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

October 27, 2014

MEMORANDUM

TO: Fish and Wildlife Committee members

FROM: Jim Ruff – Manager, Mainstem Passage and River Operations

SUBJECT: Study update on the survival and run timing of adult spring/summer Chinook salmon through the lower Columbia River to Bonneville Dam

At the November 4th Fish and Wildlife Committee meeting in Portland, Michelle Wargo Rub of NOAA's Northwest Fisheries Science Center will present updated information on the survival and run timing of adult spring/summer Chinook salmon migrating through the lower Columbia River to Bonneville Dam (Attachment).

Background

Since 2010, NOAA Fisheries scientists have been collecting and PIT tagging upriver adult spring/summer Chinook salmon in the lower Columbia River near river mile 21, releasing them and monitoring their migration and survival to Bonneville Dam. Over the 2010-2013 study period, a total of 1,055 adult Chinook salmon have been collected, determined to be destined for tributaries above Bonneville Dam using genetic stock identification, and PIT tagged.

Dr. Wargo Rub's presentation will provide estimates of in-river survival for adult spring Chinook salmon returning to the interior Columbia Basin. The survival estimates will account for mortality from harvest and sampling and thus will isolate mortality that may be attributed to predation by marine mammals in the lower Columbia River, which is consistent with a measure in our revised Fish and Wildlife Program. In addition, estimates of adult salmon run timing, travel time to Bonneville Dam, and residency in the estuary and lower Columbia River for upriver stocks will also be presented.

Attachment

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Survival and run timing for adult spring/summer Chinook salmon through the lower Columbia River to Bonneville Dam

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Background: In 2010 NOAA Fisheries developed the methodology to handle and mark adult salmon returning to the estuary in numbers sufficient for robust survival estimates (Wargo Rub et al. 2012a,b). Working collaboratively with local fishermen, we marked a total of 1,632 returning spring Chinook salmon from 2010-2013. A total of 1,055 salmon were determined to be destined for tributaries above Bonneville Dam by genetic stock identification analysis. Survival estimates for these fish indicate that lower river mortality was significant. After accounting for harvest and impacts from sampling gear, weighted mean annual survival ranged from 69%-90% for the four-year period (Table 1.). Survival was consistently higher for salmon arriving late in the run compared to those returning early or at the peak, implicating predation by pinnipeds as a likely source of mortality (Table 2.). This work also found that adult salmon tagged early in their migration period took significantly longer to reach Bonneville Dam than those sampled later, indicating that early returning stocks may be more vulnerable to both predation and lower river commercial and sport harvest compared to their conspecifics (Figure 1.).

Table 1. Lower Columbia River weighted mean survival estimates for PIT-tagged adult Chinook salmon destined for tributaries above Bonneville Dam. Survival was adjusted to account for potential harvest and impacts from sampling gear therefore estimates of greater than 100% are possible.

Year	Adult Chinook salmon (N)	Dates Sampled	adjusted Survival	95% CI
2010	174	4/14-5/11	90%	(80%-99%)
2011	374	4/1-5/16	85%	(77%-92%)
2012	393	3/23-5/31	82%	(76%-88%)
2013	114	4/19-6/20	69%	(55%-82%)

Table 2. Lower Columbia River weighted mean survival estimates for PIT-tagged adult Chinook salmon destined for tributaries above Bonneville Dam summarized by tagging date (early, midway, or late in the season). Survival was adjusted to account for potential harvest and impacts from sampling gear therefore estimates greater than 100% are possible.

	Adjusted Survival		
Year	Early Season (3/23-4/7)	Middle Season (4/9-5/2)	Late Season (5/3-5/31)
2010	NA	89%	101%
2011	89%	81%	101%
2012	74%	82%	91%
2013	NA	61%	85%

