FIELD REPORT—2007 PINNIPED RESEARCH AND MANAGEMENT ACTIVITIES AT BONNEVILLE DAM

August 29, 2007

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INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) have been studying harbor seals, California sea lions and Steller sea lions in the lower Columbia River since the early 1980s. Over the last decade a central focus of this work has been evaluating the impacts of pinniped predation on ESA-listed salmonids of the Columbia Basin, which has been identified as a potentially serious problem by ODFW, WDFW, National Marine Fisheries Service (NMFS), U.S. Army Corp of Engineers (ACOE), and the Columbia River Inter-Tribal Fish Commission (CRITFC). During this time California sea lion numbers foraging for salmonids at upriver areas have greatly increased. Each year these predators have occurred upriver earlier and stayed later than the year before. Negative interactions between sea lions, sport, and commercial fishing activities in the river have also been reported with increasing frequency.

Beginning in 1997, ODFW (with the assistance of WDFW and NMFS) began capturing and marking California sea lions in the Columbia River at Astoria in order to study individual movements and foraging behavior. As of fall 2006, over 630 sea lions have been permanently marked and released, several of which were outfitted with satellite transmitters. Also in 1997 (and through 2002), ODFW conducted observations of California sea lions preying on spring Chinook salmon and winter steelhead at Willamette Falls (ODFW, unpublished data).

Beginning in 2002, ODFW, WDFW and NMFS began to coordinate these studies with ACOE biologists who were conducting observations of sea lions preying on adult salmonids at Bonneville Dam, which, from 2002-2006, were estimated to have taken 2-4% of the total spring salmonid passage (Stansell, 2004; Stansell et al. 2006). ACOE observations have shown that roughly one-third to one-half of all sea lions preying on salmonids below Bonneville Dam were animals that had been captured and marked in Astoria.

In 2005, a test of non-lethal hazing tools to deter sea lions from occupying the tailrace at Bonneville Dam was conducted by ACOE, NMFS, ODFW and WDFW. This test indicated that hazing was effective at temporarily moving sea lions away from fish passage entrances. This work continued in 2006 on a number of different fronts including: (1) installation of Sea Lion

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Exclusion Devices (SLEDs) by ACOE to keep sea lions from entering fishways; (2) use of underwater acoustic deterrents by ACOE to prevent sea lions from foraging near the fishway entrances; (3) dam-based hazing by USDA Wildlife Service personnel; and (4) boat-based hazing by ODFW, WDFW, and CRITFC. The ACOE concluded "Non-lethal deterrence measures used in 2006 proved ineffective in reducing predation on salmonids, but more intensive and directed hazing efforts may reduce pinniped presence near fishway entrances." (Stansell et al. 2006).

Late in 2006, the states of Oregon, Washington and Idaho applied to the Secretary of Commerce for authority to lethally remove individual California sea lions that are repeatedly observed taking threatened and endangered salmonids below Bonneville Dam. In January of 2007 NMFS notified the states that their application had been accepted and that a Pinniped Task Force would be established to further review the request and make recommendations to NMFS, prior to approval or rejection of the state's request (NOAA 2007). The states anticipated that one recommendation of the Task Force would be to conduct a more complete hazing effort (i.e. 7-days/week, all daylight hours) prior to granting approval to lethally remove individual sea lions at Bonneville Dam. The states further anticipated that lethal removal authority, should it be granted, might depend on the ability to capture animals at the dam. The objectives for the 2007 field season were thus:

1) Increase sea lion hazing efforts (7 days/week, 8-10 hours/day, multiple boats) to determine if non-lethal hazing is an effective and efficient tool for significantly reducing predation on salmonids in the Bonneville Dam tailrace.

2) Develop and implement techniques to trap, hold, transport and mark sea lions captured at Bonneville Dam, and to continue the ongoing capture and marking effort at Astoria, for the purposes of identification of individuals, tracking movements and foraging behaviors, and for the potential removal of problem sea lions.

3) Collect sea lion fecal samples for dietary analysis (including genetic stock identification when possible).

Pinniped deterrent activities at Bonneville Dam in 2007 were authorized under the Endangered Species Act (ESA) and Section 109h of the Marine Mammal Protection Act (MMPA). Funding for the activities was provided by NMFS, the Pacific States Marine Fisheries Commission (PSMFC), WDFW, ODFW, CRITFC, and the Bonneville Power Administration (BPA). This report is intended to fulfill ESA, MMPA, NMFS, PSMFC, and BPA reporting requirements; as such, it is not intended to be a comprehensive report on all pinniped-related interagency activities at the dam during 2007.

