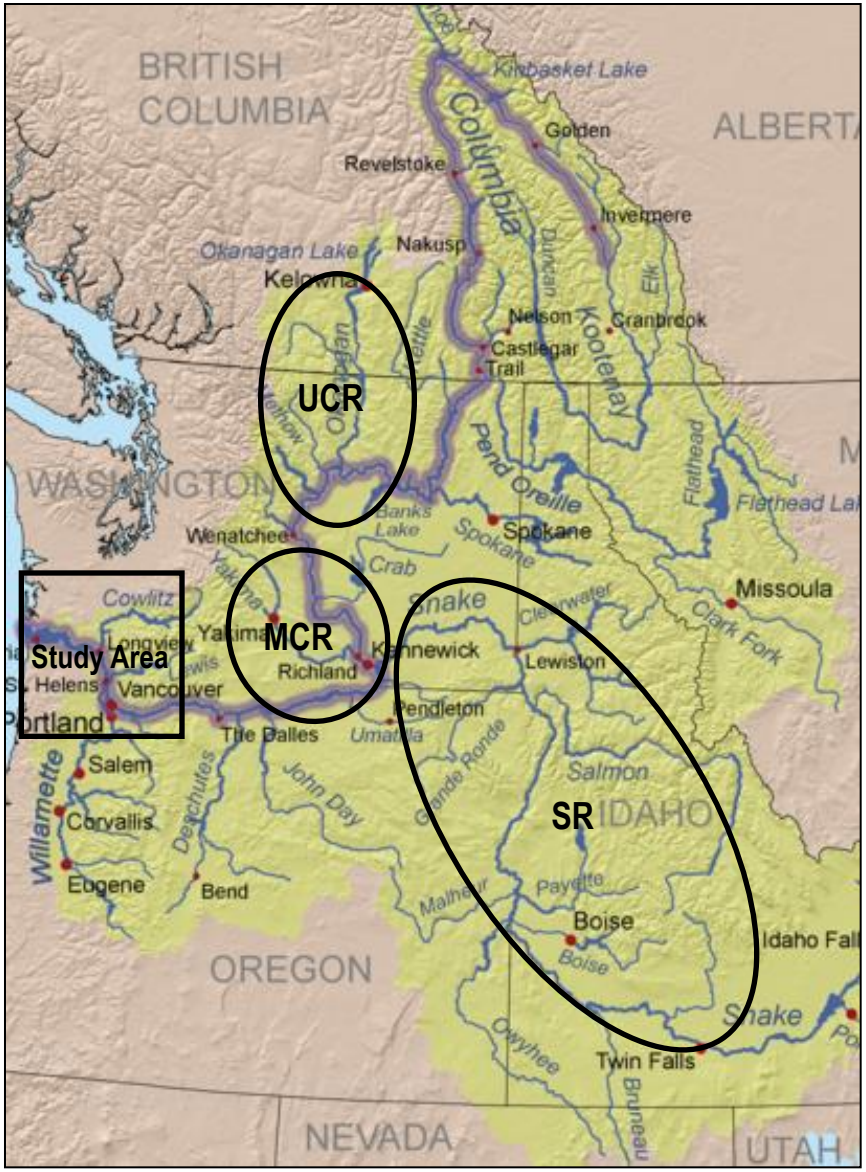
Survival of adult spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) through the estuary and lower Columbia River amid a rapidly changing predator population

A. Michelle Wargo Rub, Ben Sandford, Don Van Doornik, Matthew Nesbit, Samuel Rambo, Jesse Lamb, Louis Tullos, Gordon Axel, Brian Burke, Kinsey Frick, Mark Sorel, David Huff, & Rich Zabel

