



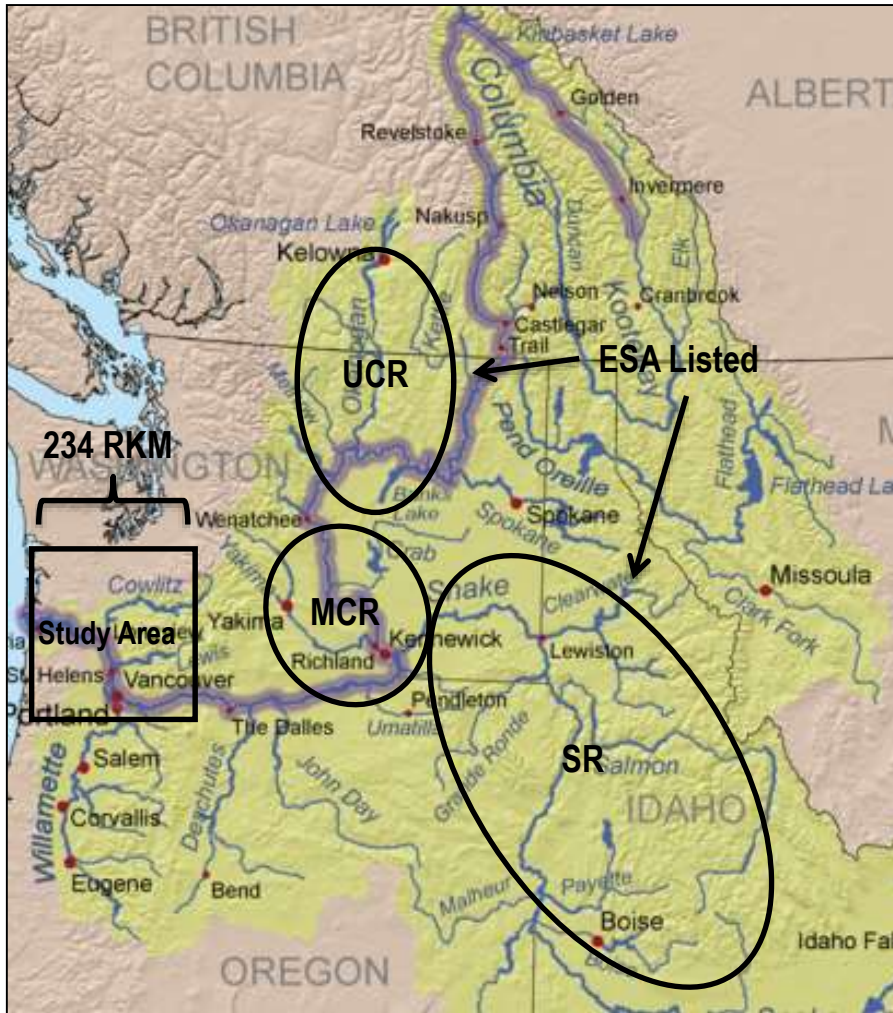
**NOAA
FISHERIES**

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

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



There is concern that pinnipeds entering the CR during spring is impacting adult salmon through predation



March 2015; 6k harbor seals (top) & 2k sea lions (bottom)



Photo credit: Washington Department of Fish and Wildlife



Commercial tangle-net crew hauling in a Chinook salmon

Fish are captured by CR commercial fishermen, tagged by NOAA Fisheries research biologists, and released. Greater than 2500 adult salmon have been PIT- tagged for this study since 2010.