METHODS

Boat-based deterrent activities

ODFW, WDFW, and CRITFC, conducted boat-based hazing below Bonneville Dam (Figure 1a) from February 1 to May 24, 2007. From February 1-26, hazing was restricted to below the Boat

Restricted Zone (BRZ) to Marker 85 and was conducted 3-5 days per week (~6-8 hours per day) by a single ODFW or WDFW crew. From February 28-May 24, hazing occurred primarily in the BRZ, but also extended down to Marker 85, and was conducted 7 days per week (~8-10 hours per day) primarily by a single ODFW-PSMFC or WDFW crew. An additional boat and crew from CRITFC hazed 1-3 days per week (~6 hours per day) in April and May.

Boat-based hazers used a combination of acoustic and tactile deterrents (seal bombs, cracker shells, rubber buckshot, and vessel chase) in an attempt to deter pinnipeds. Hazers primarily patrolled the BRZ in search of sea lions but occasionally traveled downriver as far as Marker 85 (Figure 1b). For each discrete hazing event, hazers recorded: species and number of pinniped encountered; starting location, time, and direction of travel of the pinniped(s); type and number of deterrent devices used; and ending location, time, and direction of travel of the pinniped(s) (see Appendix 1 for example of hazing datasheet). Predation observations and identifying marks of pinnipeds were noted.

For human and fish safety, boat access within the BRZ was limited to approximately 30 m from all project structures and 50 m from main fishway entrances. No seal bombs were used within 100 m of fishways, floating orifices, Powerhouse 2 (PH2) Corner Collector flume or smolt monitoring facility outfall. In addition, no seal bombs were used once salmon passage exceeded 1000 fish per day.

Hazing activities were coordinated daily with ACOE Control Room and Fisheries personnel, as well as with Wildlife Services staff who were conducting sea lion hazing activities from project ground facilities. VHF-radio contact was maintained with Control Room staff while boat hazing crews were active in the BRZ.

Trapping and marking

ODFW, WDFW, and NMFS constructed a portable sea lion trap to moor in the BRZ in an effort to develop capture techniques for sea lions at the dam. At the outset it was noted that sea lions may take many months, or more than one season, to become accustomed to hauling out and using the trap in a manner useful for capture attempts.

With the assistance of the ACOE rigging crew, the trap was placed in the tailrace of PH2 near the wall of the Corner Collector flume on February 21. The floating trap was anchored to the river bottom and secured loosely to the heavy steel railing at the top of the wall. The trap was monitored daily to check for use by sea lions and to insure that it is securely anchored and not interfering with other project facilities or activities. At the end of the capture season (May 23), the trap was closed and moved to the old navigation lock for storage until next field season.

During capture events, the ACOE rigging crew assisted with the removal of animals from the trap into smaller transfer cages and/or a modified horse trailer for transport to Astoria where handling and marking equipment was located. Animals were marked, and sometimes equipped with satellite tracking devices, and released at Astoria or at other locations along the Oregon coast.

Scat collection and analysis

Fecal samples were collected from the Corner Collector apron (PH2 tailrace), floating trap, and from docks located downriver at Dodson, OR (Figure 1a). Individual samples were bagged, labeled and frozen. Undigested remains were recovered and identified to lowest possible taxa. If possible, salmonid bones will be subjected to genetic analysis for stock or run-level identification.

RESULTS

Boat-based deterrent activities

February 1-26.—Crews from ODFW and WDFW hazed sea lions on 15 days from February 1 – February 26, 2007, in the sturgeon spawning area below the BRZ at Bonneville Dam (Table 1). A total of 137 "takes"[6] were recorded over 109 hazing events. Takes were comprised of two California sea lions (1.5% of total take; mean=0.02 per hazing event; range=0-1 per hazing event) and 135 Steller sea lions (98.5%; mean=1.2; range=0-4). Takes per hour of effort generally declined for Steller sea lions from more than 2 per hour to less than one per hour by the end of February (Figure 2).

During this period, hazers used a total of 636 cracker shells (mean = 5.8 per hazing event; range=0-40 per hazing event) and 10 rubber buckshot rounds (mean=0.09; range=0-10). Most (63%) hazing events started in McGowan's Channel (MC; Figure 1a) and ended with the animal(s) last seen headed downriver (76% of all hazing events).

Approximately one-third of all hazing events involved a predation observation. Hazers identified at least 24 sturgeon being consumed by Steller sea lions—8 of which were "oversized" (i.e., >5ft in length). Sturgeon predation was observed in HR, WR, and MC (Figure 1a).

February 28-May 24.—Crews from ODFW, WDFW, and CRITFC hazed sea lions on 85 days from February 28 – May 24, 2007, within and below the BRZ at Bonneville Dam (Table 1). A total of 2495 takes were recorded over 1494 hazing events. Takes were comprised of 2432 California sea lions (97.5% of total take; mean=1.6 per hazing event; range=0-35 per hazing event) and 63 Steller sea lions (2.5%; mean=0.04 per event; range=0-5). Takes per hour of effort increased for California sea lions from approximately 1 per hour to as many as eight per hour until dropping off as animals left for the breeding grounds at the end of May (Figure 2).