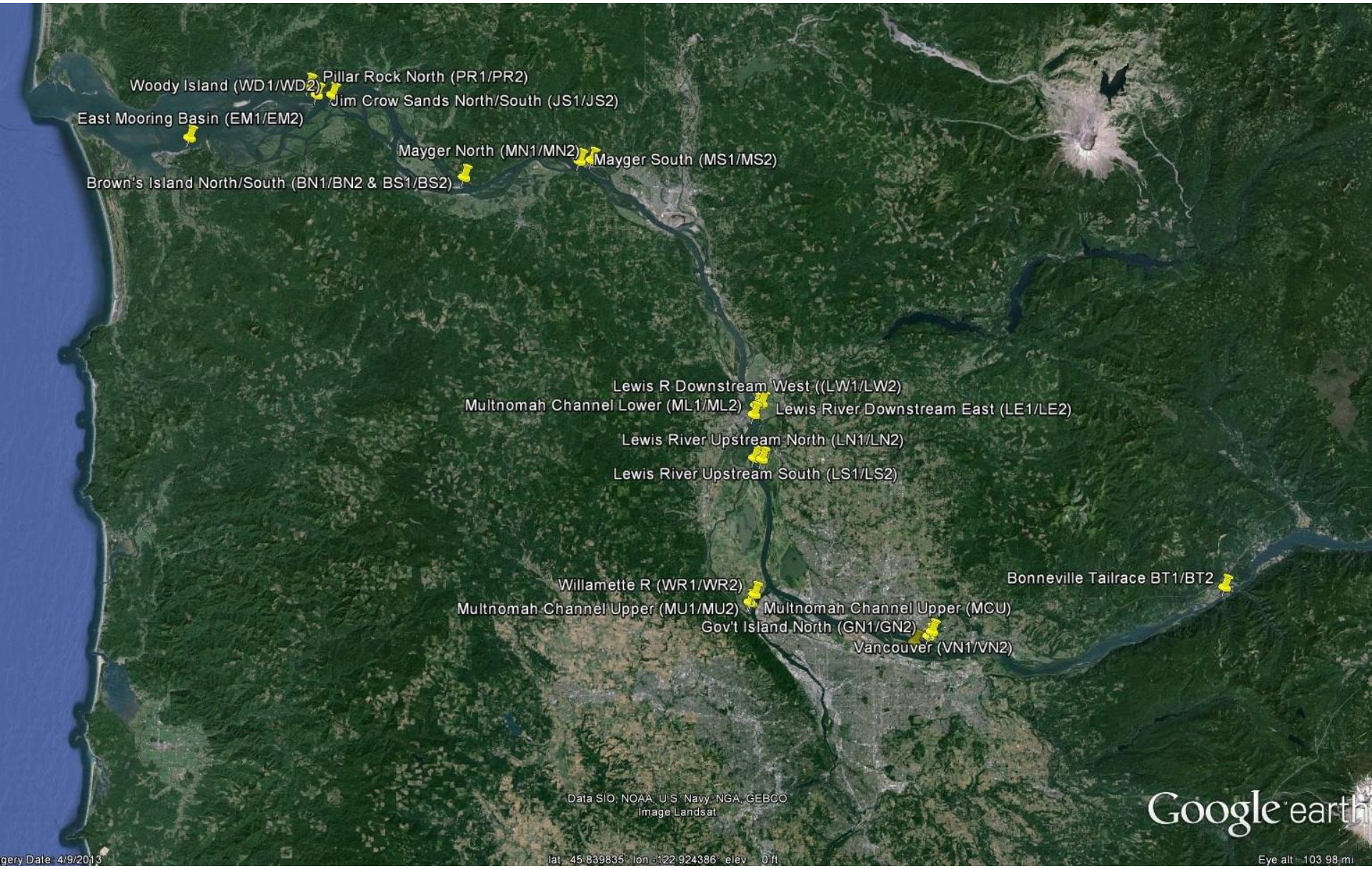
NOAA Fisheries Northwest Fisheries Science Center (NWFSC)