NOAA & ODFW began tracking fish and pinnipeds using RT in 2016



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

Year	Adult Chinook salmon (N)	Range of sampling dates	Baseline Survival (95% CI)	Baseline Mortality	Potential 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

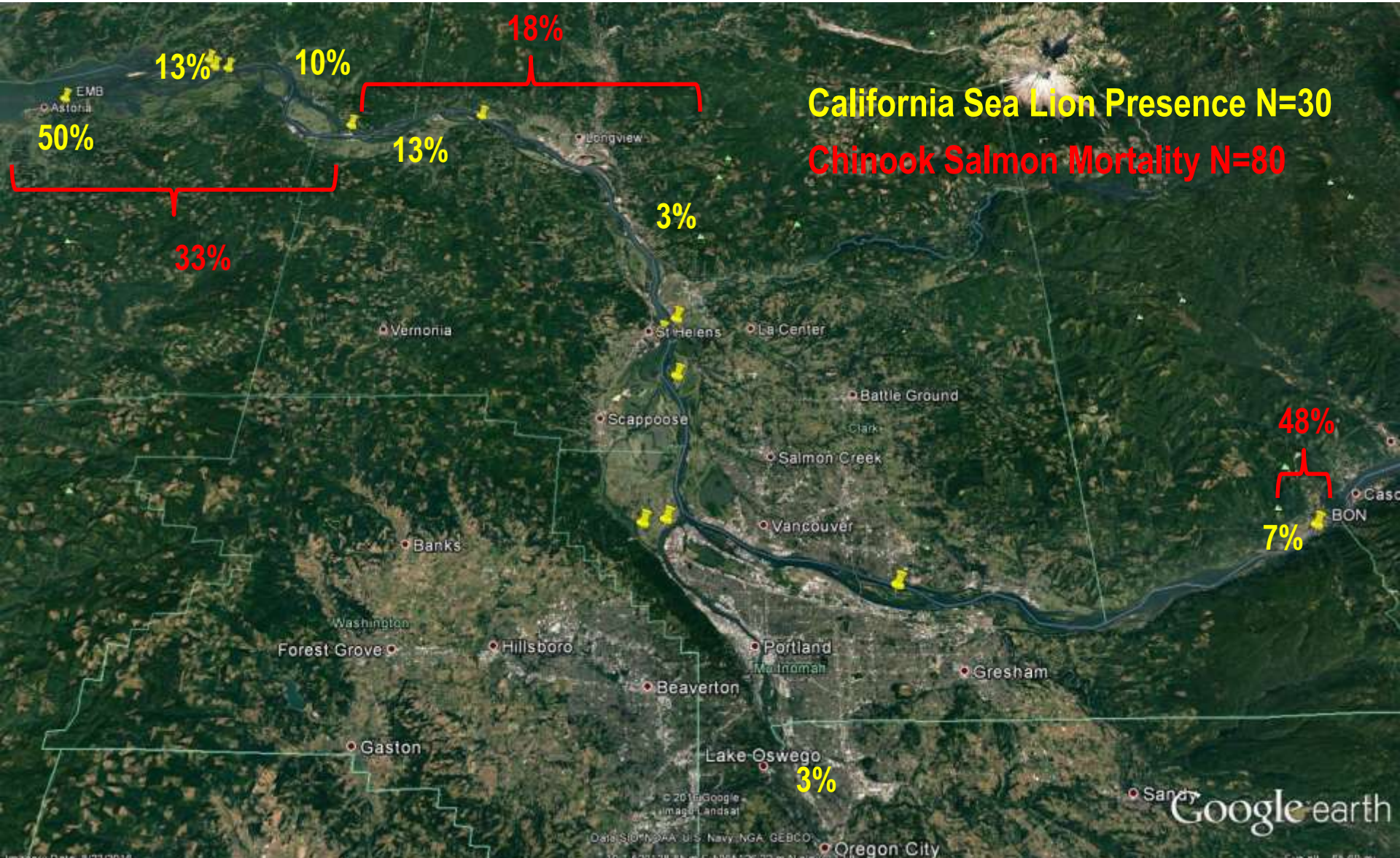
Upriver spring/summer Chinook salmon mortalities

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)

