FIELD REPORT:
2009 PINNIPED MANAGEMENT ACTIVITIES AT AND BELOW BONNEVILLE DAM

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INTRODUCTION

This year (2009) marked the fifth consecutive year of research and management of pinnipeds at Bonneville Dam led by the Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW), in association with the Columbia River Inter-Tribal Fish Commission (CRITFC). This work has been conducted in close coordination and cooperation with the US Army Corps of Engineers (USACE) and the National Marine Fisheries Service (NMFS). Other cooperating agencies and organizations included: Bonneville Power Administration (BPA), Northwest Power and Conservation Council, Pacific States Marine Fisheries Commission (PSMFC), US Department of Agriculture Wildlife Services (USDA), US Coast Guard, Point Defiance Zoo & Aquarium, Oregon State University, state and local law enforcement and others. Background on this work and links to supporting documents can be found at http://www.nwr.noaa.gov/Marine-Mammals/Seals-and-Sea-Lions/States-MMPA-Request.cfm and http://www.nwd-wc.usace.army.mil/tmt/documents/fish/ .

Pinniped management activities led by ODFW and WDFW at Bonneville Dam are authorized under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) Sections 109h and 120. This report is intended to fulfill regulatory and contractual reporting requirements; it is not intended to be a comprehensive report on all pinniped-related activities at the dam during 2009.

METHODS

Boat-based deterrent activities

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 from consuming threatened and endangered Columbia River salmon and steelhead (*Onchorynchus* spp.) as well as white sturgeon (*Acipenser transmontanus*). Hazers from ODFW, WDFW, and CRITFC primarily patrolled the Boat Restricted Zone (BRZ) at the dam in search of sea lions but also traveled downriver. The following was recorded for each discrete hazing event: species and number of pinniped encountered; starting location, time and direction of travel of pinnipeds; type and number of deterrent devices used; and ending location, time and direction of travel of

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pinniped (Appendices 1 and 2). Predation observations and identifying marks of pinnipeds were also 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 USACE Control Room and Fisheries Field Unit (FFU) personnel, as well as with USDA Wildlife Services staff, who were hazing sea lions from project ground facilities. VHF-radio contact was maintained with Control Room staff while boat hazing crews were active in the BRZ.

In March, members of the International Marine Animal Trainers Association (IMATA) visited the project site to tour Bonneville Dam, observe sea lion behavior and our use of deterrents. Their objective was to evaluate the current situation and make recommendations that might help improve the efficacy of non-lethal deterrent techniques and thereby reduce pinniped predation on salmonids.

Trapping

We captured California sea lions (*Zalophus californianus*) targeted for removal using haul-out traps. Sea lions entered and exited traps via a vertically-sliding door which was pad-locked open whenever a capture event was scheduled to be greater than 48 hours in the future. Traps were monitored daily when locked open. During active capture operations, the traps were unlocked and were routinely monitored day and night to be sure the doors remained open until we chose to close them. Trap doors were closed using a remote-controlled magnetic release mechanism rather than a pull-cord as in previous years. Trapping operations were limited if Steller sea lions (*Eumetopias jubatus*) were present on the trap. Monitoring the traps used a combination of physical visits to the trapping site, monitoring from the Washington shoreline and use of USACE remote camera observation. Monitoring was accomplished in coordination with USACE Bonneville FFU, FFU sea lion predation observers, USDA Wildlife Services staff, Bonneville Project security staff, federal Park Rangers and Bonneville facility, security and control room staff. For interagency coordination, a telephone contact list was provided to all staff involved with monitoring the traps to insure a quick response by trained staff should any trap door close unexpectedly.

Two traps were placed below PH2 along the Corner Collector wall early in the season (2/3/09) to allow time for animals to habituate to them. A third trap was initially deployed below PH1 at moorings below the old navigation lock on 2/4/09 since a known predatory sea lion had been previously observed using this location as a haulout area. On 3/24/09 this trap was moved near the two traps along the Corner Collector wall below PH2. All trap doors were locked open and not set for use until 3/10/09 when sea lion presence began to increase. An additional sea lion trap was also operated in Astoria at the East Mooring Basin.