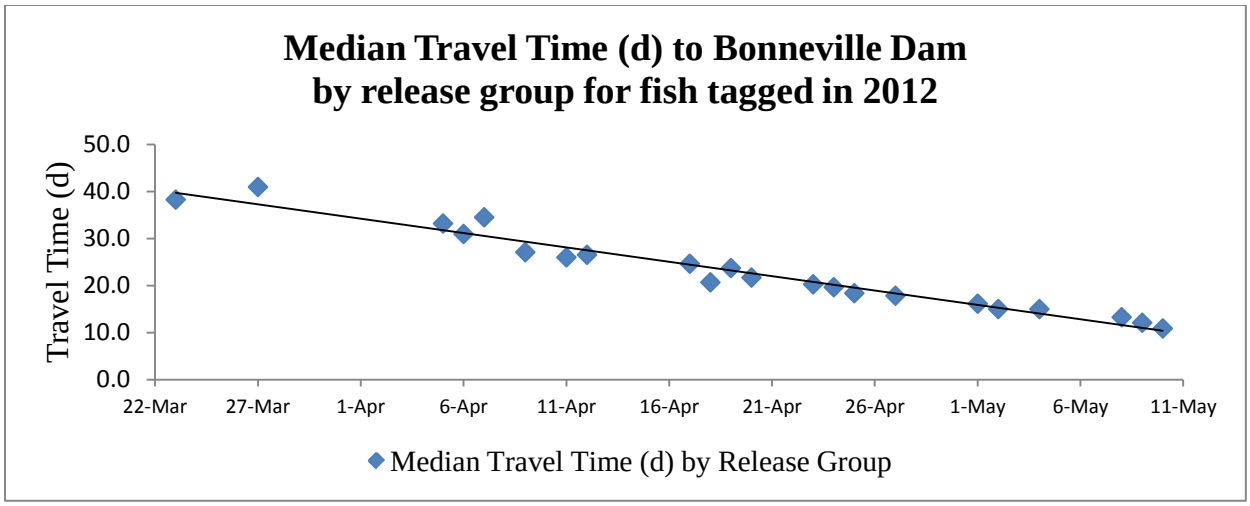


Figure 1. Median travel times to Bonneville Dam by release date for fish tagged in 2012.

Justification: Although tens of thousands of juvenile salmon are implanted with PIT-tags each year, additional tagging of adults is necessary because only about 2-3% of the returning adult salmon population carry tags each year. Furthermore, previously tagged salmon are not likely representative of the run at large, and their return to the river may be clustered in space and time. Our study fish represent the Columbia River (CR) spring Chinook salmon run at large. These salmon are captured, tagged, and released at several locations within the lower CR near rkm 34 over the course of the entire spring return. Data from detections of these fish provides an overall survival estimate from the estuary to Bonneville Dam. Tissue samples from all study fish are genetically analyzed. Results from these analyses provide information on movement and survival through the lower CR and hydrosystem for fish returning to the Upper and Middle Columbia and Snake Rivers.

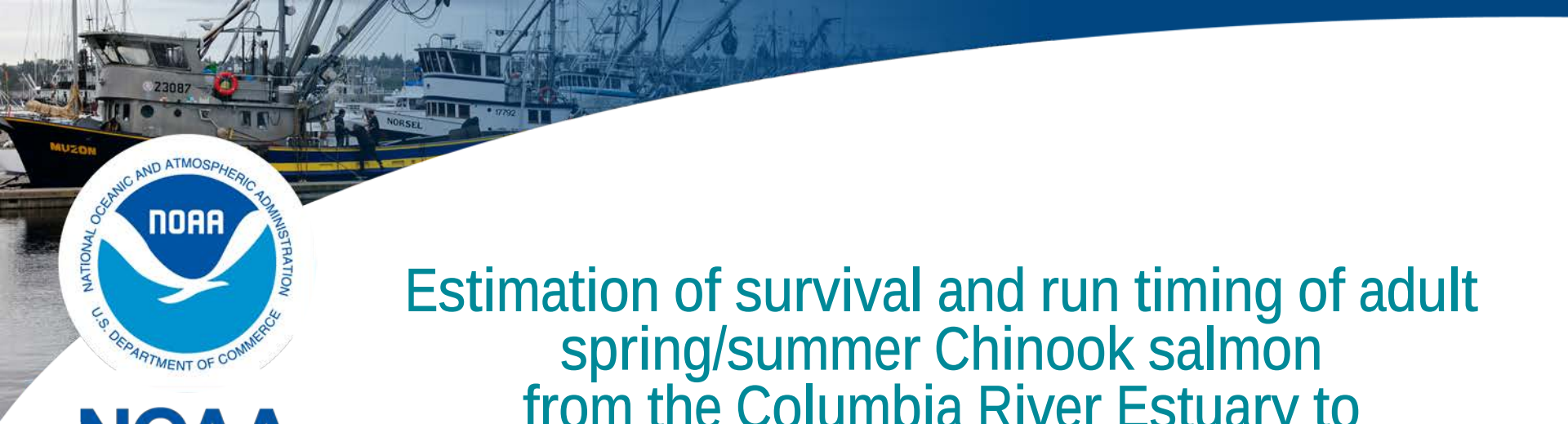
Deliverables: This study provides estimates of in-river survival for adult spring Chinook salmon returning to the interior Columbia Basin. These estimates account for mortality from harvest and sampling and thus isolate mortality that may be attributed to predation by marine mammals. Estimates of run timing and residency in the estuary/lower river for upriver stocks are also identified. Sampling information from this study can be used by fisheries managers to estimate run strength during the course of the season. Managers can also track progress of marked fish through the CR hydrosystem via PTAGIS. This information will assist managers in adjusting preseason run forecasts and regulating harvest. In 2015 it will also be possible to identify hatchery Chinook salmon released above Bonneville Dam back to their parents based on single nucleotide polymorphisms (SNIPS) genetic testing (Hess et al. 2013).