During this period, hazers used a total of 13,511 cracker shells (mean = 9.0 per hazing event; range=0-181 per hazing event), 2694 seal bombs (mean=1.8; range=0-65), and 1040 rubber buckshot rounds (mean=0.7; range=0-15). Most (62%) hazing events started in one of the powerhouse tailraces (PH1 and PH2; Figure 1a) and ended with the animal(s) last seen headed downriver (61% of all hazing events).

[6] Defined under the Marine Mammal Protection Act as "harass, [emphasis added] hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect."

Approximately one-quarter of all hazing events involved a predation observation. Hazers identified at least 8 sturgeon (none were oversized fish), 369 salmonids, 3 lamprey, and 1 shad being consumed by sea lions. Salmonid predation was observed in every site within the study area (Figure 1a).

Trapping and marking

Sea lions began hauling out on the trap near PH2 on March 26 and continued to do so intermittently throughout the study period. From April 4 to May 17, a total of three Steller sea lions and 11 California sea lions were captured and relocated at least as far as Astoria (Table 2); an additional five California sea lions were captured and released at the dam because they were already marked and/or there were no more satellite transmitters to deploy.

A total of seven California sea lions captured at Bonneville received satellite transmitters (Table 2); a summary of their movements, along with those of other satellite-tagged California sea lions captured in Astoria, are depicted in Figure 3. One animal, C265, was captured three times during this season and changes in weight plus satellite fix locations, are depicted in Figure 4. On average, California sea lions captured at Bonneville Dam were heavier (mean=739 lbs) than animals captured in Astoria (mean=511 lbs) during the same time period.

Scat collection and analysis

A total of 71 scat samples were collected from sea lion haul-outs at or near Bonneville Dam from February-May, 2007. Twelve samples were collected from Steller sea lions, primarily from RM 140 (Dodson) during February and March (Table 3). Forty-two and 29 samples were collected from California sea lions and potentially mixed (Steller and California) sea lions, respectively, from RM 145 (Bonneville Dam) primarily during April (Table 4).

The most frequently occurring identifiable prey for Steller sea lions was sturgeon (50% of all samples, Table 3). Other prey remains recovered included American shad (25%), adult salmonids (25%), and Pacific lamprey (8.3%), as well as a unidentified fish (66.7%). Unidentified fish which were likely sturgeon but specific diagnostic skeletal structures were not recovered to allow for a definitive identification. Salmonids were the most frequently occurring identifiable prey for California sea lions (includes mixed sea lion) (95.8% of all samples, Table 4). Salmonids included both adult (93%) and juvenile (4.4%) age classes. Other prey remains included Pacific lamprey (7%), American shad (1.4%), and suckers (1.4%), as well as unidentified fish (2.8%).

In addition to scat, five spew samples (1 California sea lion, 4 mixed sea lion) were collected during the study; 4 had remains from adult salmonids and one contained remains from fish that were unidentified due to lack of diagnostic skeletal structures.

DISCUSSION

Over the course of 100 days from February-May, 2007, boat-based hazers used over 14,000 cracker shells, 2,500 seal bombs, and 1,000 rubber buckshot rounds during approximately 2,500

hazing events. In addition, a total of 14 sea lions were captured at the dam and transported to Astoria or the Oregon coast. Despite this effort, and those of dam-based hazers, the preliminary estimate of salmonid consumed by seal lions was 3,557 fish (Stansell et al. 2007). In addition, 361 sturgeon, 119 lamprey, 3 smolt, and 532 unidentified fish (likely salmonids) were observed killed by at least 80 different (primarily California) sea lions.

Given that salmonid predation was as great or greater than estimates from years without intensive hazing, we conclude that intensive hazing was unsuccessful at reducing the impact of sea lions at Bonneville Dam. However, some level of future hazing may nonetheless be beneficial to discourage some types of predation (e.g., Steller sea lion predation on sturgeon) and to limit the recruitment of new sea lions into the area.

ACKNOWLEDGEMENTS

We wish to acknowledge and thank all those who cooperated in the conduct of this work:

- ODFW: Steve Williams, Charlie Corrarino, John North, Rick Hargrave, Bonneville Hatchery staff
- WDFW: Guy Norman, Sandra Jonker, Bill Fleenor, Brad Cody, Dean Pyzik
- PSMFC: Dan Heiner, Mike Brown, Linda Fulop, Brad Triplet
- ACOE: Robert Stansell, Bob Willis, David Clugson, Ben Hausman, rigging crew
- NMFS: Merrill Gosho, Brent Norberg
- CRITFC: John Whiteaker, Bobby Begay
- USDA Wildlife Services

Partial funding was provided by NOAA-Fisheries to WDFW (Contract AB133FO55E67980), by the PSMFC to WDFW (Contract 497J.06-07), and by NOAA-Fisheries to PSMFC (Contract NA05NMF4391151). Special thanks to Garth Griffin from NOAA-Fisheries and Dave Colpo from PSMFC for help with contract administration and coordination.

