CALIFORNIA SEA LION PREDATION ON STEELHEAD AT WILLAMETTE FALLS, 2014-2020

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Oregon Department of Fish and Wildlife

2018 Pacific Coast Steelhead Management Meeting

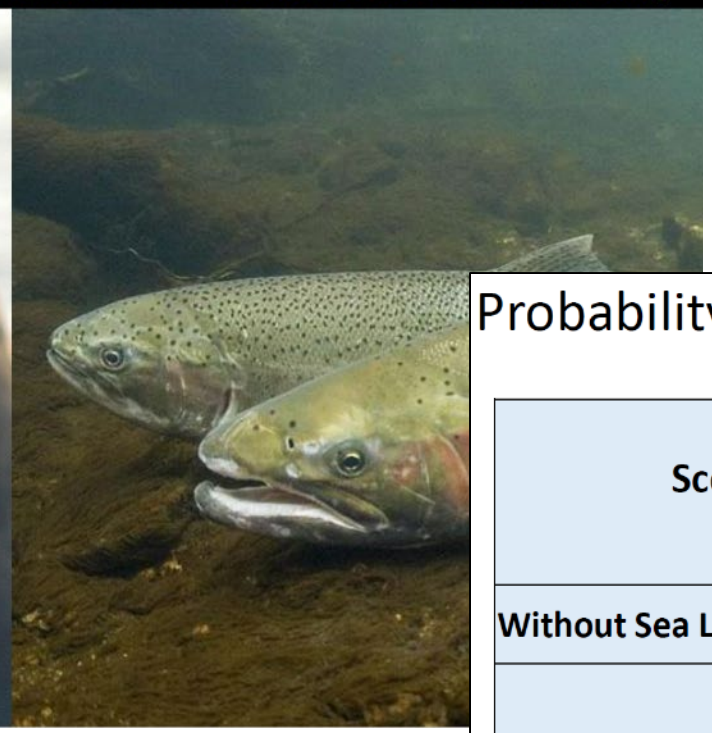
Marcus Whitman Hotel

Walla Walla, Washington

March 20-22, 2018

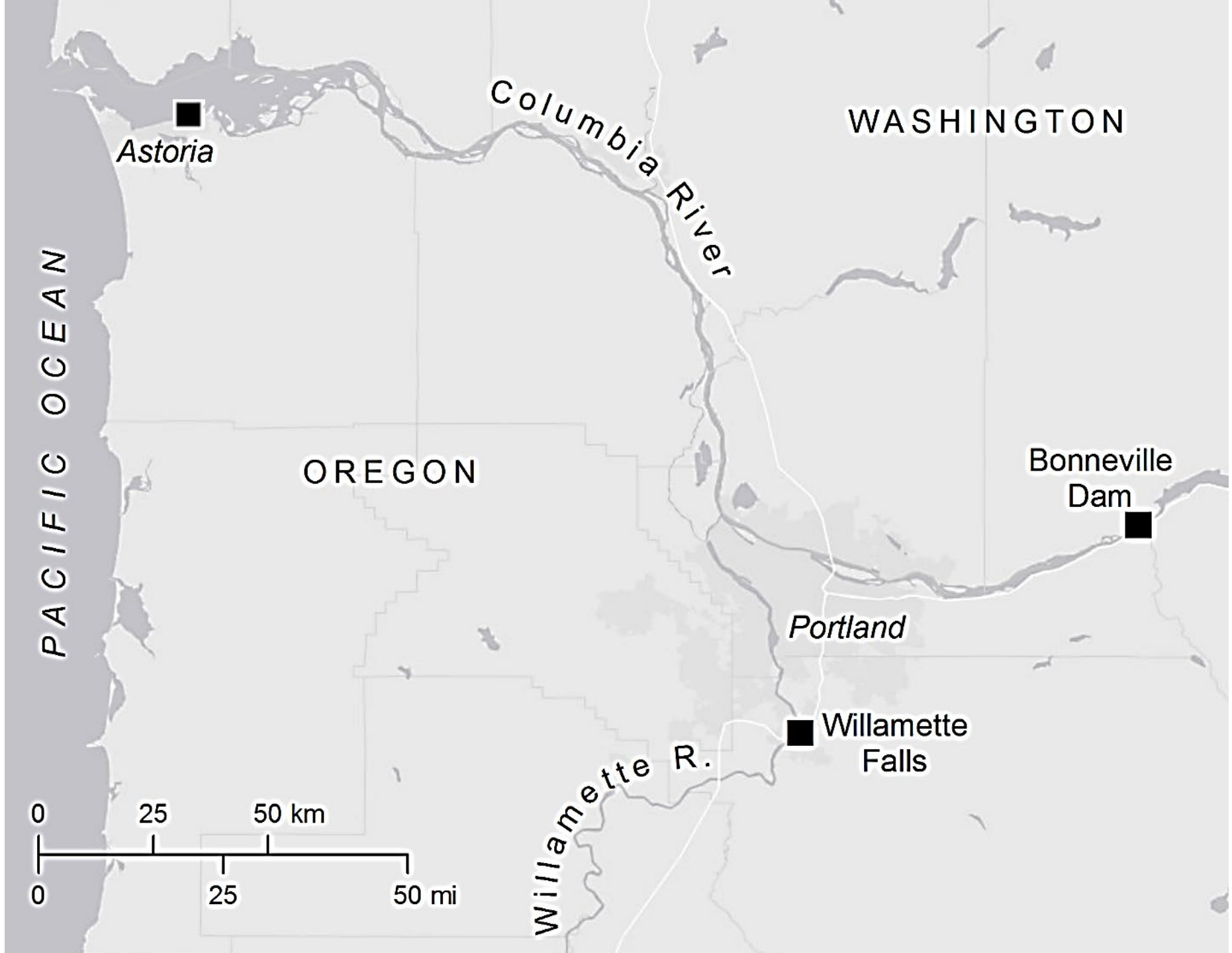
Effects of sea lion predation on Willamette River winter steelhead viability