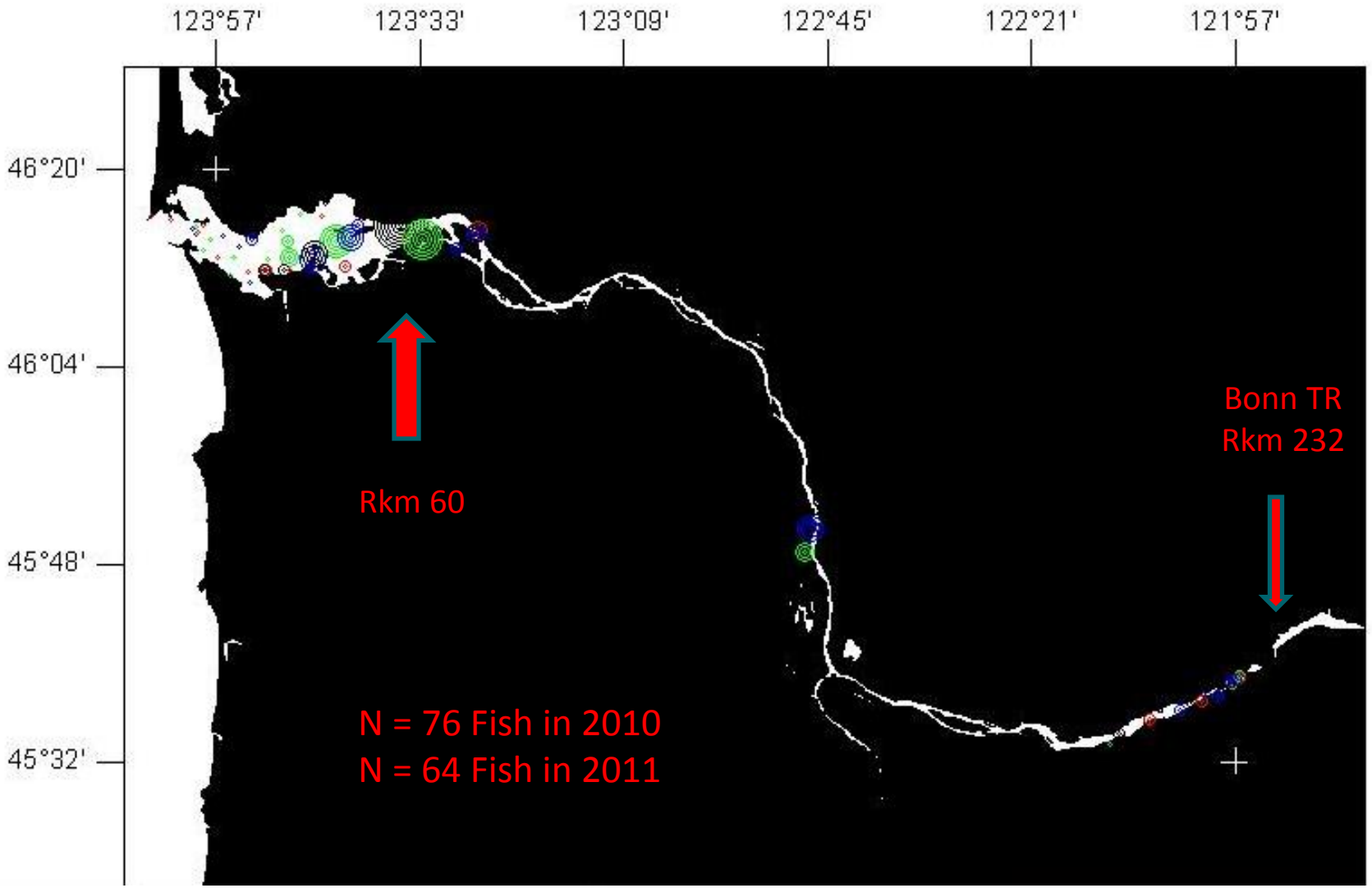
The primary goal of this study is to provide estimates of survival and run timing for spring/summer Chinook salmon returning to the Middle & Upper Columbia & Snake Rivers


Photo by Darren Ogden, NOAA NWFSC



Commercial tangle–net crew hauling in a Chinook salmon


Woody Island (WD1/WD2)
Pillar Rock North (PR1/PR2)
Jim Crow Sands North/South (JS1/JS2)
East Mooring Basin (EM1/EM2)
Mayger North (MN1/MN2)
Mayger South (MS1/MS2)
Brown's Island North/South (BN1/BN2 & BS1/BS2)
Lewis R Downstream West ((LW1/LW2)
Multnomah Channel Lower (ML1/ML2)
Lewis River Downstream East (LE1/LE2)
Lewis River Upstream North (LN1/LN2)
Lewis River Upstream South (LS1/LS2)
Willamette R (WR1/WR2)
Bonneville Tailrace BT1/BT2
Multnomah Channel Upper (MU1/MU2)
Multnomah Channel Upper (MCU)
Gov't Island North (GN1/GN2)
Vancouver (VN1/VN2)
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Google earth
gery Date: 4/9/2013
lat 45.839835° lon -122.924386° elev 0 ft
Eye alt 103.98 mi