LITERATURE CITED

NOAA [National Oceanic and Atmospheric Administration]. 2007. Marine mammals; pinniped removal authority. Federal Register 72(19):4239-4242. (http://www.nwr.noaa.gov/Publications/FR-Notices/2007/upload/72FR4239.pdf ; accessed June 13, 2007).

Norberg, B., R. Stansell, G. Griffin, R. Brown, S. Jeffries, and P. Gearin. 2005. Field report – preliminary observations of non-lethal deterrence measures for California sea lion predation at Bonneville Dam. http://www.nwr.noaa.gov/Marine-Mammals/Seals-and-Sea-Lions/upload/Bonneville-Field-Rprt.pdf (accessed November 8, 2006).

Stansell, R. J. 2004. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2002-2004. U.S. Army Corps of Engineers, CENWP-OP-SRF, Bonneville Lock and Dam, Cascade Locks, OR 97014.

Stansell, R. J., S. C. Tackley, and K. M Ewald. 2006. Sea lion predation and deterrence measures at Bonneville Dam. Abstract *in* 2006 Anadromous Fish Evaluation Program. http://www.nwp.usace.army.mil/pm/e/conference/home.asp (accessed November 9, 2006).

Stansell, R., S. Tackley, and K. Gibbons. 2007. Status report – pinniped predation and hazing at Bonneville Dam in 2007.

Wright, B., S. Jeffries, R. Brown, R. Stansell, D. Hatch, and B. Norberg. Field report – non-lethal pinniped deterrent activities at Bonneville Dam, Spring 2006. http://www.nwr.noaa.gov/Marine-Mammals/Seals-and-Sea-Lions/upload/Bonneville_Pinn_Rpt_06.pdf (accessed May 7, 2007).

Table 1. Weekly summary of boat-based pinniped hazing and munitions used at and below Bonneville Dam, February-May, 2007. Hazing during weeks 1-4 occurred below the Bonneville Dam Boat Restricted Zone (BRZ); weeks 5-17 occurred above and below the BRZ.

			Pinniped take		Munitions used		
Week	Dates	# days	CSL	SSL	Cracker shells	Seal bombs	Rubber buckshot
1	2/1-2/7	5	0	74	387	0	10
2	2/8-2/14	3	1	24	79	0	0
3	2/15-2/21	4	1	26	66	0	0
4	2/22-2/26	3	0	11	104	0	0
Subtotal		15	2	135	636	0	10
5	2/28/-3/7	7	67	16	556	194	8
6	3/08-3/14	7	103	5	1,213	478	21
7	3/15-3/21	7	130	5	849	698	42
8	3/22-3/28	7	106	7	270	479	61
9	3/29-4/04	7	238	1	1,537	63	125
10	4/05-4/11	7	235	5	1,352	0	101
11	4/12-4/18	7	222	5	782	265	97
12	4/19-4/25	7	234	5	1,158	65	97
13	4/26-5/2	7	299	5	1,102	32	150
14	5/3-5/9	7	420	8	1,768	58	181
15	5/10-5/16	7	305	1	1,638	260	119
16	5/17-5/23	7	70	0	1,264	102	38
17	5/24-5/30	1	3	0	22	0	0
Subtotal		85	2,432	63	13,511	2,694	1,040
Total		100	2,434	198	14,147	2,694	1,050

Table 2. Summary of sea lion trapping activity at Bonneville Dam April-May, 2007.