Matt Falcy
Bryan Wright

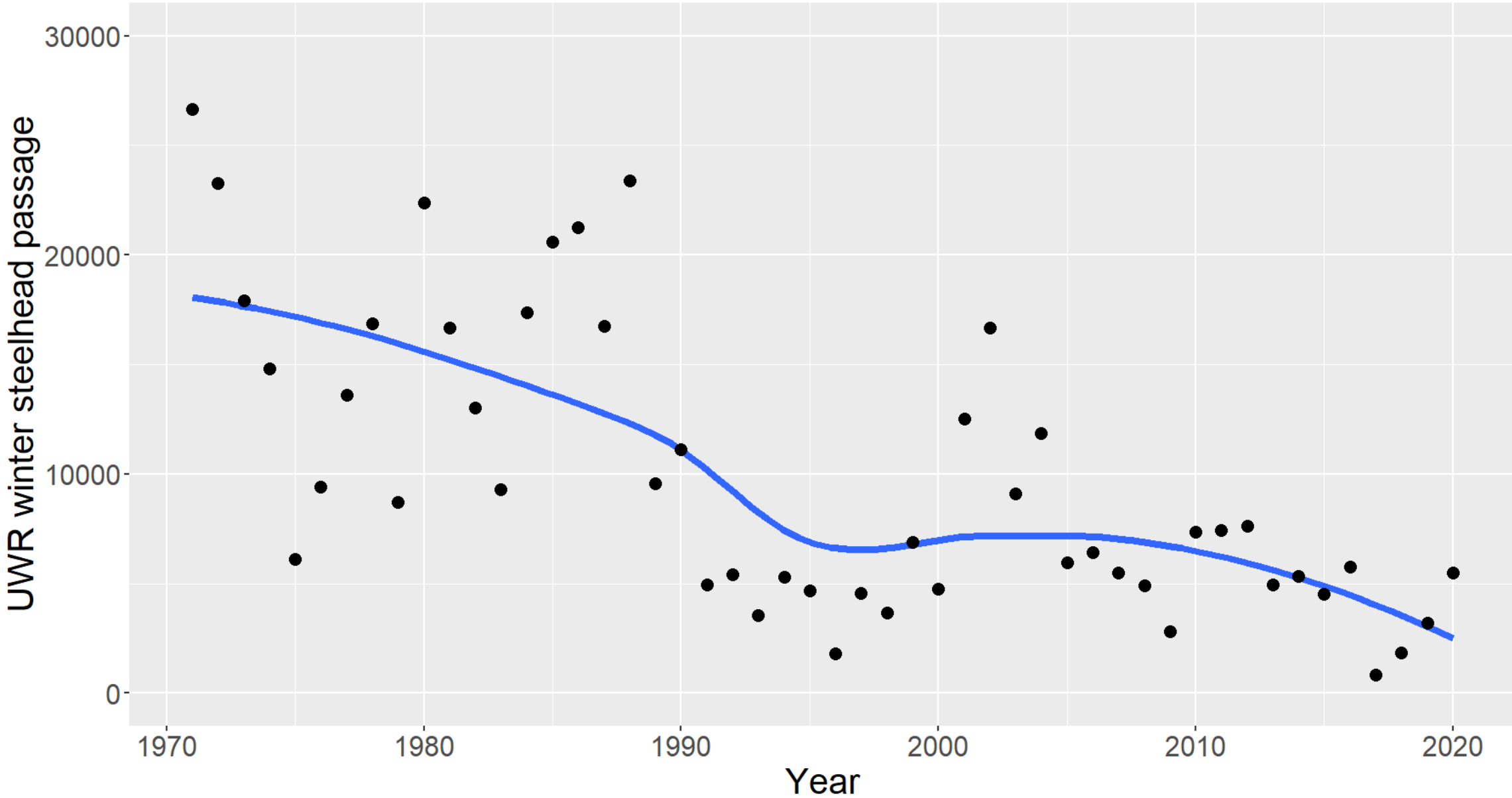


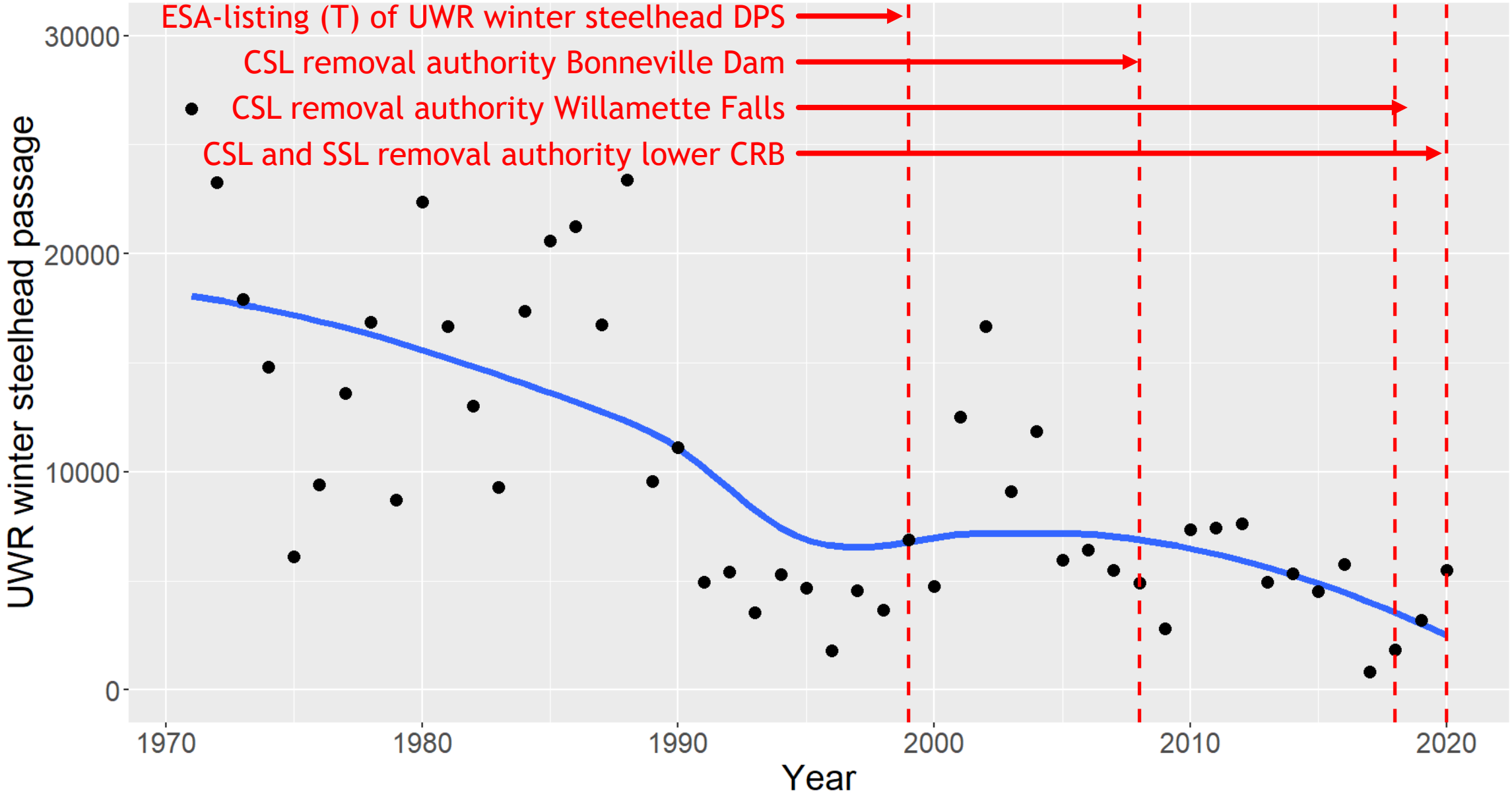
Probability of Extirpation

Scenario		Population			
		North Santiam	South Santiam	Molalla	Calapooia
Without Sea Lions:		2%	5%	0%	99%
With Sea Lions:	lowest observed predation (2015)	8%	16%	0%	99%
	average predation (2016)	27%	34%	2%	99%
	highest observed predation (2017)	64%	60%	21%	99%


PACIFIC OCEAN
Astoria
Columbia River
WASHINGTON
OREGON
Bonneville Dam
Portland
Willamette Falls
Willamette R.
0
25
50 km
0
25
50 mi

COMMON PINNIPEDS IN OREGON


UWR winter steelhead passage
30000
20000
10000
0
1970
1980
1990
2000
2010
2020
Year


ESA-listing (T) of UWR winter steelhead DPS
CSL removal authority Bonneville Dam
CSL removal authority Willamette Falls
CSL and SSL removal authority lower CRB
UWR winter steelhead passage
30000
20000
10000
0
1970
1980
1990
2000
2010
2020
Year