123°57'
123°33'
123°09'
122°45'
122°21'
121°57'
46°20'
46°04'
45°48'
45°32'
Rkm 60
Bonn TR
Rkm 232
N = 76 Fish in 2010
N = 64 Fish in 2011

Weighted Mean Survival for Interior CR adults (FL ≥ 56 cm)

Year	Adult Chinook salmon (N)	Range of sampling dates	Baseline Survival (95% CI)	Potential Mortality		
				Baseline Mortality	Mortality due to harvest and handling	Unexplained mortality
2010	172	4/14-5/11	.74 (.68-.80)	0.26	0.15	0.11
2011	381	4/1-5/16	.73 (.69-.77)	0.27	0.14	0.13
2012	372	3/23-5/31	.69 (.64-.75)	0.31	0.16	0.15
2013	73	4/19-6/14	.60 (.47-.74)	0.40	0.12	0.28
2014	297	3/20-5/13	.46 (.38-.53)	0.54	0.11	0.43
2015	205	3/19-5/8	.52 (.42-.61)	0.48	0.11	0.37
2016*	70	3/28-5/23	.70 (.58-.82)	0.30	0.16	0.14
2017*	89	3/21-5/22	.62 (.50-.74)	0.38	0.14	0.24

*Preliminary estimates and assume 7% harvest

Upriver spring/summer Chinook salmon mortalities

year	Total CR spring/summer Chinook salmon returns (N)	Upriver spring/summer Chinook salmon returns (N)	Number of upriver fish mortalities (95% CI)
2010	468,536	315,345 (.67)	34,688 (9,460-59,916)
2011	323,099	221,158 (.68)	28,751 (2,212-33,174)
2012	297,034	203,090 (.68)	30,464 (18,278-40,618)
2013	192,881	123,136 (.64)	34,478 (13,545-54,180)
2014	313,491	242,635 (.77)	104,333 (82,496-126,170)
2015	416,731	288,994 (.69)	106,928 (75,138-138,717)
2016		137,215*	19,210 (2,744-37,048)
2017		101,008**	24,242 (10,101-39,393)

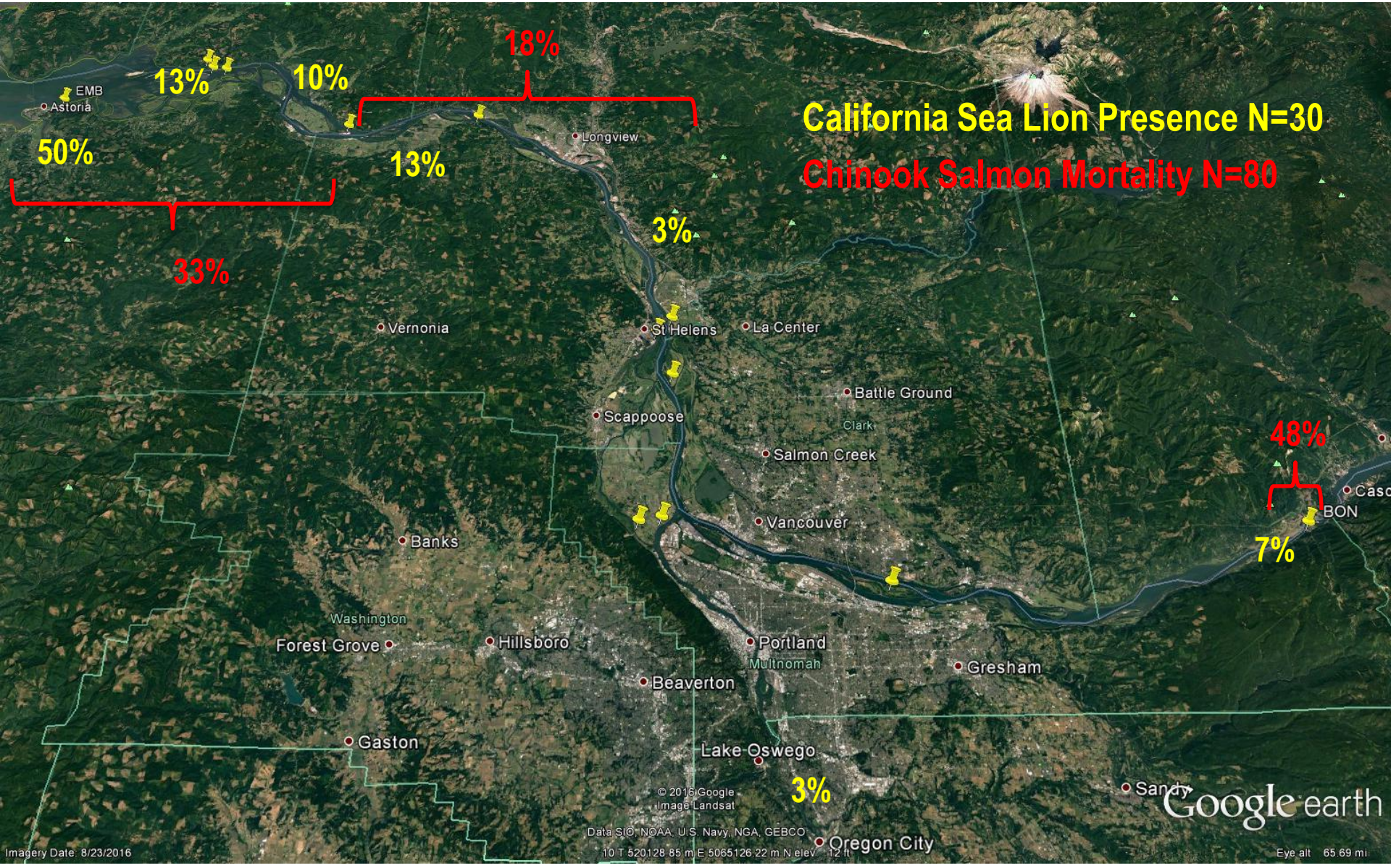
*Upriver return to Bonneville Dam as of 5/31/17