References:

Wargo Rub, A. M, Gilbreath, L. G., McComas, R. L, Sandford, B. P., Teel, D. J., and Ferguson, J. W. 2012a. Estimated survival of adult spring/summer Chinook salmon from the mouth of the Columbia River to Bonneville Dam, 2010. Report of the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. http://www.nwfsc.noaa.gov/research/divisions/fe/documents/adult-survival-2010.pdf (February 2014).

Wargo Rub, A. M, Gilbreath, L. G., McComas, R. L, Sandford, B. P., Teel, D. J., and Ferguson, J. W. 2012b. Survival of adult spring/summer Chinook salmon from the mouth of the Columbia River to Bonneville Dam, 2011. Report of the National Marine Fisheries Service. , Northwest Fisheries Science Center, Seattle, WA http://www.nwfsc.noaa.gov/research/divisions/fe/documents/adult-survival-2011.pdf (February 2014).

Hess, J. E., Campbell, N. R., Matala, A. P., and Narum, S. R. 2013. Annual Report: Genetic Assessment of Columbia River Stocks. U. S. Department of Energy Bonneville Power Administration Report Project #2008-907-00.



NOAA FISHERIES

Northwest Fisheries Science Center

Estimation of survival and run timing of adult spring/summer Chinook salmon from the Columbia River Estuary to Bonneville Dam: a cooperative effort between NOAA Fisheries and Columbia River commercial fishermen

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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 and Snake Rivers

Contemporary smolt-to-adult return rates (SARs) for spring/summer Chinook salmon originating above Bonneville Dam (RKM 234) are based on adult returns to Bonneville Dam. As such, any 'natural mortality' (e.g. any mortality not due to fishing) that might have occurred in the estuary or lower river gets attributed to the ocean phase of the salmonid life history.

- mask important stressors that adult fish may encounter within the estuary and lower river
- may underestimate the true benefits of conservation measures implemented at earlier life history stages
- may effect predictions of run size

Natural mortality in the CR estuary and lower river may be significant

- The CR pinniped population has grown steadily since passage of the Marine Mammal Protection Act in 1972
- In 2010 as many as 7k pinnipeds were estimated to reside in the near ocean & CR below Bonneville Dam for all or part of the year including 3k California and Stellar Sea Lions & 4k Harbor Seals
- >90% of the CR population resides in the estuary and lower River
- There is concern that the number of sea lions has increased further in response to recent robust smelt runs.
- In 2013 the number of sea lions identified at haul out sites near Astoria, OR was 5x's that observed during each of the previous three years
- The number of sea lions identified at haul out sites near Astoria in 2014 exceeded those observed during 2013

Commercial tangle–net crew hauling in a Chinook salmon

Custom fabricated PVC tubes

Facilitated safe handling, holding, and transfer of study fish

Adult Chinook salmon being transferred from the commercial fishing vessel to a research vessel using PVC tubes

Study fish were physically restrained in dorsal recumbency for tissue collection and tagging

> 2200 returning spring/summer Chinook salmon have been tagged for this study since 2010

- Willamette River spring Chinook (22%)
- West Cascade tributary spring Chinook (9%)
- Middle and Upper Columbia River spring Chinook (36%)
- Snake River spring/summer Chinook (31%)
- Upper Columbia River summer/fall Chinook (<1%)
- North Oregon Coast Chinook (<1%)

Survival to Bonneville Dam is determined for upriver stocks after adjusting for:

- detection efficiency at Bonneville Dam (98-99%)
- gear associated mortality (12.8%)
- mortality due to harvest (2.5-4 %)

Adjusted Survival for Interior CR stocks

Year	Interior CR Adult Chinook salmon (N)	Dates Sampled	adjusted Survival	95% CI
2010	174	4/14-5/11	90%	(80%-99%)
2011	374	4/1-5/16	85%	(77%-92%)
2012	393	3/23-5/31	82%	(76%-88%)
2013	114	4/19-6/20	69%	(55%-82%)
2014	324	3/20-5/13	*55%	(46%-65%)