The Marine Mammal Protection Act of 1972 As Amended

as amended through 2018

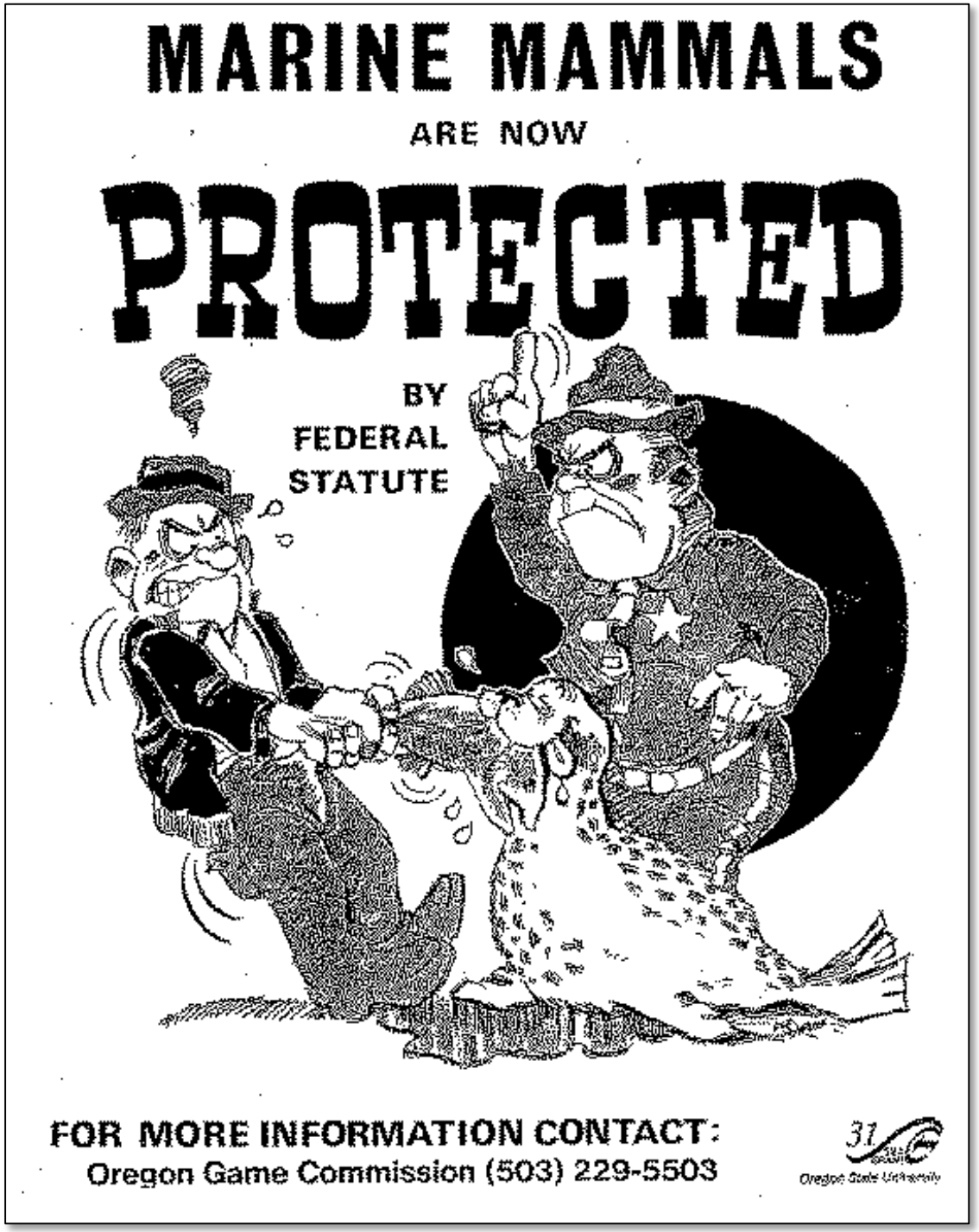
Compiled and annotated by the

Marine Mammal Commission
4340 East-West Highway
Bethesda, MD 20814

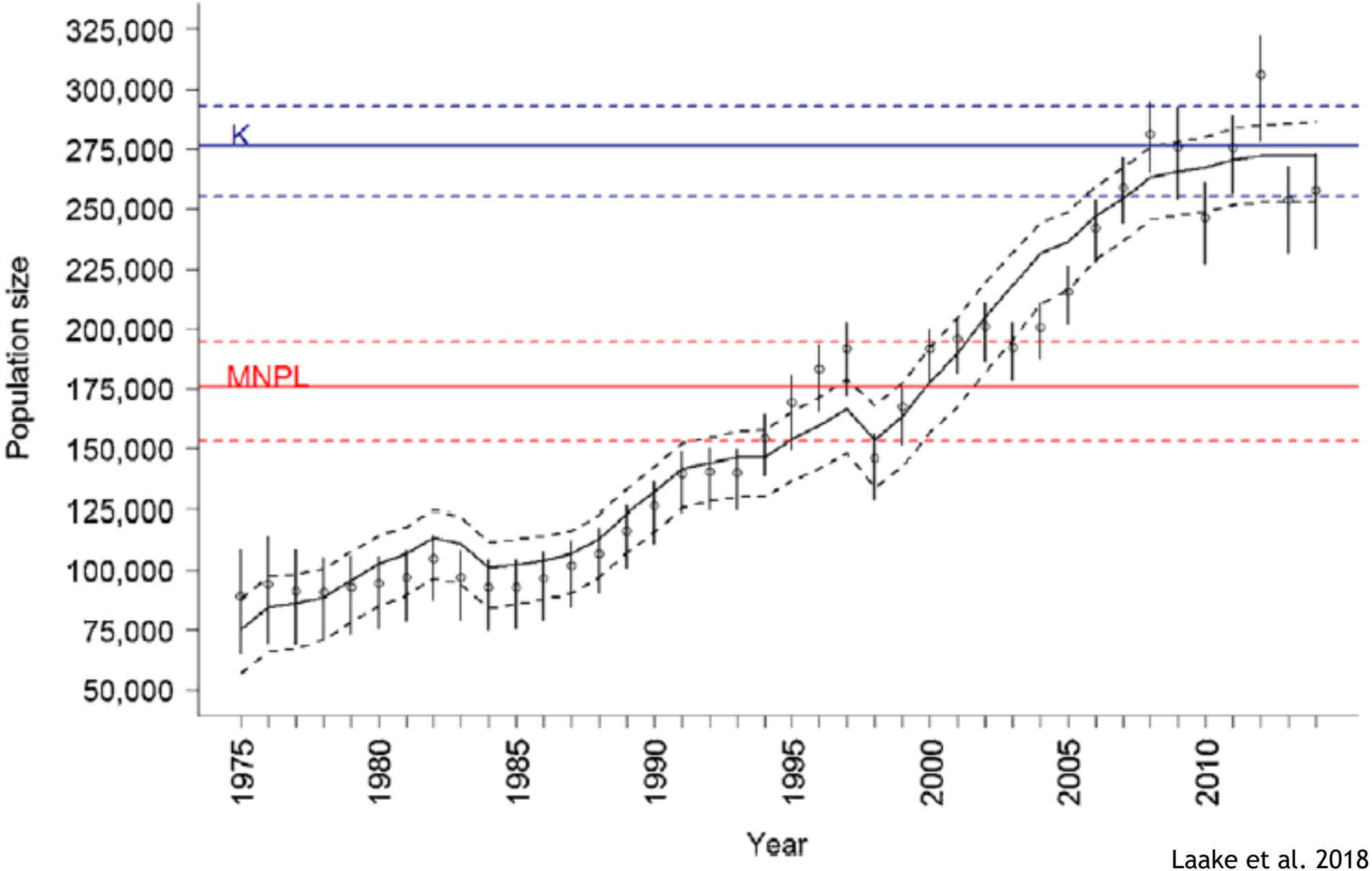
Updated with 2018 Amendments by

NOAA's National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Revised March 2019



California sea lion abundance (U.S. stock)



Source:
Laake et al. 2018 J Wildlife Management

California sea lion counts (Oregon)

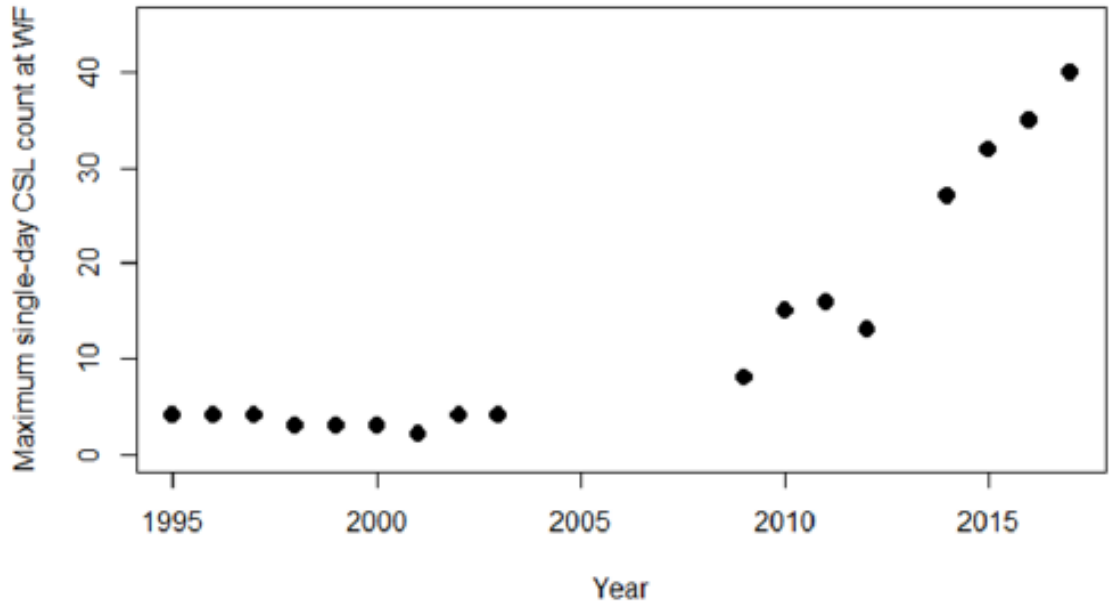


Figure 1. Maximum single-day CSL count at Willamette Falls by year. Monitoring from 1995-2003 and 2014-2017 was conducted by ODFW; monitoring from 2009-2012 was conducted by PSU.