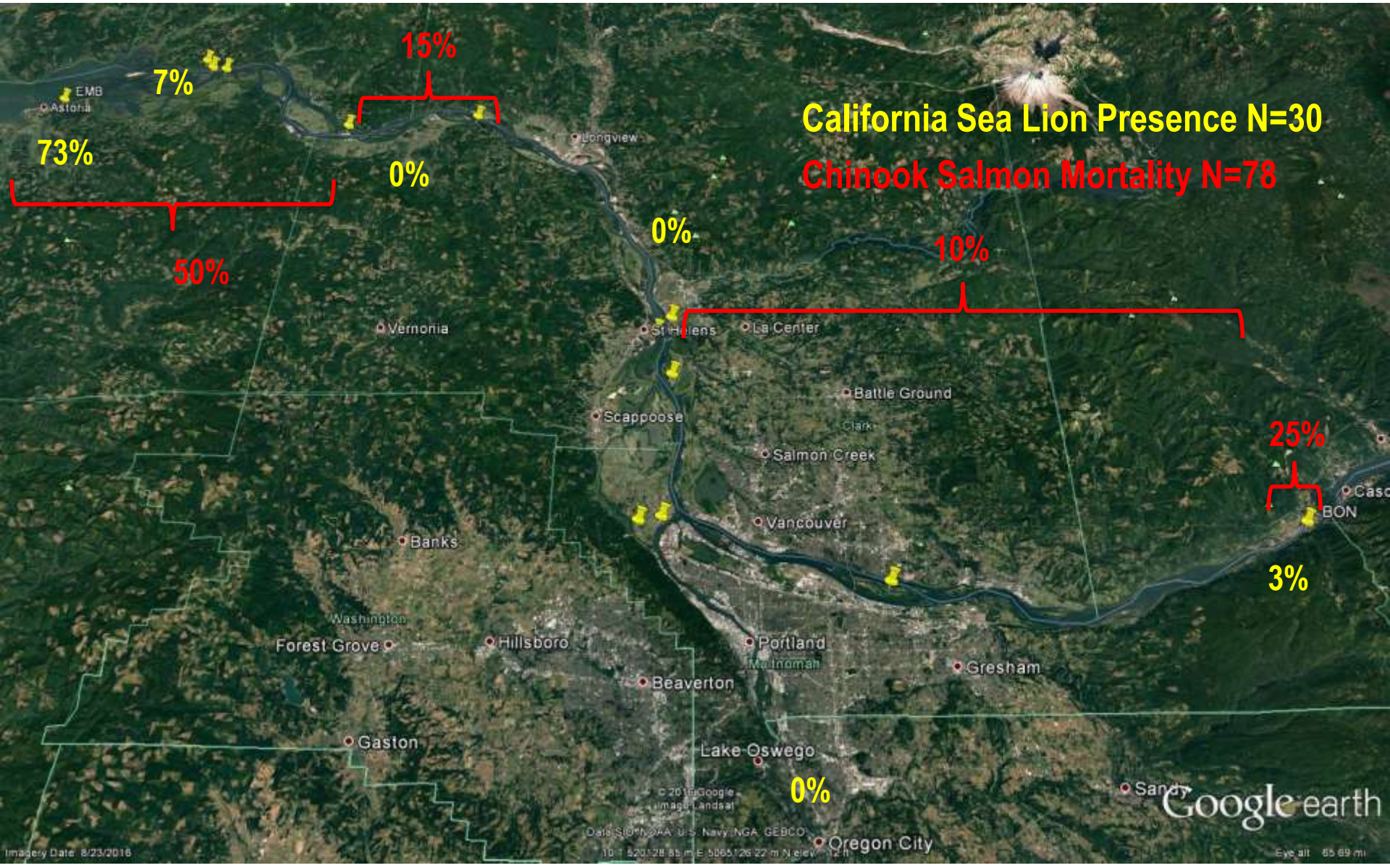
*Upriver return to Bonneville Dam as of 5/31/17

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

Radio Telemetry Results 2016



Radio Telemetry Results 2017



Linear Mixed Effects Modelling

Random effect:

- Week of tagging nested within year with autoregressive component

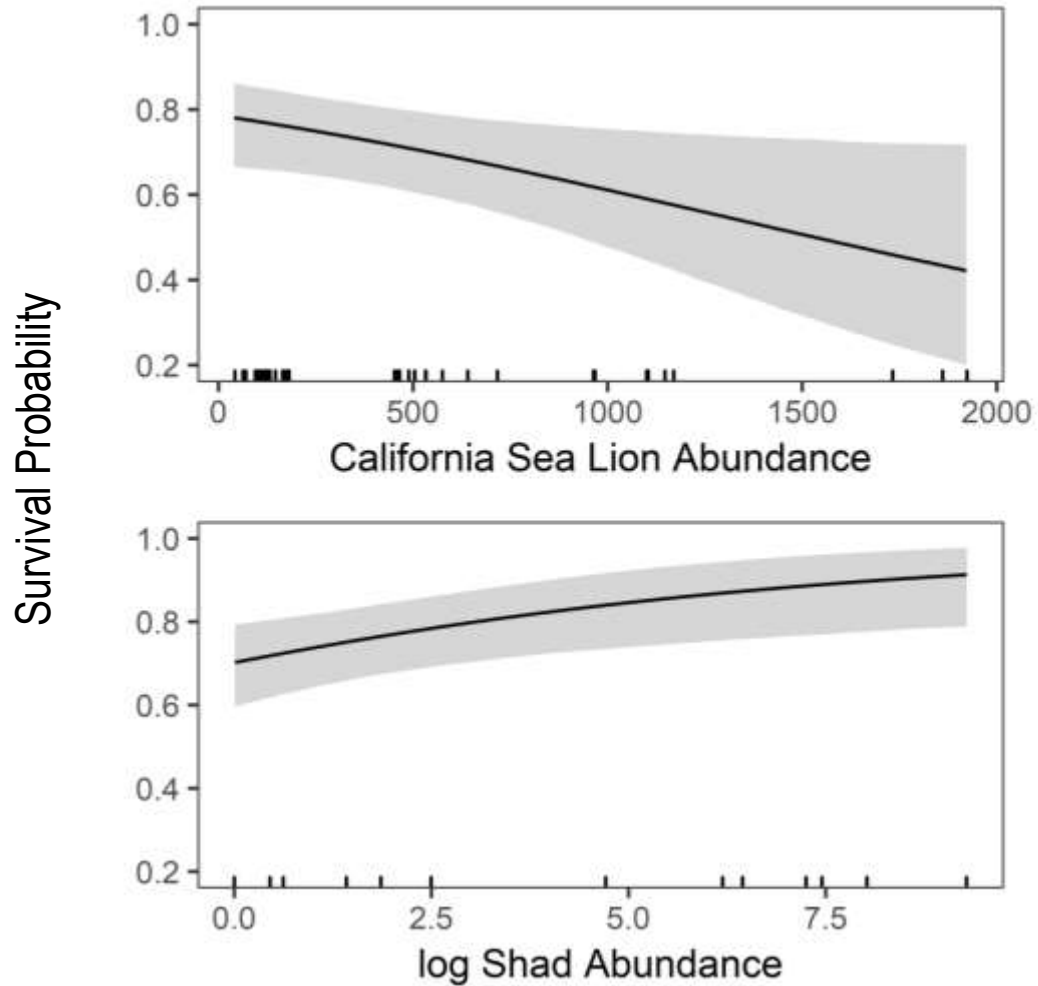
Fixed effects:

- Clip status
- Exposure to California Sea Lions based on EMB abundance during the week fish were tagged
- Abundance of Shad in the estuary during the week fish were tagged

Note: Annual Eulachon abundance is highly correlated ($=.83$) with annual CSL abundance

*The area under the ROC was .70 indicating the model is 'good' with respect to being able to predict survival

Model response curves:



What have we learned?

- 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.
- 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 covariates potentially influencing survival include the abundance of shad, and clip status, and the abundance of eulachon

Stay tuned.....