*Preliminary estimate; assumes harvest of 4%

Survival varied by tagging date

	Adjusted Survival		
Year	Early Season (3/20-4/7)	Middle Season (4/9-5/2)	Late Season (5/3-6/20)
2010	NA	89%	101%
2011	89%	81%	101%
2012	74%	82%	91%
2013	NA	61%	85%
2014	*40%	*63%	*82%

*Preliminary estimate; assumes harvest of 4%

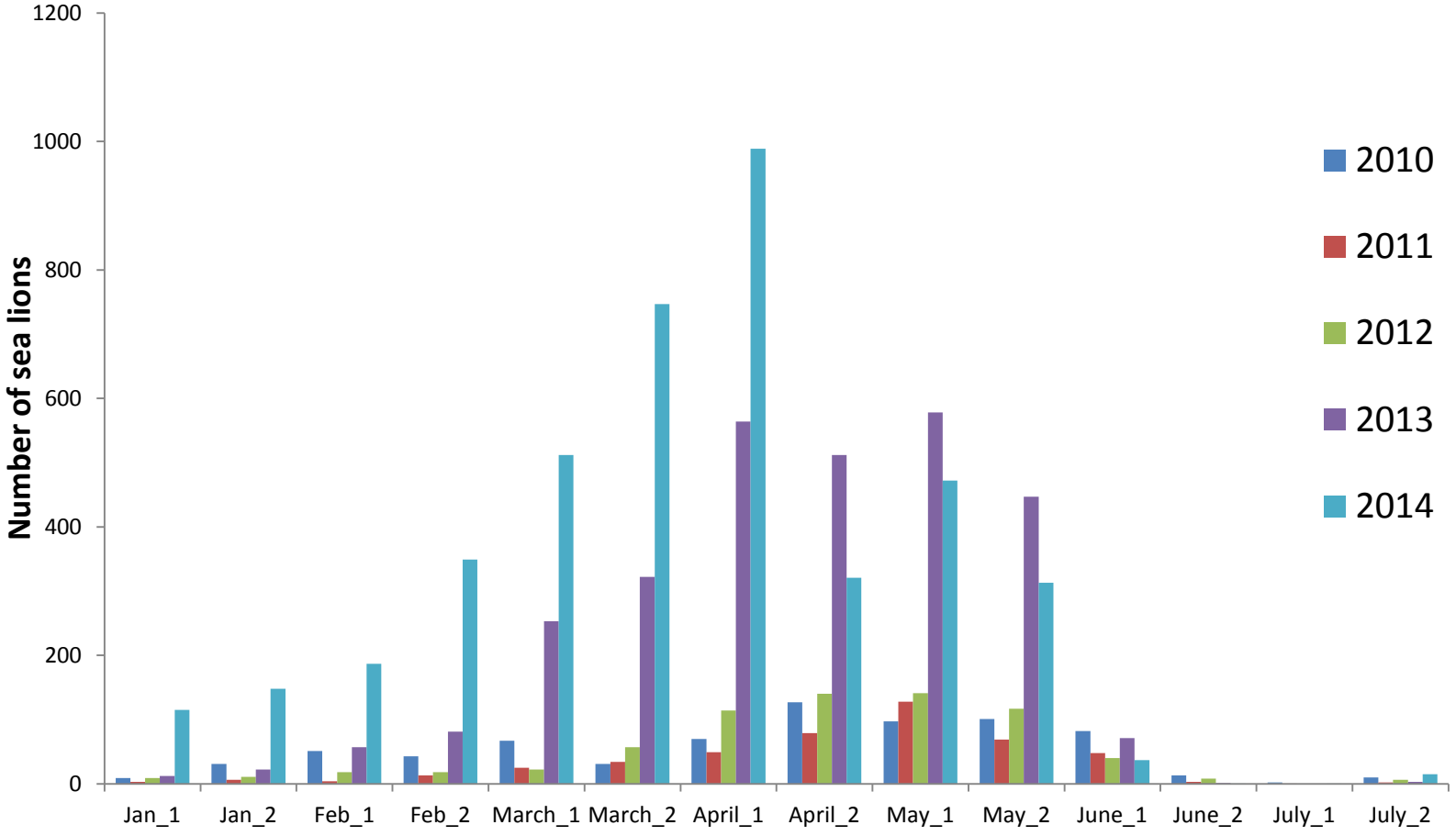
What does this imply?