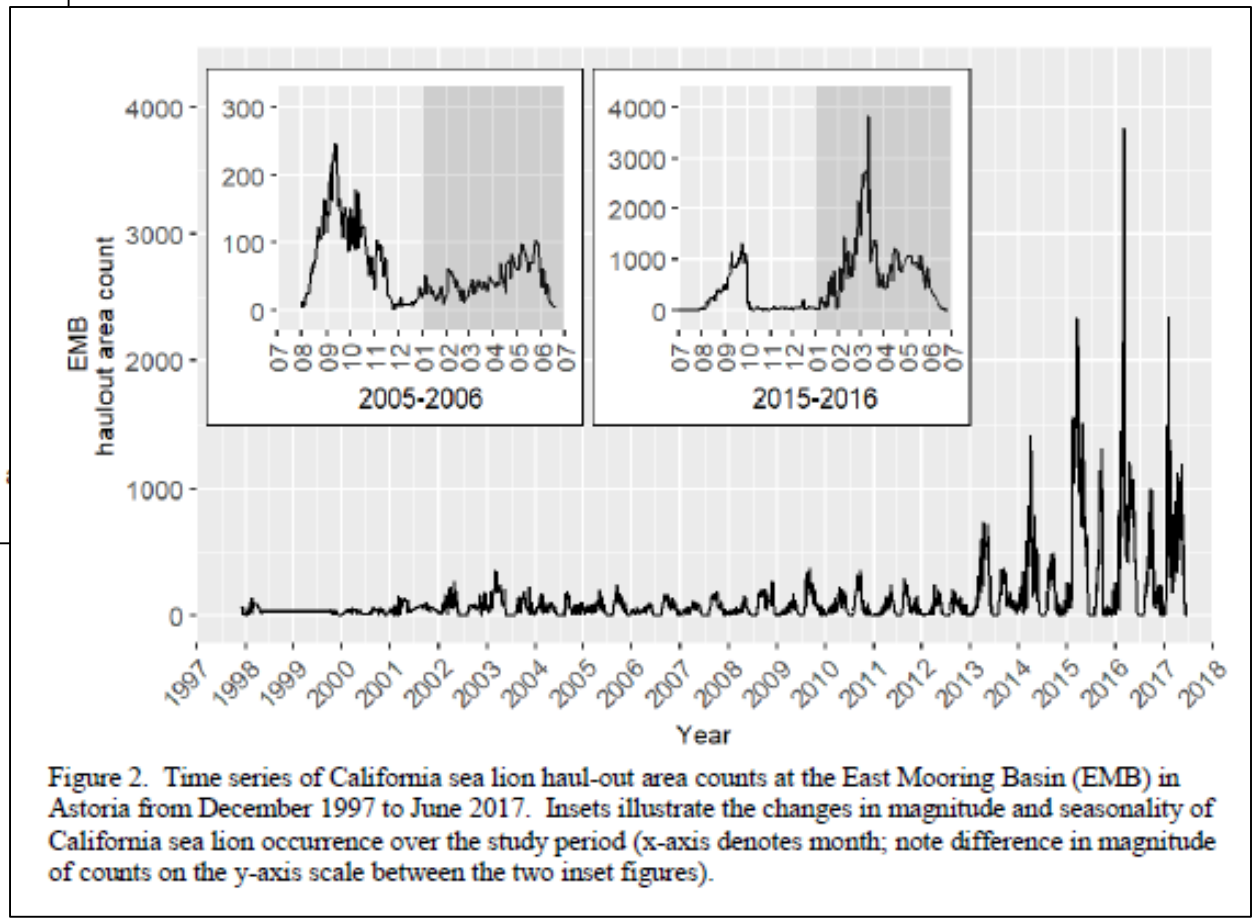
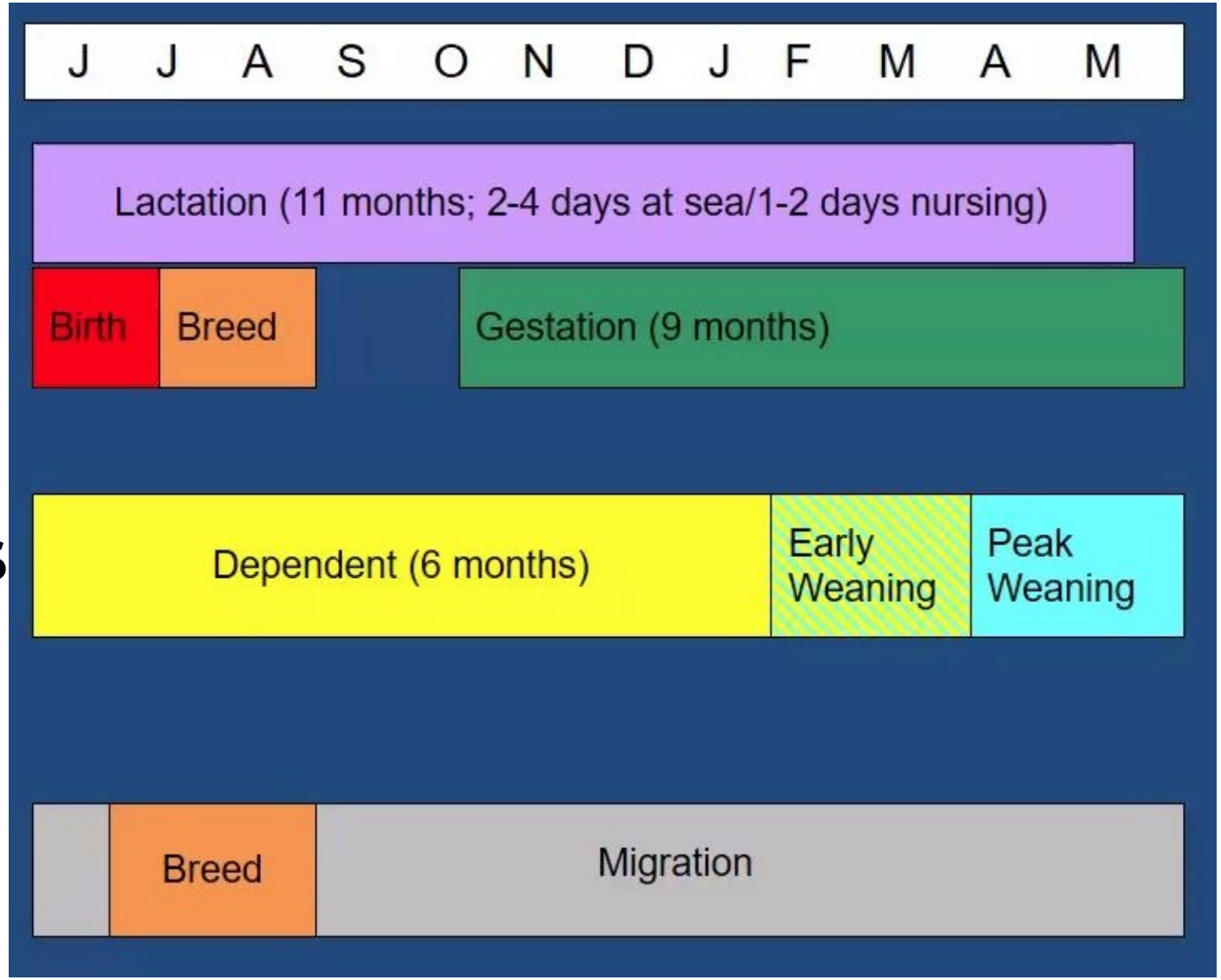
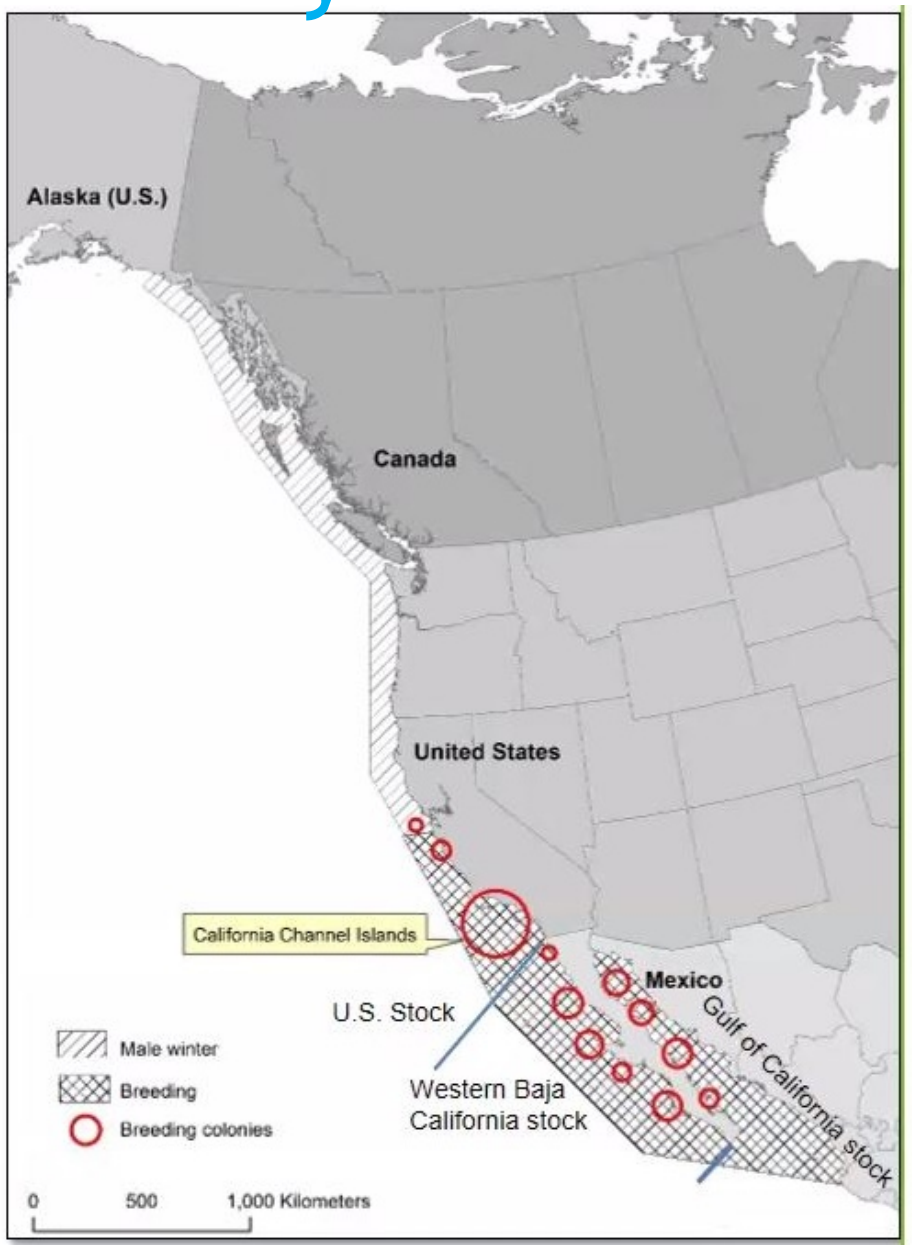


Figure 2. Time series of California sea lion haul-out area counts at the East Mooring Basin (EMB) in Astoria from December 1997 to June 2017. Insets illustrate the changes in magnitude and seasonality of California sea lion occurrence over the study period (x-axis denotes month; note difference in magnitude of counts on the y-axis scale between the two inset figures).