**Upriver return to Bonneville Dam as of 6/11/17

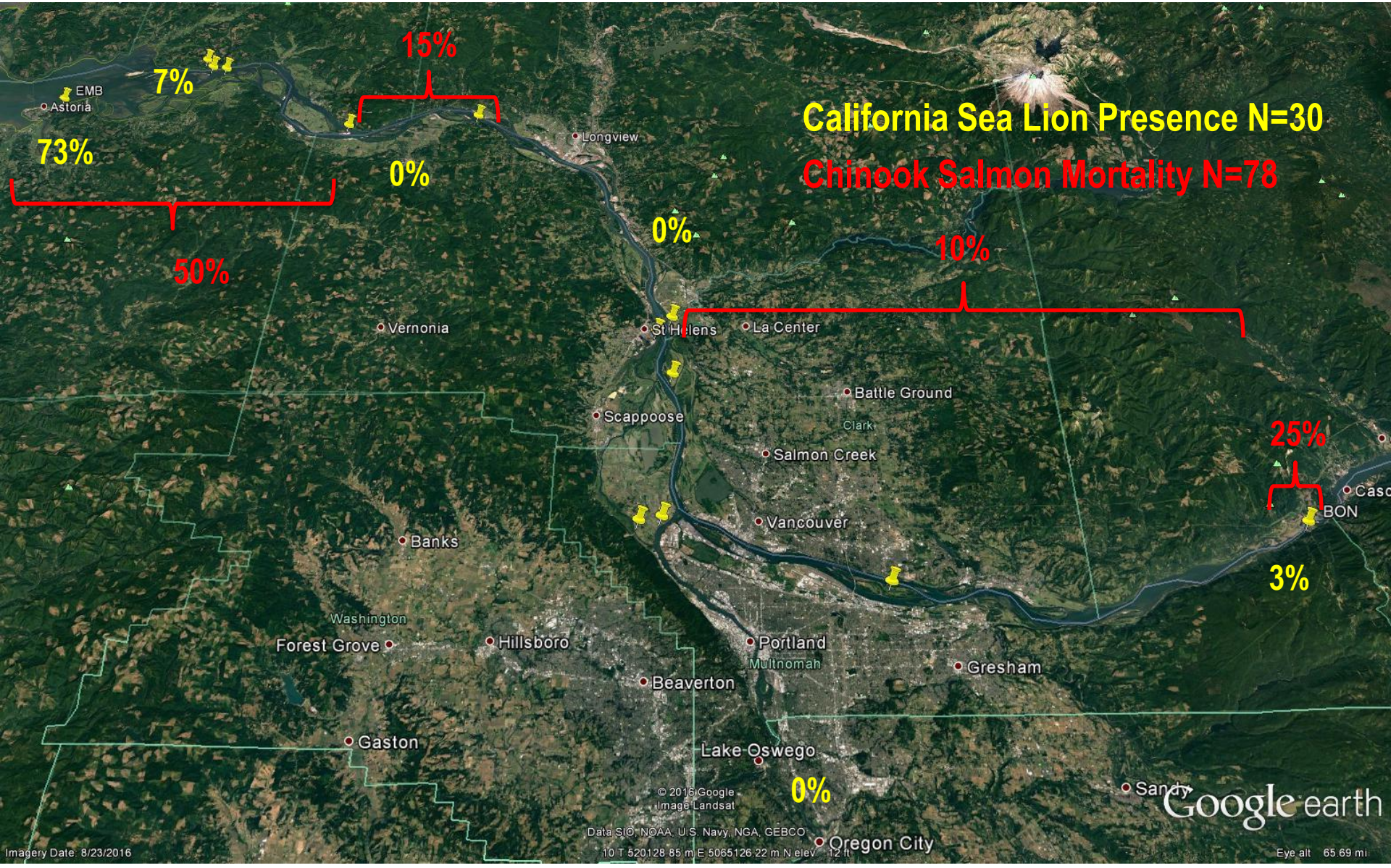
Radio Telemetry

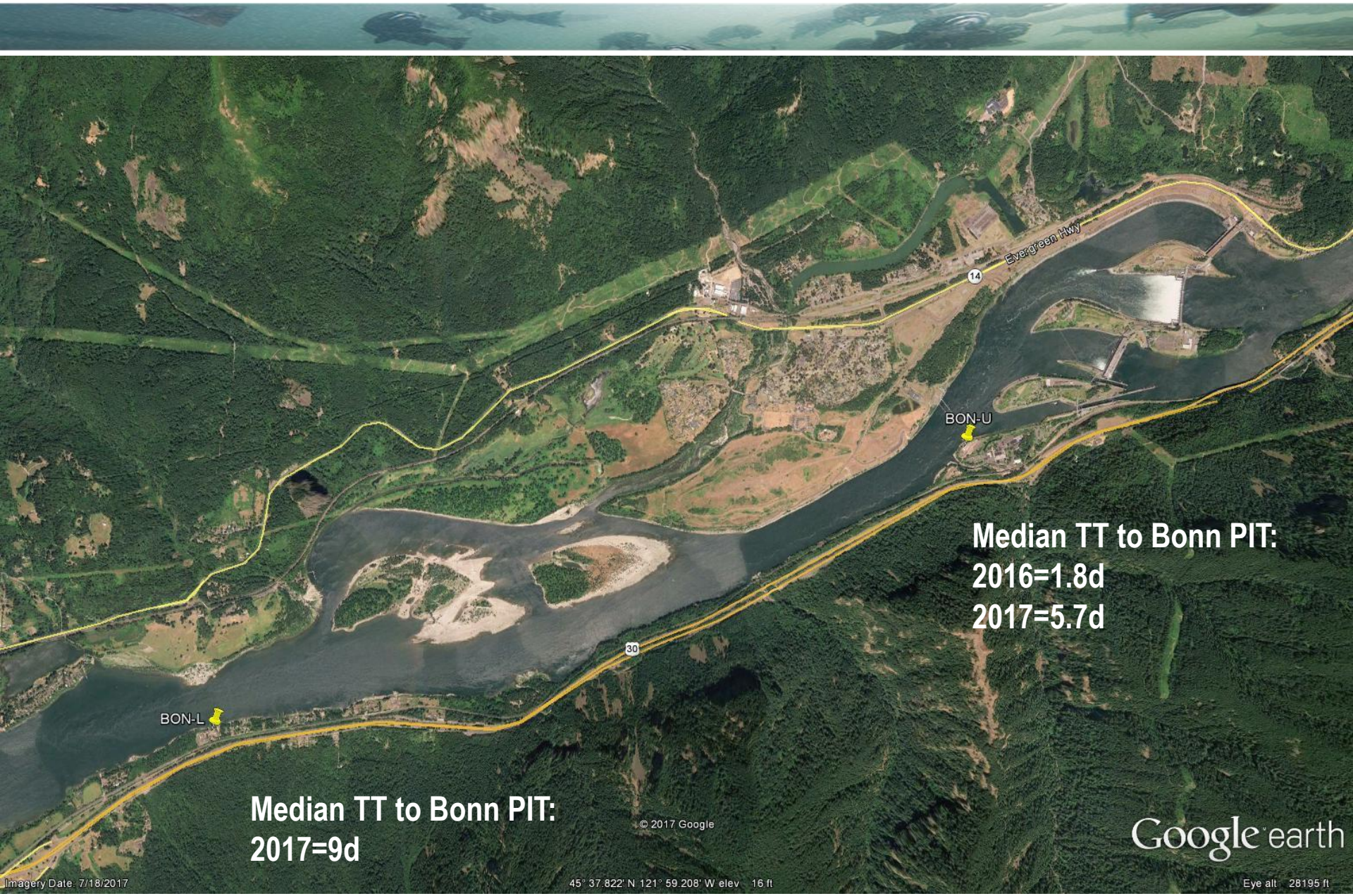
EMB
Astoria
Longview
St Helens
La Center
Battle Ground
Clark
Scappoose
Salmon Creek
Vancouver
BON
Hillsboro
Portland
Multnomah
Gresham
Beaverton
Gaston
Lake Oswego
Sandy
Oregon City
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
10 T 520128.85 m E 5065126.22 m N elev 12 ft
Imagery Date: 8/23/2016
Eye alt 65.69 mi
Google earth