Capture date	Species[1]	Brand	Release date	Release location	Weight (lbs)	Transmitter (PTT) ID#	Bonneville return date (*n* days)
4/4/07	SSL	-	4/4/07	Astoria	1580		
	CSL	3341[2]	4/4/07	Astoria	617		4/10/07 (6 d)
	CSL	C443[2]	4/4/07	Astoria	711	62187	4/12/07 (8 d)
	CSL	C643	4/4/07	Astoria	734	62188	4/14/07 (10 d)
	CSL	C644	4/4/07	Astoria	494	62189	4/16/06 (12 d)
	CSL	C645	4/4/07	Astoria	576	62190	4/14/07 (10 d)
4/18/07	CSL	C653	4/19/07	Seaside	715	62184	4/27/07 (8 d)
4/19/07	CSL	C319[2]	4/20/07	Newport	1151	62191	4/26/07 (6 d)
4/25/07	SSL	-	4/25/07	Astoria	-		
	SSL	-	4/25/07	Astoria	-		
	CSL	C668	4/25/07	Astoria	844		
	CSL	C669	4/25/07	Astoria	760	62176	5/14/07 (19 d)
5/16/07	CSL	C347[2]	5/16/07	Bonneville Dam	-		
	CSL	C192[2]	5/16/07	Bonneville Dam	-		
	CSL	C669[2]	5/16/07	Bonneville Dam	-	62176[2]	
5/17/07	CSL	C347[2]	5/17/07	Bonneville Dam	-		
	CSL	C645[2]	5/17/07	Bonneville Dam	-	62190[2]	
	CSL	C699	5/17/07	Astoria	995		
	CSL	C700	5/17/07	Astoria	535		5/24/07 (7 d)
Total captured (# relocated)	SSL	3 (3)					
	CSL	16 (11)					
	Total	19 (14)					

[1]SSL=Steller sea lion, CSL=California sea lion

[2]Previously branded and/or tagged.

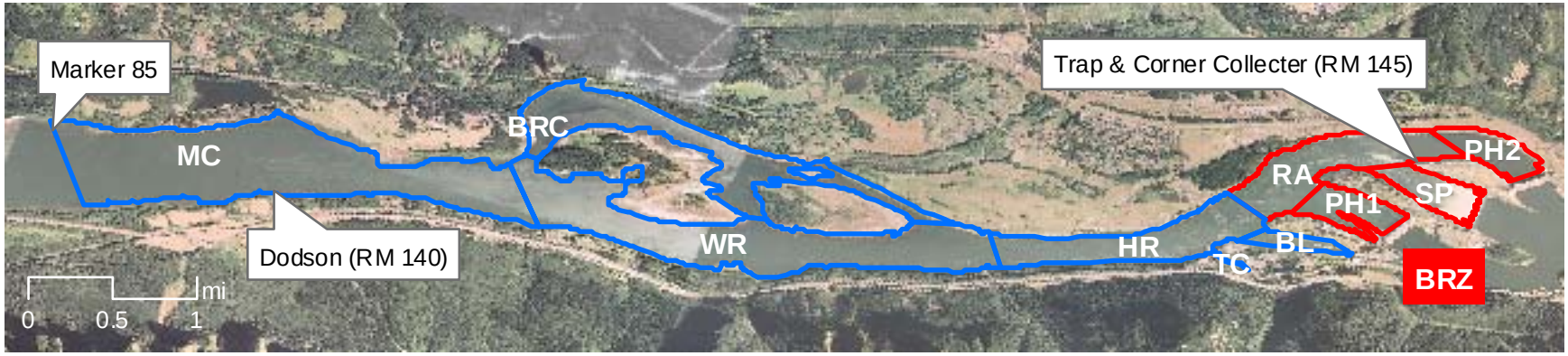
Table 3. Percent frequency of occurrence of prey identified in Steller sea lion fecal matter (scat) collected at Dodson, OR (RM 140) and Bonneville Dam (RM 145), February-April 2007.

Prey type	Location		Month			All
	RM 140 (n=11)	RM 145 (n=1)	FEB (n=7)	MAR (n=4)	APR (n=1)	(n=12)
Unidentified fish	63.6	100	42.9	100.0	100	66.7
Sturgeon	54.5		85.7			50.0
Shad	27.3		42.9			25.0
Adult salmonid	**27.3**		**28.6**	**25.0**		**25.0**
Lamprey	9.1			25.0		8.3

Table 4. Percent frequency of occurrence of prey identified in California sea lion, and potentially mixed sea lion, scat collected at Bonneville Dam (RM 145), March-May 2007. Mixed scat refers to samples that were likely deposited by California sea lions but which may have come from Steller sea lions sharing the same haulout area.

Prey type	Sea lion species		Month*			All
	CA sea lion (n=42)	Mixed? (n=29)	MAR (n=2)	APR (n=64)	MAY (n=4)	(n=71)
Salmonid	**95.2**	**96.6**	**50.0**	**96.9**	**100**	**95.8**
Adult	92.9	93.1	50.0	93.8	100	93.0
Juvenile	4.8	3.4		4.7		4.2
Unknown ageclass	2.4	3.4		3.1		2.8
Lamprey	4.8	10.0	50.0	3.1	25.0	7.0
Unidentified fish	2.4	3.4	50.0	1.6		2.8
Shad	2.4			1.6		1.4
Sucker	2.4			1.6		1.4

* Total across months does not equal 71 because of a single scat with missing collection date.



(a.)

(b.)

Figure 1. (a) Study area (showing site names and other features) patrolled by boat-based hazer crews. (b) GPS track of boat-based hazing effort on 19 May, 2007.