Source: ODFW Section 120 application to NMFS, 2017

California sea lion life history





Source: NMFS

California sea lion movements

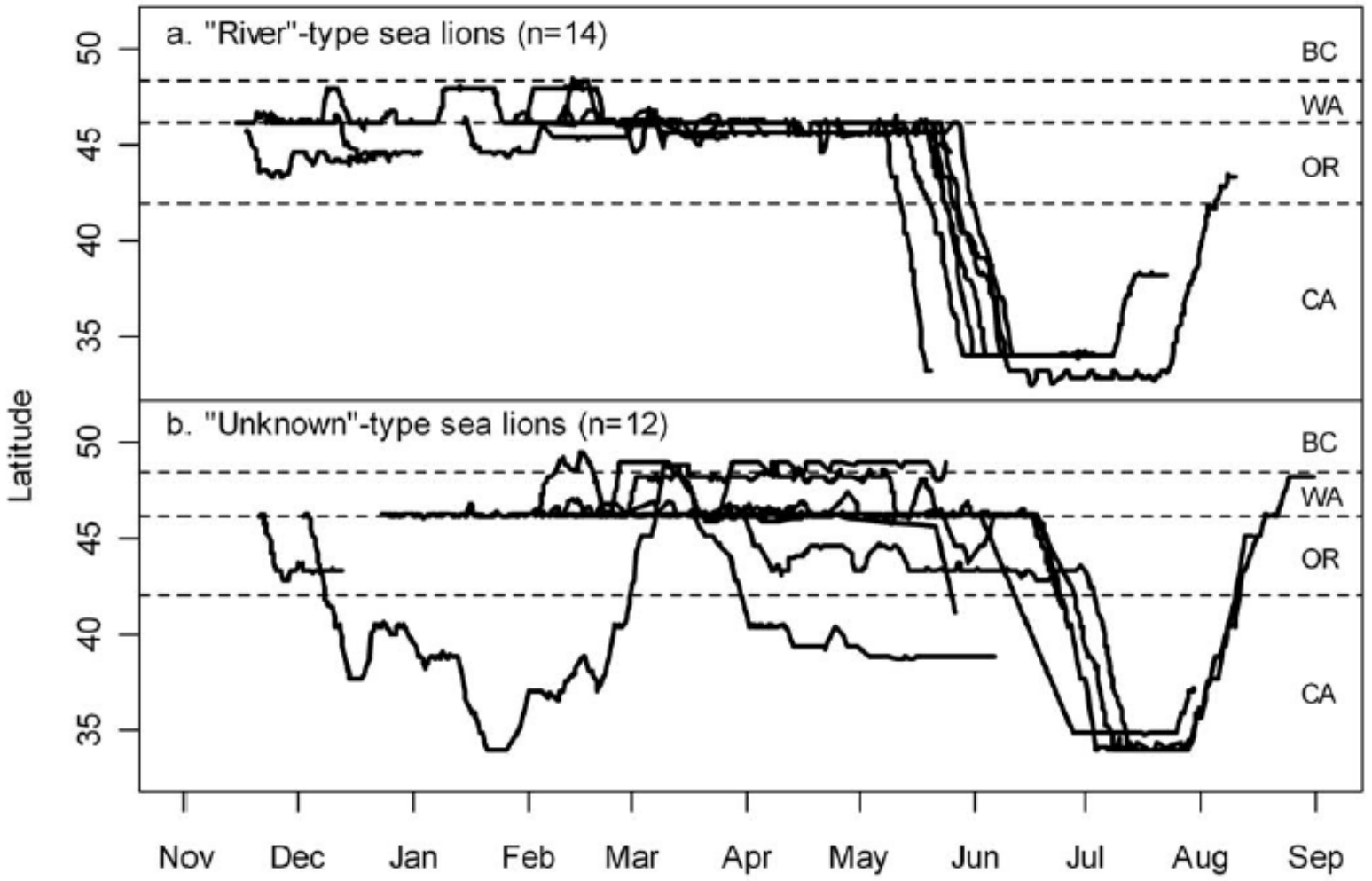
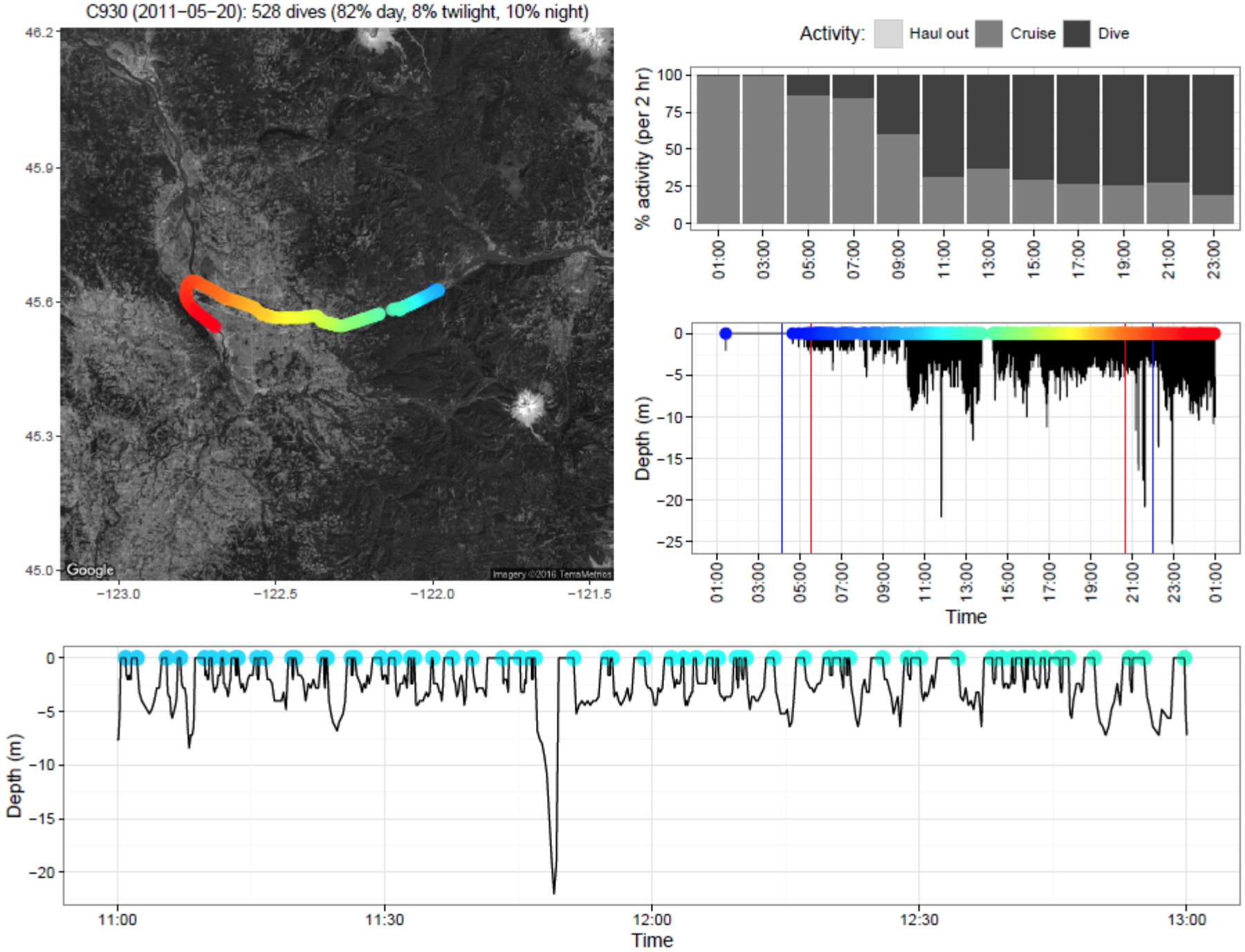
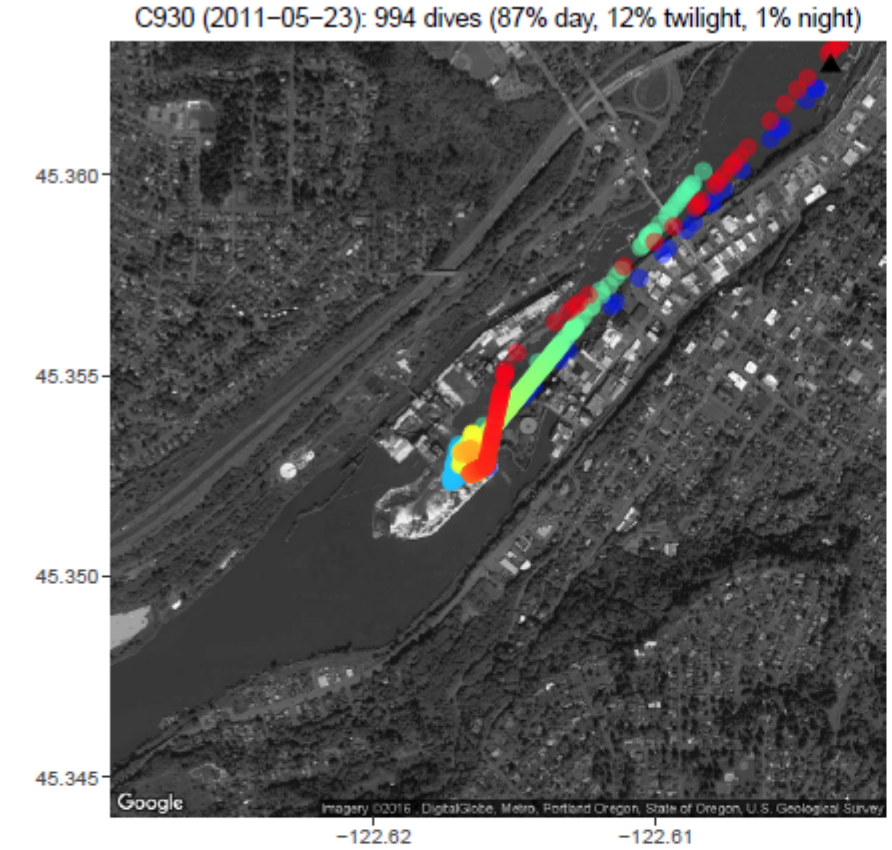
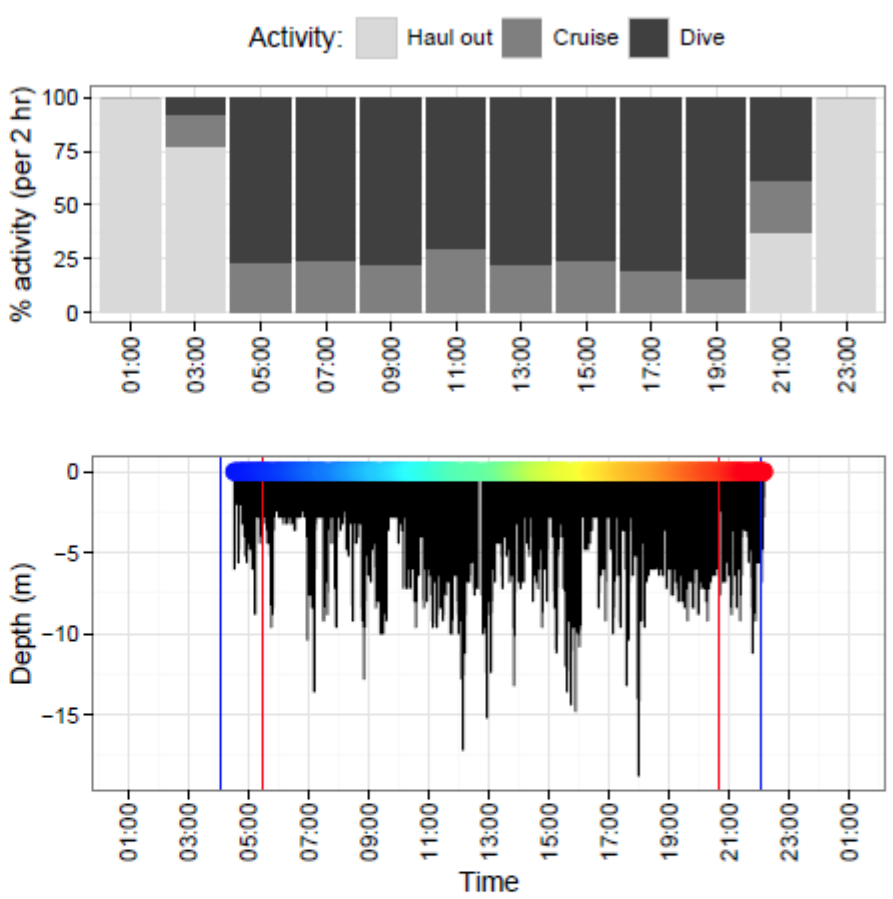


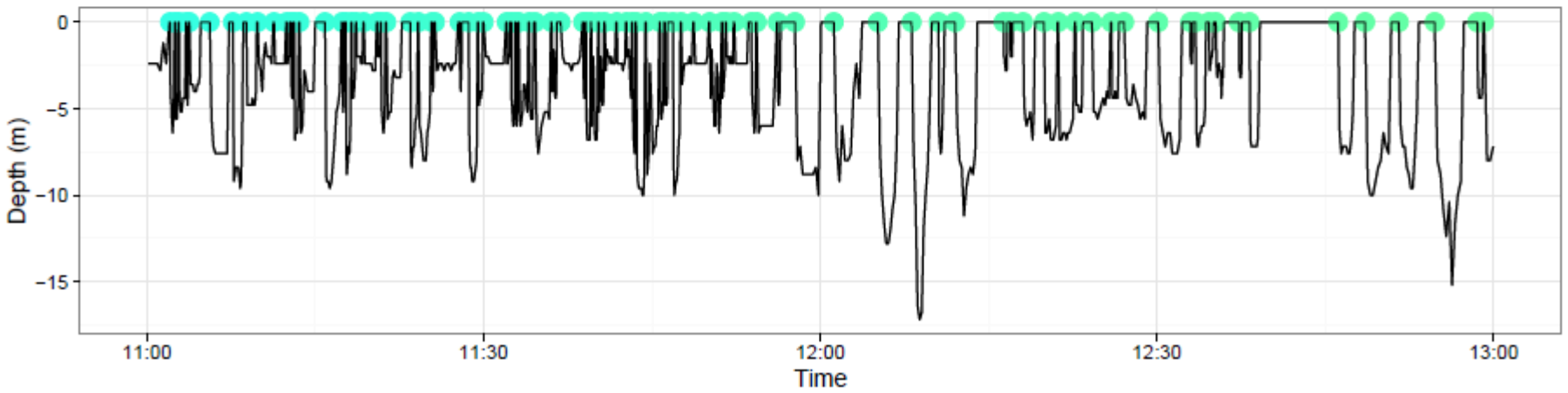
Figure 2. Latitude by date movement profiles for (a) 14 "river"-type and (b) 12 "unknown"-type male California sea lions based on satellite telemetry during 2003-2004, 2004-2005, and 2006-2007. Dashed lines represent coastal latitudinal boundaries between California, Oregon, Washington, and British Columbia.