Year	Spring/summer Chinook returns (N)	mortalities (N)	*sea lions (N)
2010	315,345	35,038	80
2011	221,200	39,035	72
2012	203,100	44,582	109
2013	123,100	55,260	495
2014	~220,000	99,000	616

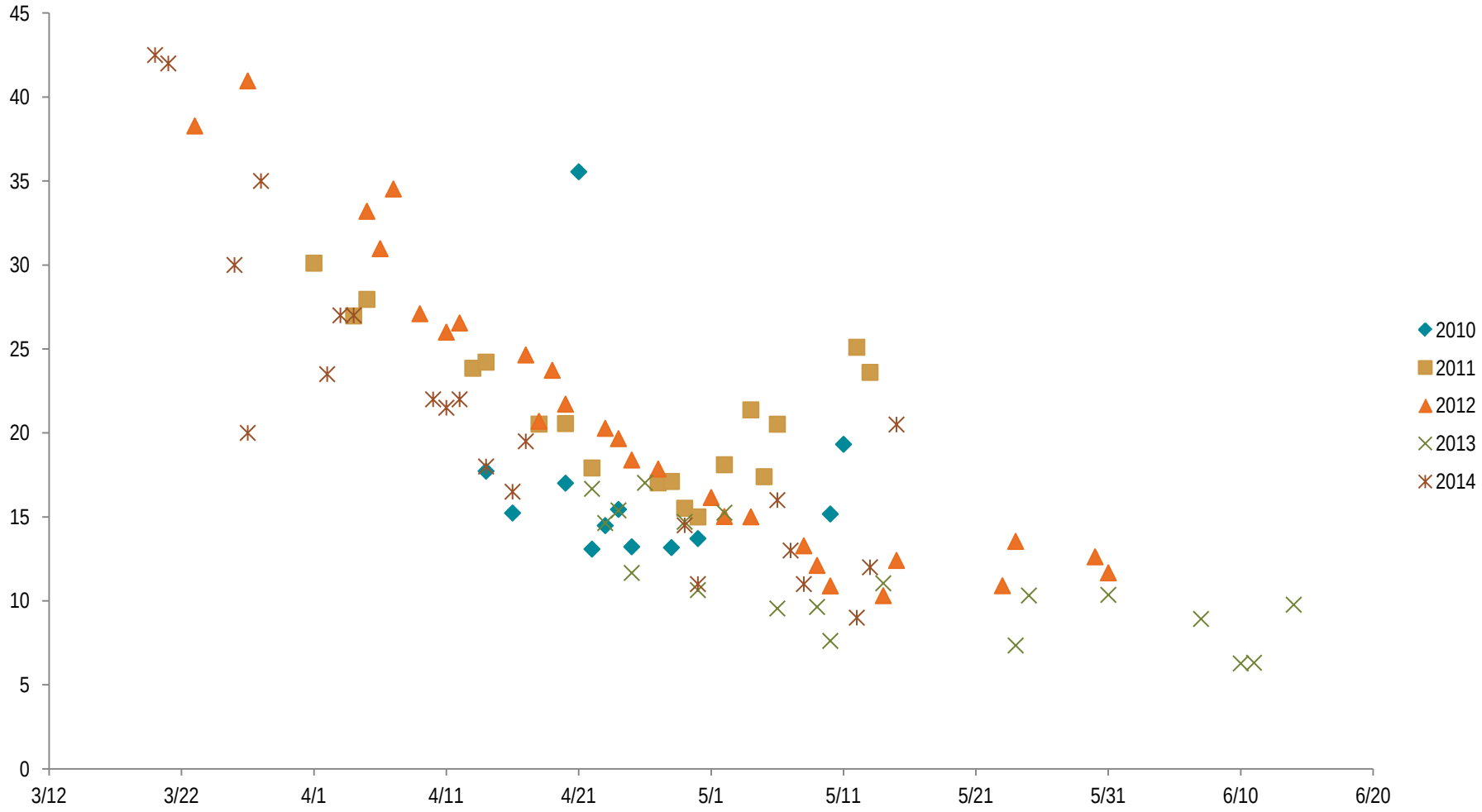
*The average number of sea lions observed at haul out sites near Astoria, OR by ODFW staff for the period March 15-May 15 (M. Tennis, ODFW, pers. comm.).