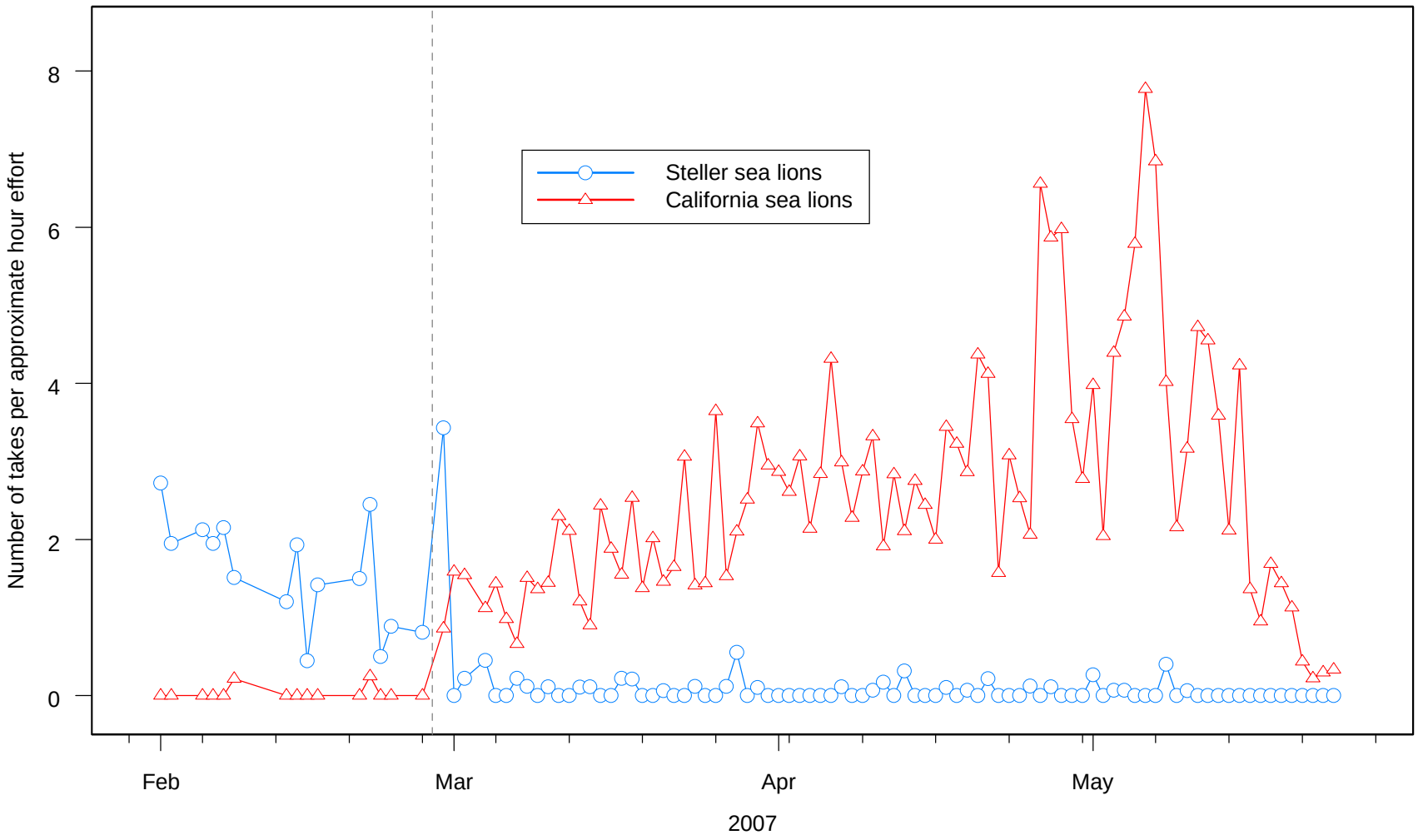


Figure 2. Mean pinniped take per hour of effort. Vertical dashed line indicates the start of hazing within the BRZ.