Source: Wright et al. 2010 Northwest Science


C930 (2011−05−20): 528 dives (82% day, 8% twilight, 10% night)
46.2
45.9
45.6
45.3
45.0
Google
Imagery ©2016 TerraMetrics
−123.0
−122.5
−122.0
−121.5
Activity:
Haul out
Cruise
Dive
% activity (per 2 hr)
100
75
50
25
0
01:00
03:00
05:00
07:00
09:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
Depth (m)
0
−5
−10
−15
−20
−25
01:00
03:00
05:00
07:00
09:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
01:00
Time
Depth (m)
0
−5
−10
−15
−20
11:00
11:30
12:00
12:30
13:00
Time


C930 (2011−05−23): 994 dives (87% day, 12% twilight, 1% night)
45.360
45.355
45.350
45.345
−122.62
−122.61
Google
Imagery ©2016 , DigitalGlobe, Metro, Portland Oregon, State of Oregon, U.S. Geological Survey


Activity:
Haul out
Cruise
Dive
% activity (per 2 hr)
100
75
50
25
0
01:00
03:00
05:00
07:00
09:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
Depth (m)
0
−5
−10
−15
01:00
03:00
05:00
07:00
09:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
01:00
Time


Depth (m)
0
−5
−10
−15
11:00
11:30
12:00
12:30
13:00
Time


Willamette Falls
Oregon City
West Linn
Willamette River
Sea lion traps
Photo credit: Statesman Journal

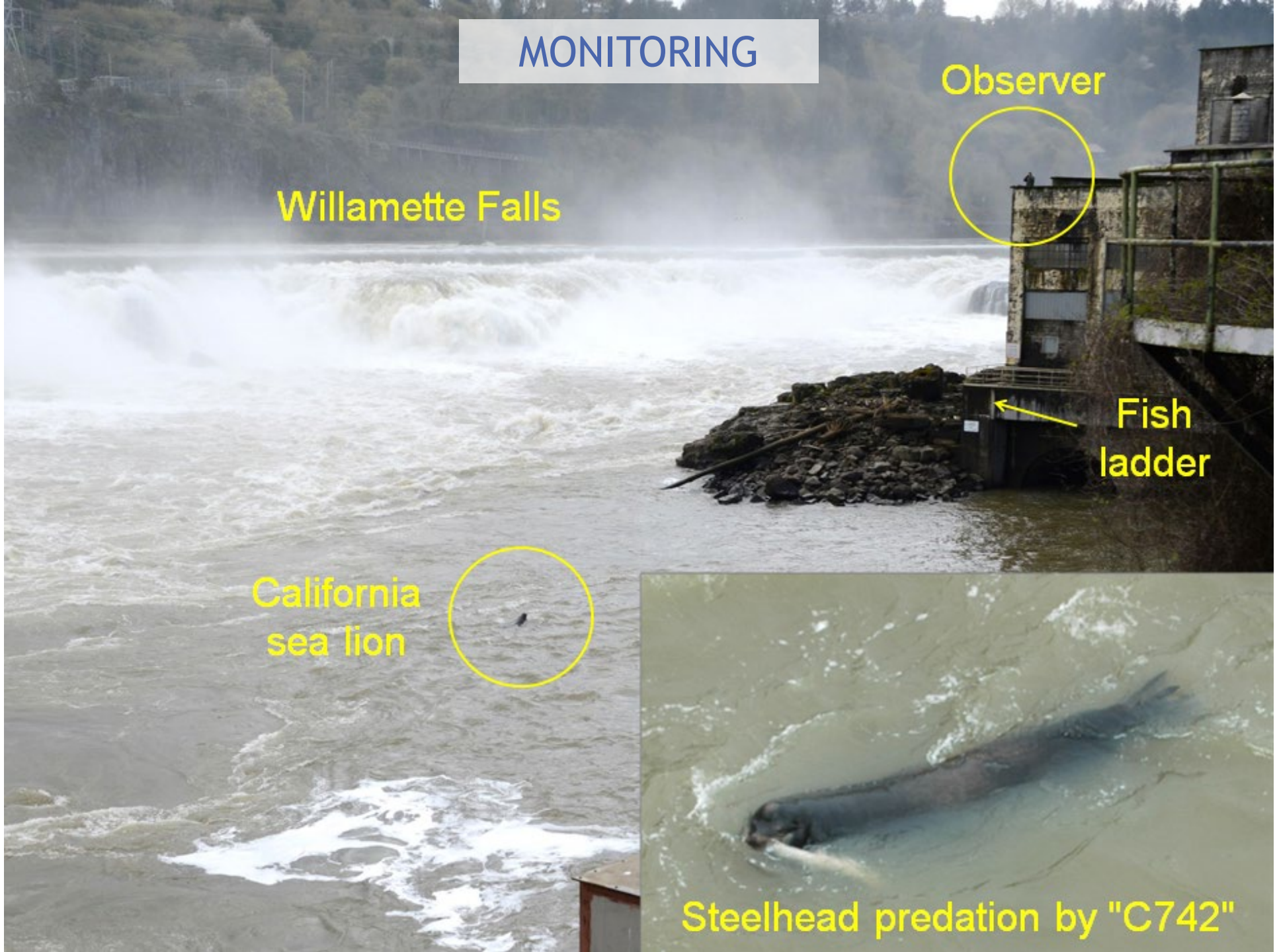
HAZING (2010-11, 2013)

MONITORING (2014-2021+)

TRAPPING (2018-2021+)

Photo: AP

MONITORING


Observer
Willamette Falls
Fish ladder
California sea lion
Steelhead predation by "C742"

Estimation (part 1)

- Total salmonid predation estimated from a probability sample of spatio-temporal sampling units
  - 2014-2015: Stratified, multi-stage design
  - 2016-2020: Un-stratified, multi-stage design
  - 2021: spatio-temporal balanced design (HIP sample)
- Measurement variable is the initial surfacing of a sea lion with an intact prey in its mouth
  - Only applicable to “large” prey items
  - Prey handling times vary from seconds to hours
  - Focus on initial surfacing necessary to avoid unequal inclusion probabilities due to variable handling times
- Model-based and bioenergetic approaches also possible

Sampling Frame

- Spatial component (since 2017): six ~1 ha sites
- Temporal component (since 2017): ~21 weeks (January-May); ~1,600 hours (approximately ~sunrise to <=1900)
- Observation units (=1 ha, 30 min)
  - Frame: ~20K
  - Sample: ~1,300
- Sampling units (clusters)
  - Sampled fraction: ~7% (~3% in 2021)
  - Sampling weight: ~15 (~35 in 2021)
- Non-sampling errors: undercoverage

Datetime	1	2	3	4	5	6
2020-01-06 10:30						10506
2020-01-06 11:00						10507
2020-01-06 11:30						
2020-01-06 12:00						
2020-01-06 12:30						
2020-01-06 13:00						
2020-01-06 13:30						
2020-01-06 14:00						
2020-01-06 14:30						
2020-01-06 15:00						
2020-01-06 15:30						
2020-01-06 16:00				11001		
2020-01-07 08:00		20201				
2020-01-07 08:30		20202				
2020-01-07 09:00		20203				
2020-01-07 09:30						
2020-01-07 10:00			20205			
2020-01-07 10:30			20206			

Estimation (part 2)

- Total run-specific predation estimated from probabilistic assignment of observed predation to a run (winter/summer steelhead, wild/hatchery Chinook) based on window count composition.
- 1000 runs each under three lags and two ID “models”
- Uncertainty estimated based on averaged means and 95 percentiles of each “model”

```
y_i <- sample(x = c(“StW", “StS", “hChS", “wChS"),
              size = 1,
              prob = c(0.5, 0.2, 0.2, 0.1))
```

Raw observation data

	California sea lions					Steller sea lions				
Year	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count
2014										
2015										
2016										
2017										
2018										
2019										
2020										
*2021**										

Raw observation data

	California sea lions					Steller sea lions				
Year	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count
2014	959	126	3	18	27					
2015	1167	175	2	24	32					
2016	1001	182	0	11	35					
2017	753	145	0	12	41					
2018	749	108	0	11	35 (-1) [10]					
2019	250	70	0	12	15 (-33)					
2020	166	32	0	7	8 (-0)					
*2021**	*4*	*0*	*0*	*0*	*2 (-0)*					

*2021 data through March 3rd.