Theoretical estimates of predation = 22.5-57k

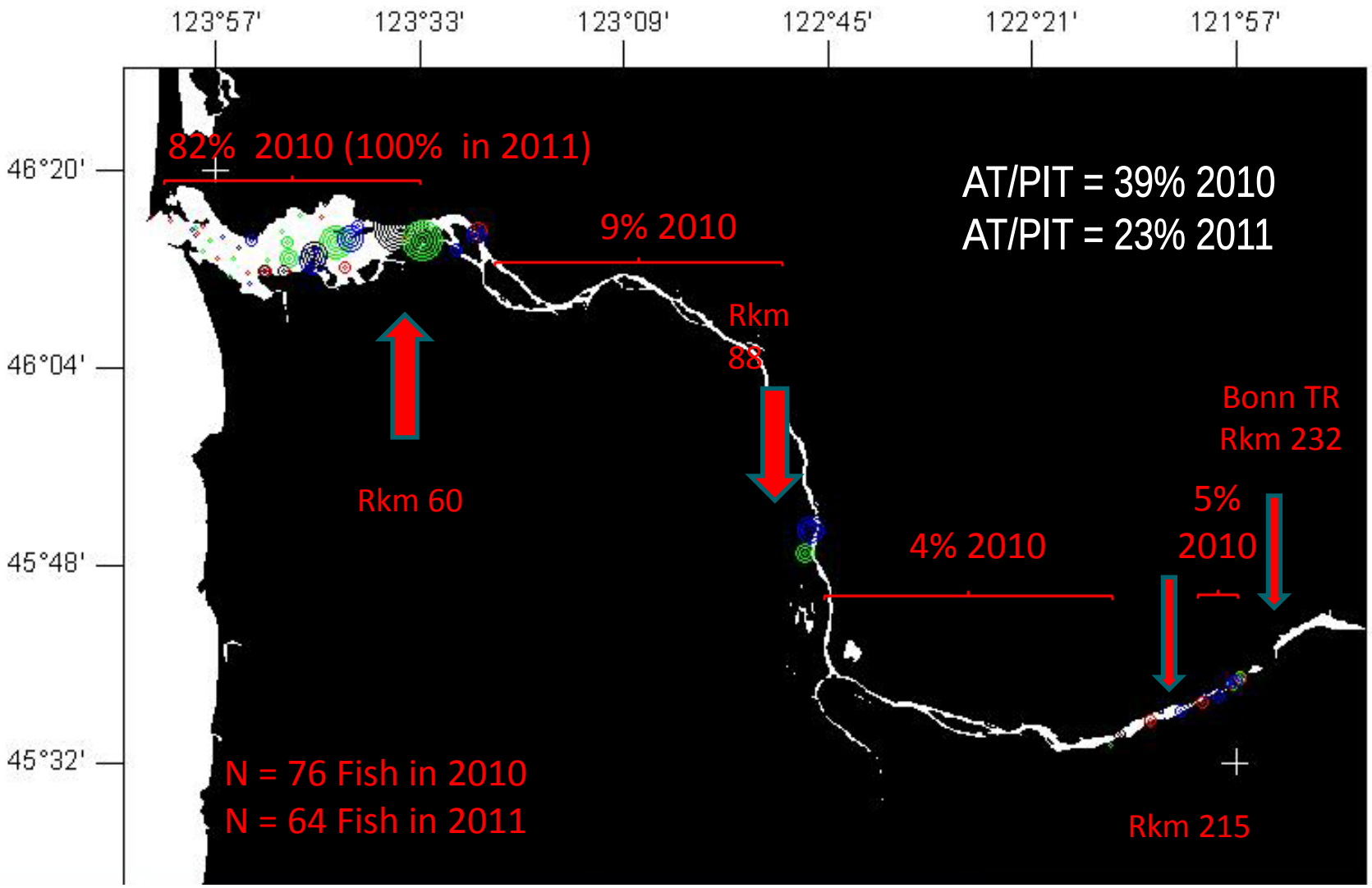
Average biweekly number of sea lions hauled out at the East End Mooring Basin near Astoria, OR



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



Where did mortality occur?