Radio Telemetry Results 2016



Radio Telemetry Results 2017





TT from release to Brown's Island=6.7d in 2016 and 15.1d in 2017

Early modelling

GLM Regression analysis indicates the following variables are significantly related to survival:

- CSL haul out counts at the EMB
- Clip Status
- Water temperature below Bonneville Dam
  (also highly correlated with date)
- Bonneville Spill

However, these predictors are describing only 8% of the variance. We need to go further if we are going to use the resulting model to predict survival.

Linear Mixed Effects Modelling

Random effect:

- Tagging date

Fixed effects:

- Clip status
- Exposure to CSL based on EMB counts and travel time to Bonneville Dam
- Eulachon abundance (based on plankton counts)
- Bonneville Dam spill

*The area under the ROC was .71 indicating the model is ‘adequate’ with respect to being able to predict survival

Linear Mixed Effects Modelling

	Mean	Range	Unit equivalent	Odds ratio (95% CI)
Clip	NA	0 - 1	NA	0.67 (.51-.89)
CSL	7 591	36 – 49 701	7 906	0.76 (.64-.90)
Eulachon	3.2×10^{10}	$0 – 7.8 \times 10^{11}$	1.0×10^{11}	0.78 (.70-.93)
Spill	87.9	1.2 - 214.7	39.8	1.24 (1.08-1.51)

The mean, range, unit equivalent and estimated odds ratios for the *fixed effects* covariates (Clip = no adipose fin, CSL = sea lion exposure, Smelt = smelt abundance, Spill = spill over Bonneville Dam (kcfs)) selected for the final model.