Raw observation data

	California sea lions					Steller sea lions				
Year	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count	Salmonids	Lamprey	Sturgeon	Other/ unknown	Single-day max count
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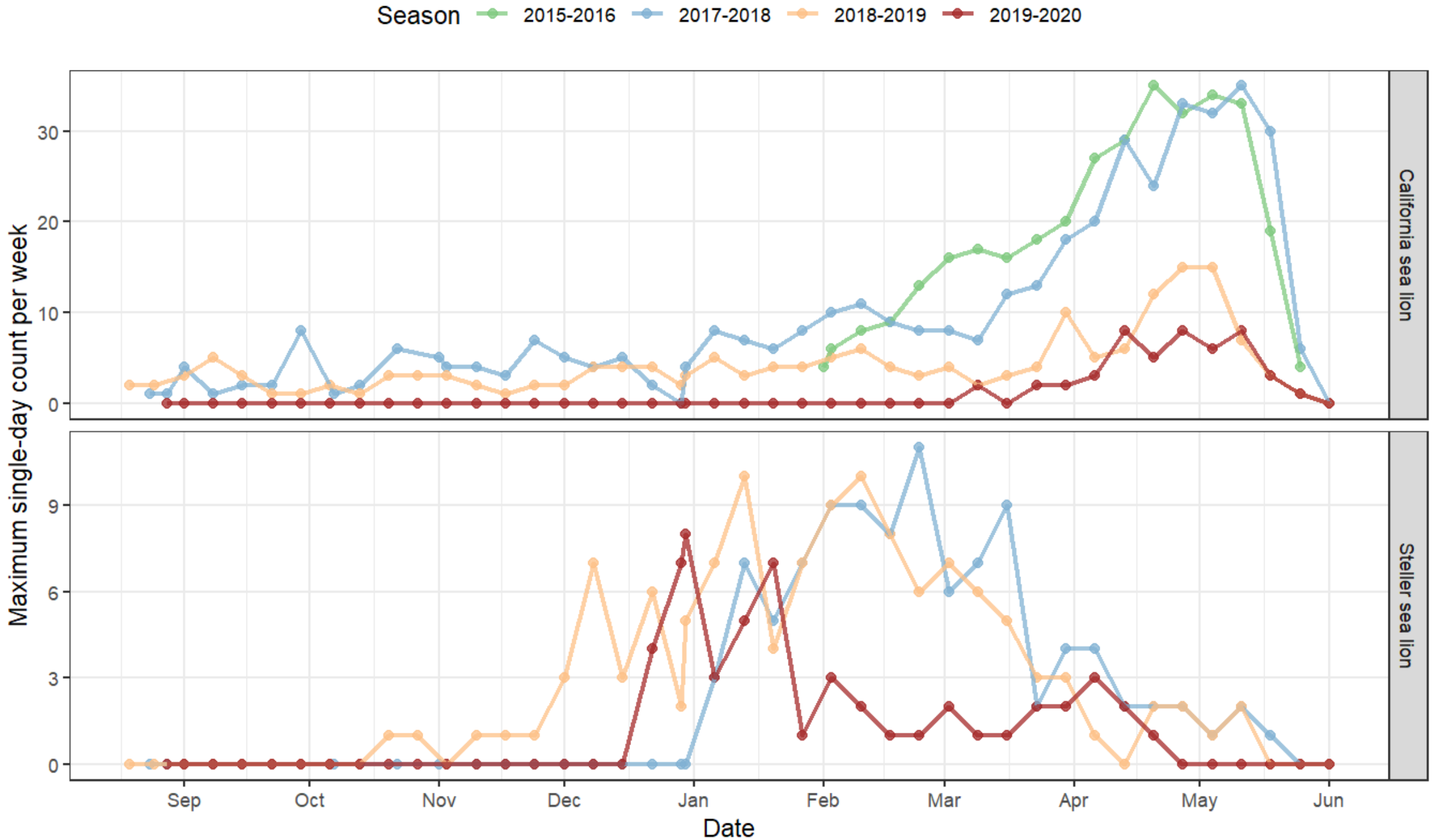
2015	1167	175	2	24	32	2	0	12	0	2
2016	1001	182	0	11	35	9	0	8	0	1
2017	753	145	0	12	41	1	0	69	5	4
2018	749	108	0	11	35 (-1) [10]	19	4	79	2	11
2019	250	70	0	12	15 (-33)	25	11	98	7	10
2020	166	32	0	7	8 (-0)	14	0	27	13	8
*2021**	*4*	*0*	*0*	*0*	*2 (-0)*	*7*	*0*	*5*	*0*	*3 (-1)*

*2021 data through March 3rd.


Season
2015-2016
2017-2018
2018-2019
2019-2020
Maximum single-day count per week
California sea lion
Steller sea lion
0
10
20
30
0
3
6
9
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Date

Estimated predation by California sea lions

Year	Salmonid predation (95% CI)	Winter steelhead passage	Winter steelhead predation (95% CI)	Predation as % of potential passage (95% CI)
2014	3690 (3321 - 4059)	5349	780 (563 - 998)	12.7% (9.5 - 15.7%)
2015	5775 (5096 - 6455)	4508	561 (370 - 752)	11.1% (7.6 - 14.3%)
2016	4585 (3680 - 5490)	5778	916 (635 - 1196)	13.7% (9.9 - 17.1%)
2017	2673 (1658 - 3688)	822	270 (148 - 392)	24.7% (15.3 - 32.3%)
2018	3435 (3019 - 3850)	1829	503 (351 - 655)	21.6% (16.1% - 26.4%)
2019	1120 (963 - 1277)	3202	280 (156 - 405)	8% (4.6% - 11.2%)
2020	702 (479 - 924)	5510	22 (0 - 51)	0.4% (0% - 0.9%)

What's next?

- Continue removal of both sea lion species at Willamette Falls and Bonneville Dam for next several years (5-year removal authority expires August 14, 2025)
- Encourage development of new, effective non-lethal deterrents to reduce new recruitment
- Evaluate program effectiveness

Probability of Extirpation

Scenario		Population			
		North Santiam	South Santiam	Molalla	Calapooia
Without Sea Lions:		2%	5%	0%	99%
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Acknowledgments

Robin Brown (retired, ODFW)
Tom Murtagh (retired, ODFW)
Dan Heiner (deceased, PSMFC)
Steve Jeffries (retired, WDFW)
Bob DeLong (retired, NMFS)
Pat Gearin (retired, NMFS)

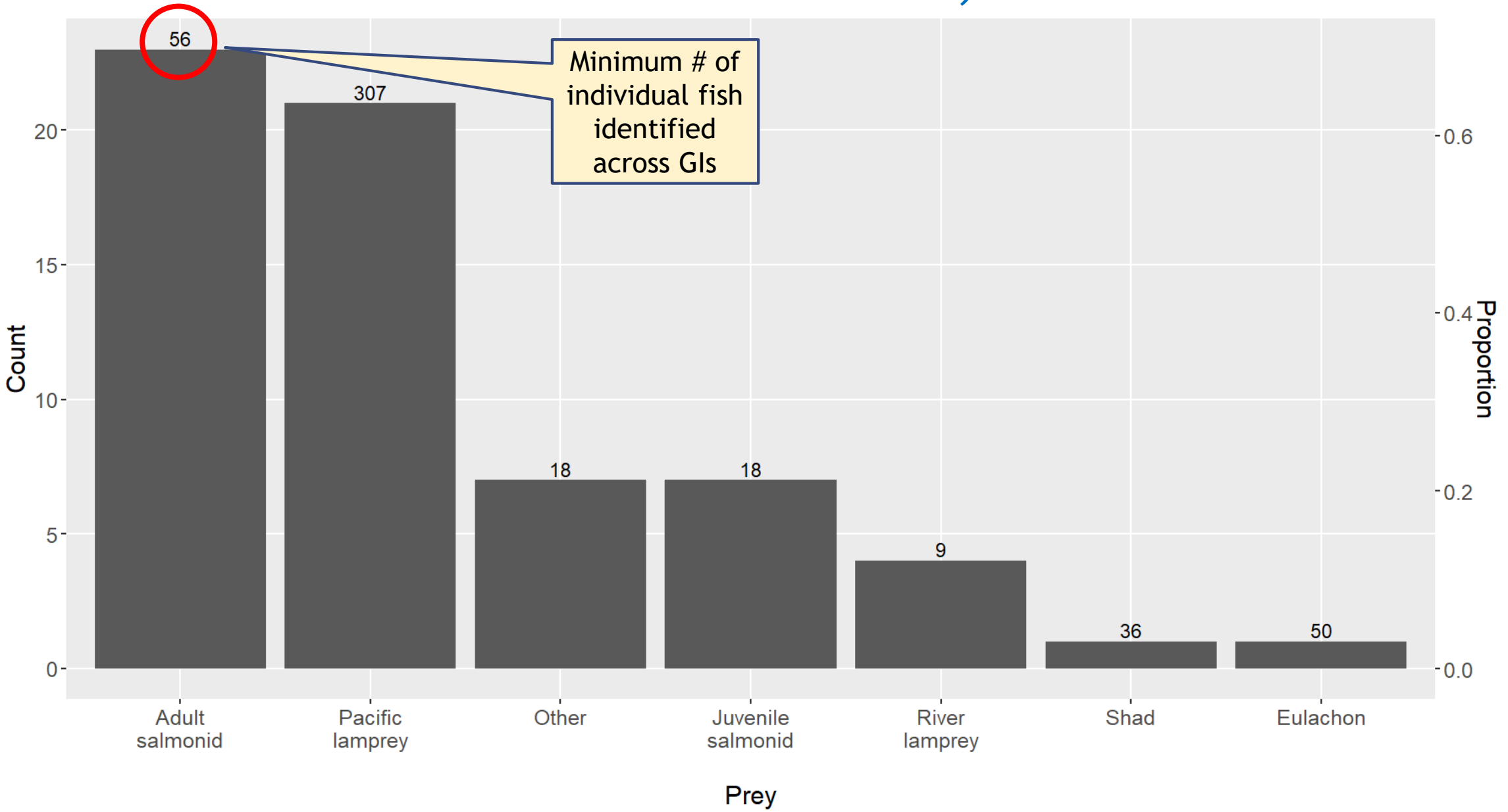
Seasonal ODFW observers:
Clifford Owens, Kelsey Sandoval, Theresa Tillson Elizabeth Warren, and others