+

69 kHz @ 158 dB
re 1µ Pa

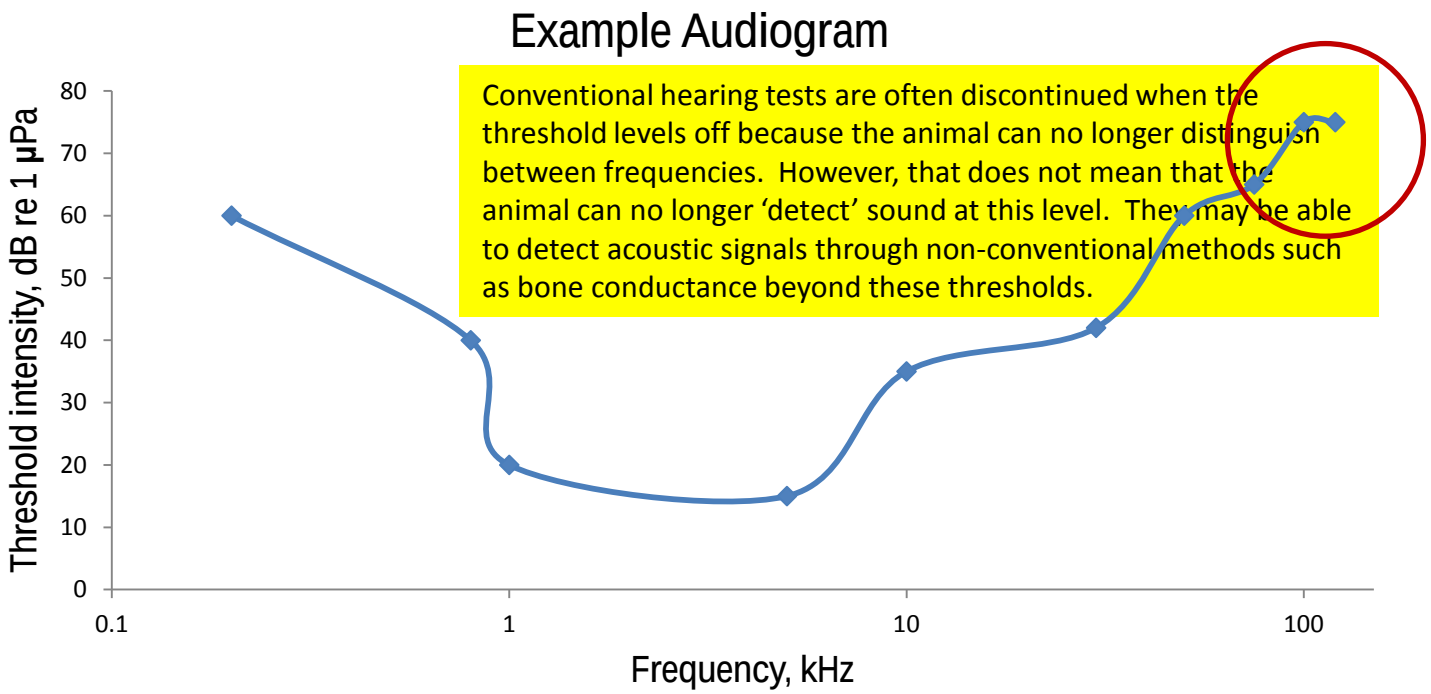
=

?

Published High-Frequency hearing limits:

100 kHz for Harbor Seals

34kHz for California Sea Lions



There are at least three problems with applying hearing thresholds from the published literature to our applications:

1.) studies were conducted on only a few animals

2.) tests were conducted to determine the upper threshold with which animals were able to distinguish between different frequencies, not necessarily the upper hearing limit

3.) tag intensities are well above those which have been tested during conventional hearing tests (e.g. 150 dB re 1µPa compared to 60 dB re 1µPa

Collaborative research conducted between researchers at the NWFSC, the SWFSC, and the Institute of Marine Sciences, Long Marine Laboratory, UCSC

24yr old male harbor seal Sprouts

4yr old female CSL Ronin

Both Animals were exposed to a 69 kHz pure tone

Harbor seal detected this tone at 106 dB (this was slightly lower (i.e. more sensitive than expected), but within the range of published data)