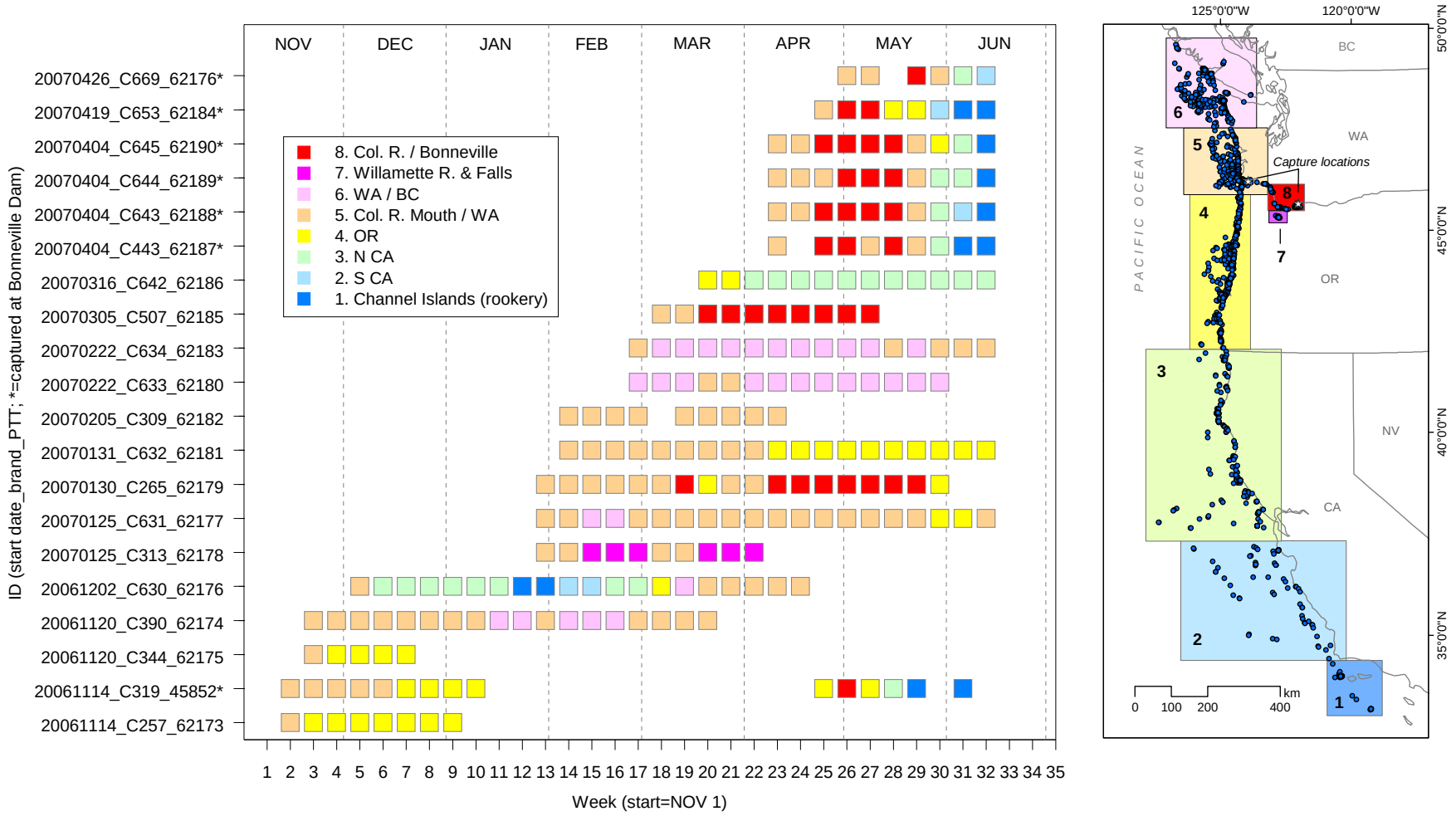


Figure 3. Modal locations by week for 20 California sea lions instrumented with satellite transmitters. Animals were captured in Astoria or at Bonneville Dam and then released in either Astoria or on the Oregon coast. Satellite location fixes were filtered by ARGOS location class (≥1) and swim speed (≤ 3 m s^{-1}).