ODFW staff:
Susan Riemer, Mike Brown, Shay Valentine, Zane Kroneberger, Brad Triplett, Buddy Phibbs, Shaun Clements, Debbie Ames, Matt Falcy

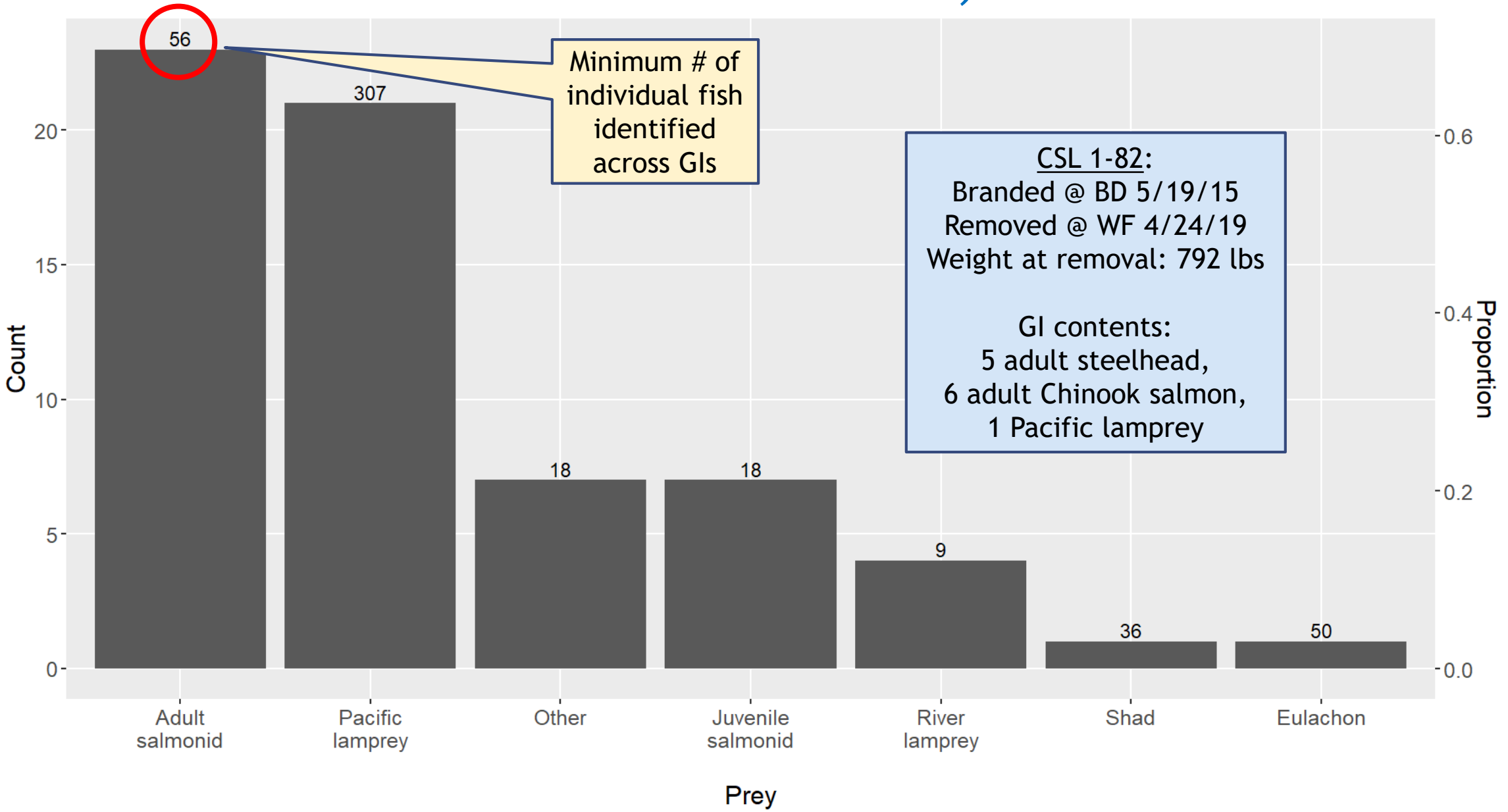
WDFW
Robert Anderson (NMFS)
Dave Colpo (PSMFC)
Sportcraft Moorages
Clackamas Co. Sherriff Dept.
Oregon State Police

Stomach contents

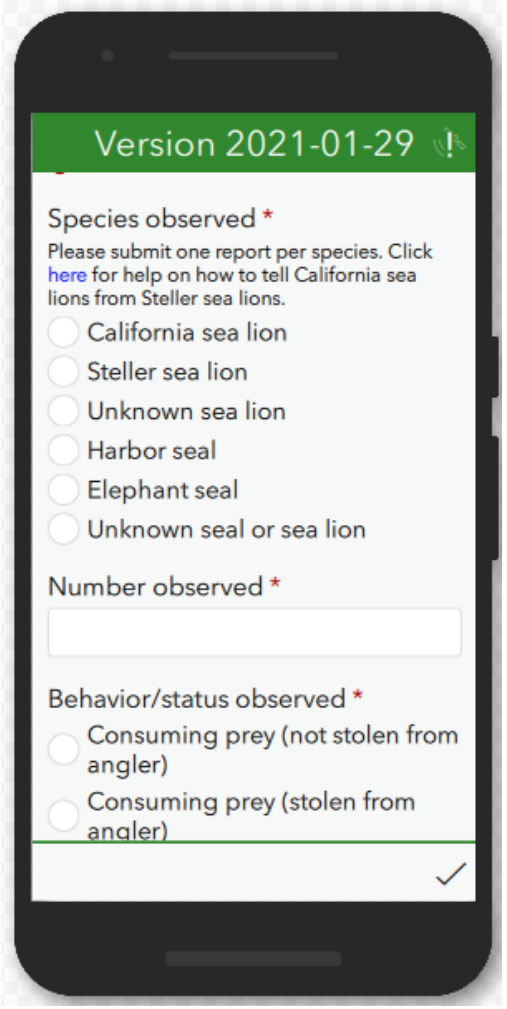
Stomach contents: *n*=33 CSLS, WF 2018-2019

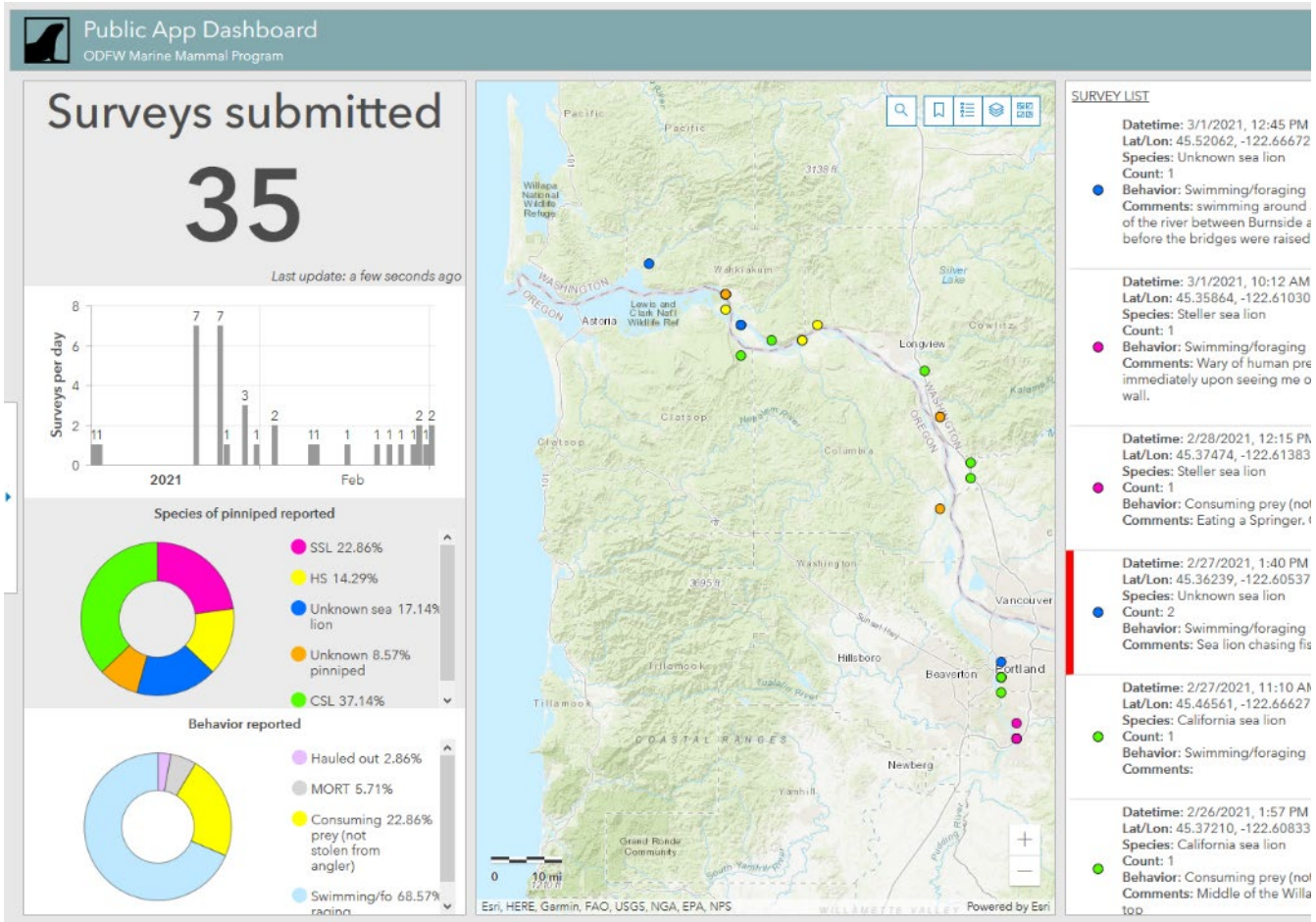


Stomach contents: *n*=33 CSLS, WF 2018-2019



Citizen science pinniped reporter app*





https://www.dfw.state.or.us/MRP/mammals/docs/Seal%20and%20Sea%20Lion%20Reporter%20User%20Guide%20v%202021-01-22.pdf