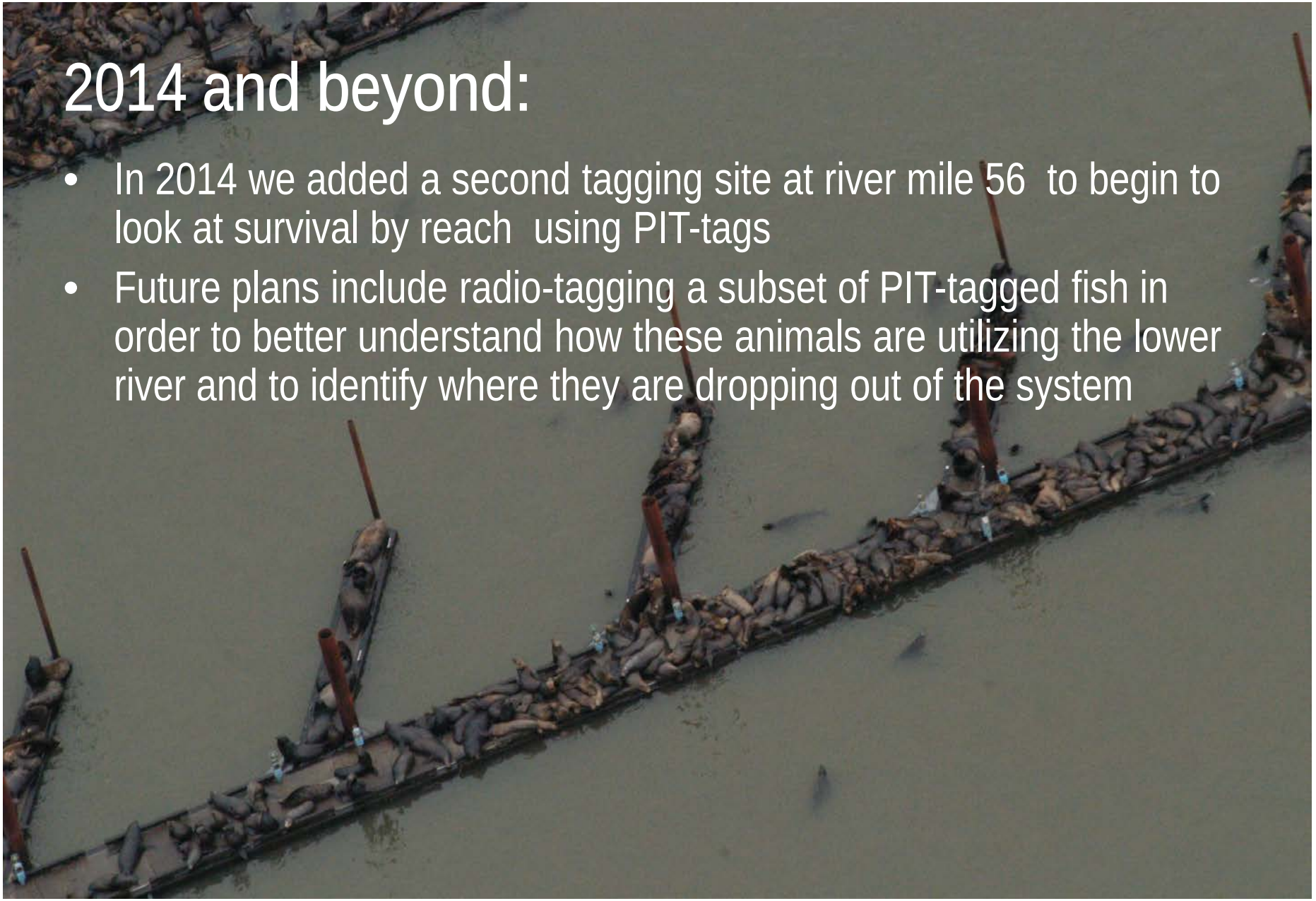
*Based on this information, the detection range of a Vemco 69 kHz high OP transmitter would be ~900 m in FW

CSL detected this tone at 112dB
(this was 33 dB lower than expected compared to published data)

*Based on this information, the detection range of a Vemco 69 kHz high OP transmitter would be ~350m in FW

2014 and beyond:

- In 2014 we added a second tagging site at river mile 56 to begin to look at survival by reach using PIT-tags
- Future plans include radio-tagging a subset of PIT-tagged fish in order to better understand how these animals are utilizing the lower river and to identify where they are dropping out of the system



Genetics 2014 and future:

Genotypic Sex	(N)
F	264
M	301
Total	565

Spawn Year	(N)
2008	1
2009	2
2010	133
2011	28
Total	164

PBT Hatchery Assignment	(N)
Clearwater	17
Dworshak	37
Lookingglass	23
LyonsFerry	2
McCall	1
NezPerce	5
Pahsimeroi	2
PowellSatellite	11
RapidRiver	59
Sawtooth	7
Total	164

Summary:

- >2200 fish tagged since 2010
- Average annual survival ranged from 55-90%
- Mortality was highest for fish tagged in late March and April
- Travel time to Bonneville Dam is also longer for fish tagged during March and April
- Higher mortality coincides with peak sea lion presence
- Average annual survival decreased from 2010-2014
- The number of sea lions hauled out near Astoria, OR increased over same time period
- Early attempts to identify reach survival were confounded by an acoustic tag effect so radio-telemetry is planned for 2015
- SNPs parent-based genetics testing is promising for hatchery and tributary level information on survival and movement

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 & Don Van Doornik 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)

www.nwfsc.noaa.gov/research/divisions/fe/estuarine/adult-est-survival.cfm