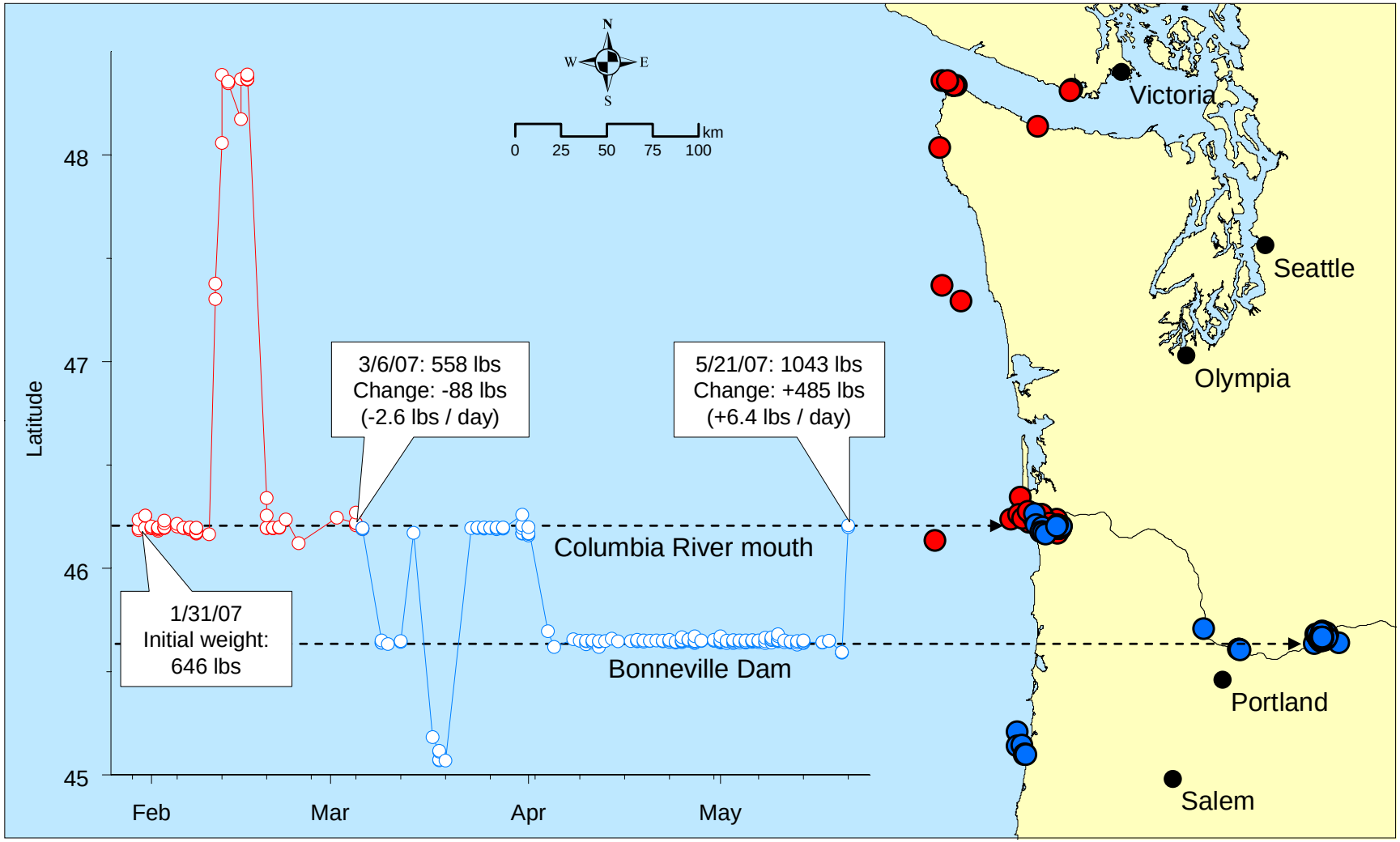


Figure 4. C265 foraging areas and associated weight change from January 31-May 21, 2007

Appendix 1. Example of data form used during 2007 boat-based hazing activities.

BONNEVILLE PINNIPED HAZING PROJECT

DATE(MM/DD/YY) 5/15/07 AGENCY/CREW CRITFC BB, MSH, RF

VISIBILITY (G/F/P) G TIME START 0830 TIME END 1424

COMMENTS (e.g., haul-out count, angling pressure):

Enter one record per animal or group hazed*:

START			SPP. #		METHOD(S) #				END			Fish kill (sp.)	Brand
TIME (24 hr)	AREA (map)	DIR (↑↓?)	Zc	El	CS	SB	SR	RB	TIME (24 hr)	AREA (map)	DIR (↑↓?)		
0901	PH1	↑	1		8				0909	PH1	↓		
NOTES:													
0921	SP	↑	1		4				0929	RA	↓		
NOTES:													
0937	PH2	↑	1		6				1000	PH2	↓		
NOTES:													
1010	PH1	↑	1		1				1016	PH1	↓		
NOTES:													
1017	HR	↑	1		3	3			1032	HR	↓		
NOTES:													
1045	WR	↑	2		13	4			1103	BRC	↓		
NOTES: One Branded													
1114	HR	↑	1		13				1033	HR	↓		
NOTES: Orange tag. Branded last number 5													
1157	HR	↑	1		6				1203	HR	↓		
NOTES:													

*Data codes: Direction: ↑=upriver; ↓=downriver, /=stationary, ?=unknown. Hazing method(s): CS=cracker shells; SB=seal bombs; SR=screamer/banger rockets; RB=rubber buckshot/batons (enter amounts). Fish kill: SA=salmonid; ST=sturgeon; LA=lamprey; OT=other (describe in notes). Brand: enter letter and #s (use ? as placeholder for unread, but seen, letter or digit)

Entered by / date: Verified by / date:

Robin Brown, Oregon Department of Fish and Wildlife, 7118 NE Vandenberg Ave., Corvallis, OR 97330, 541-757-4186 x242