- Up close study of tailrace survival
- Population level survival and behavior as we summarize results using parentage-based genetics

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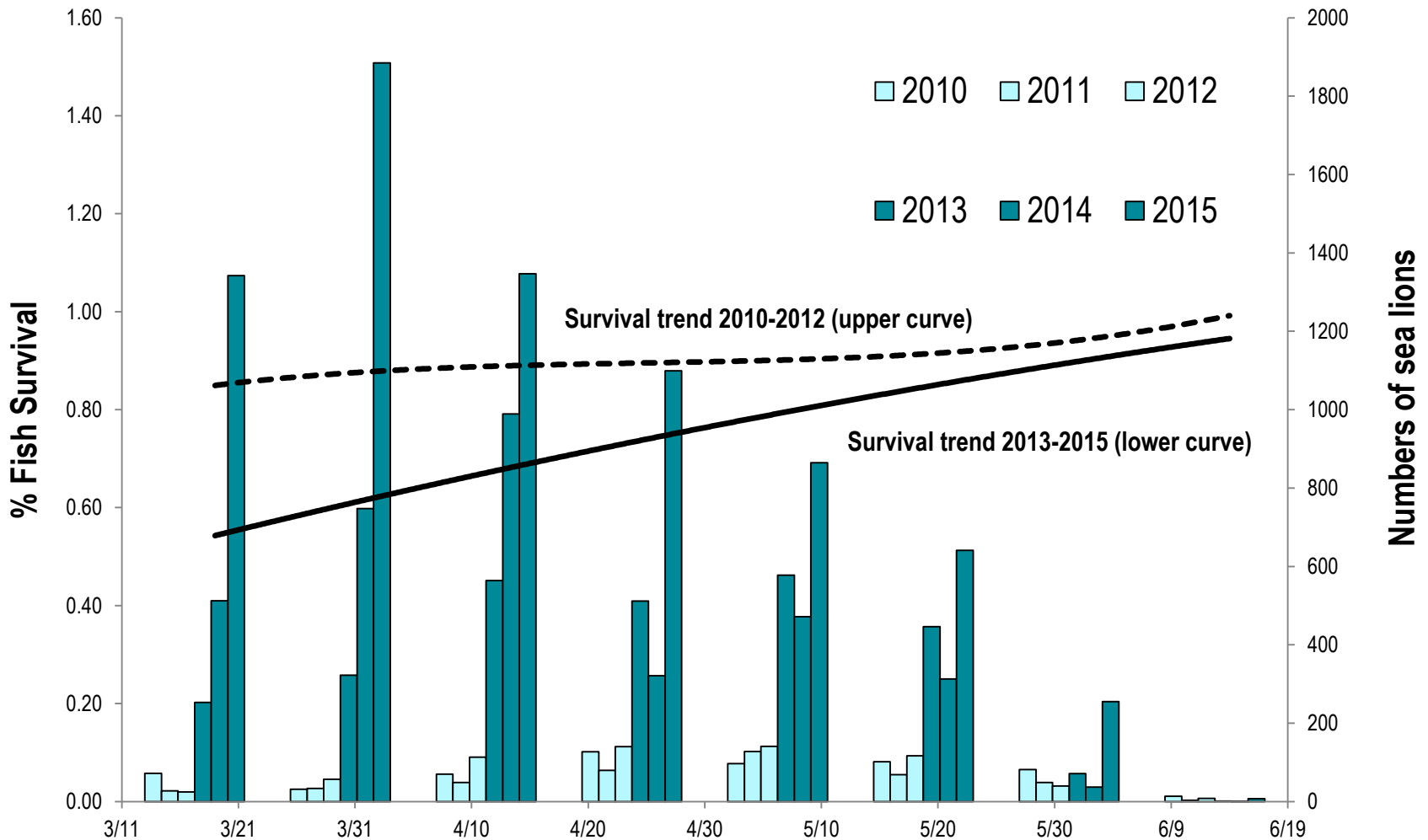


Figure 1. Trends in Survival for PIT-tagged adult Chinook salmon tagged from 2010-2012 and from 2013-2015 (dashed and solid lines) and the corresponding number of sea lions observed at haul out sites (vertical bars) near Astoria, Oregon (rm 16).