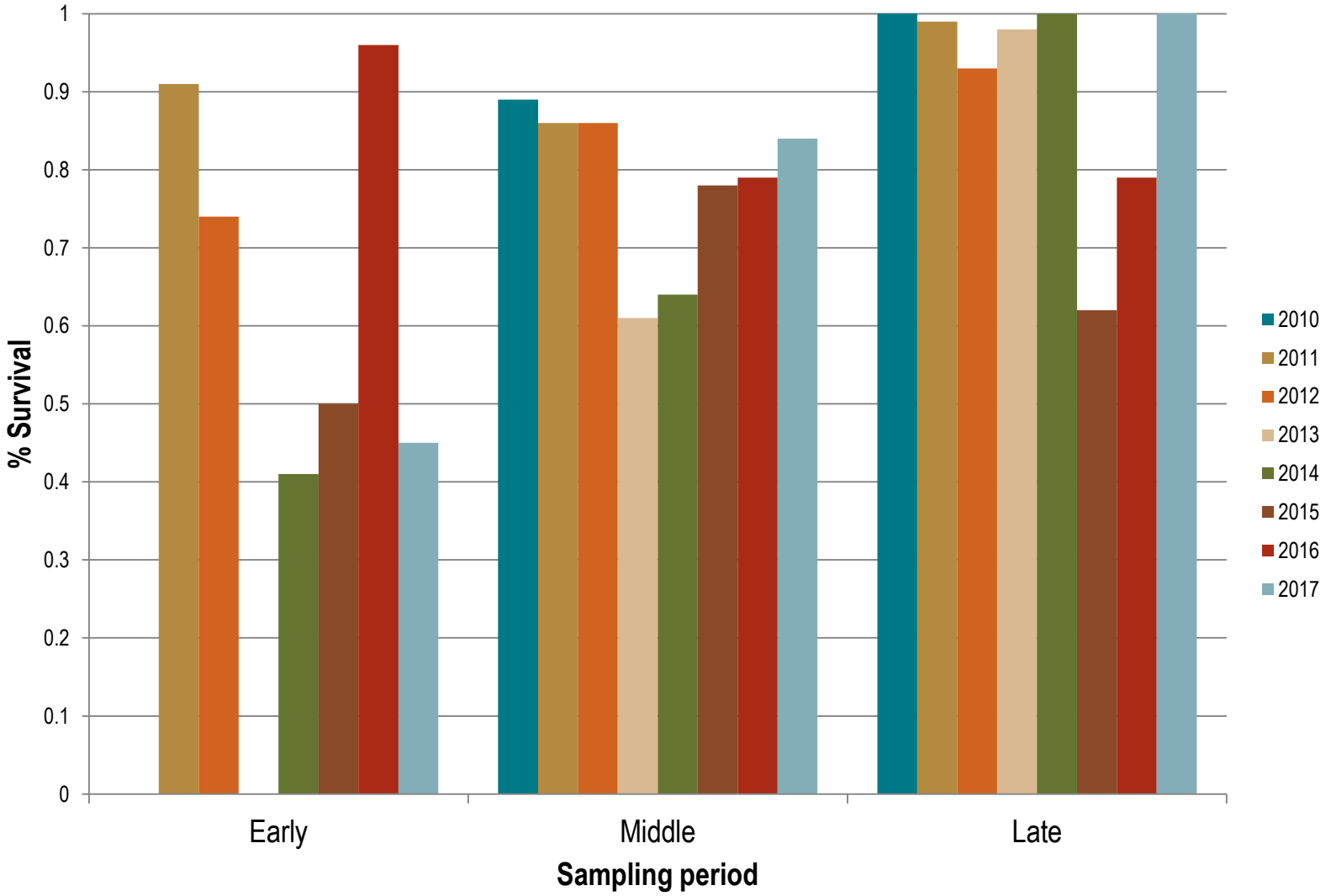
Conclusions:

- We have identified significant mortality that is unexplained by harvest and handling for upriver spring/summer Chinook salmon
- This mortality appeared to peak during 2014 and 2015 at approximately 100k fish.
- Mortality during 2016 and 2017 was ~19k and ~24k respectively and appears to be similar to estimates from 2010-2012 ranging from 29-35k
- Pinniped predation is likely the primary source of mortality but not all animals are equal with respect to the impact they are having on returning fish
- Additional covariables potentially influencing survival include spill, abundance of smelt, and clip status

Acknowledgements:

Susan Hinton, George McCabe, and Bob Emmett of NOAA Fisheries Pt. Adams Research Station, Jim Simonson and crew of NOAA Fisheries Pasco Research Station, Laurie Weitkamp of NOAA Fisheries NWFSC, Newport Research Station, David Kuligowski of NOAA Fisheries NWFSC, Manchester Research Station, John Hess, Doug Hatch & Ryan Brandstetter of CRITFC, Jason Romine and Mike Parsley of USGS, Chris Kern and Geoffrey Whisler of ODFW, Matt Campbell of IDF&G, Brian, Frank, & Stephanie Tarabochia, and Dan Marvin of Astoria, OR, Sean Hayes of NOAA Fisheries SWFSC, Kane Cunningham & Colleen Reichmuth of the Institute of Marine Sciences, Long Marine Laboratory, UCSC, NOAA Near Term Priority (2010 & 2011) and NOAA Fisheries Cooperative Research (2012, 2013, & 2014), Albert Little, Wyatt Wullger, Ben Rudolph, & Cody May of Ocean Associates, Dave Caton & Lila Charlton of PSMFC

Survival varied by tagging date



Median Travel Time (d) to Bonneville Dam by release group