Once sea lions were captured they were herded into holding cages on a barge built specifically to work on sea lions. If an animal was an approved candidate for permanent removal it was

transferred to an on-site holding facility for further evaluation. A crane operated by the Bonneville rigging crew was used to lift and transfer candidate sea lions. If a captured animal was not a candidate for removal it was released, possibly after branding and/or instrumentation.

If a NMFS-approved zoo or aquarium facility was available to receive captured sea lions then candidate animals were given a health screening by field staff and veterinarians, including members of the States' Animal Care Committee. If an animal passed the health screening it was transferred to Point Defiance Zoo and Aquarium in Tacoma, WA for temporary housing prior to shipment to a permanent holding facility. If an animal failed the health exam, or if there were no approved facilities prepared to accept an animal, then it was chemically euthanized. Euthanized animals were necropsied and tissues were typically collected for further analysis.

Acoustic telemetry

Acoustic pingers (ultrasonic transmitters) were attached to a sample of California sea lions captured at Bonneville Dam in order to track movements and infer foraging behavior around Bonneville Dam and in the lower Columbia River. We used Vemco V16-5H coded pingers (Vemco Ltd., Nova Scotia, Canada) which were 16-mm in diameter, 955-mm in length, weighed 16-g in water and operated at a frequency of 69-kHz with a power of 165 dB re 1 μPa at 1 m. Each pinger emitted a uniquely identifiable pulse train at random intervals every 30-90 s. Pingers were attached to the dorsum of a sea lion using 5-minute epoxy.

Sea lions were passively tracked using fixed arrays of Vemco VR2W acoustic receivers. Receivers were located from Bonneville Dam to Astoria. In narrow locations, a single receiver was used to provide acoustic coverage over the width of the river, whereas in wider areas a pair of receivers were used to create "passage gates". Receivers recorded a pinger's identification number, date and time whenever a marked sea lion traveled within a receiver's detection range. Range testing was conducted three times early in the season by towing a pinger with a boat. The velocity of the boat was ~13 km/hr and the pinger used continuously pulsed signals at 5 s intervals. The boat / pinger unit traveled throughout the study area during each test. An onboard GPS unit recorded the location of the boat / pinger and these data were combined with detections from the array of fixed receivers to study detection range.

To investigate nocturnal sea lion activities we reviewed the acoustic detection history of each instrumented animal and tallied the number of nights when they were not detected near the haul-out area in the PH2 tailrace. We then divided that number by the total number of nights that each animal spent in the vicinity of Bonneville Dam to calculate a nocturnal activity rate.

Food habits

Fecal (scat) samples off haul-out structures as well from the gastro-intestinal tracks of euthanized animals were collected for food habits information. Undigested prey structures were recovered by rinsing scat through a series of nested sieves. Prey will be identified to the lowest taxon possible based on species-specific or family-specific diagnostic structures such as otoliths, teeth, gill rakers and vertebrae.

Effect of removals

We attempted to estimate the number of salmonids that were not consumed due to the removals of California sea lions in 2008 and 2009. We started by trying to predict the number of days an animal would have been present had it not been removed. We did this by looking at the observed residence time of sea lions on the list for removal. We reasoned that candidate animals were a more appropriate reference group to predict predation rates and residence time of removed animals than the general sea lion population as a whole. For each year we calculated the median 'minimum number of days observed' for animals that were not removed in that year (retaining removed animals would have biased low an estimate of residence time). For 2008 and 2009, median residence times of candidate animals were 30 and 32 days, respectively.

Recognizing that an animal's removal date could come at any point during its residency at the dam, we assumed that it occurred, on average, at its midpoint. That is, for animals removed in 2008, we assumed that they would have been present at the dam, had they not been removed, for an additional 15 days. However, we also realized that this needed to be modified if those 15 days projected an animal to be present past the typical southward migration departure date from the dam (assumed to be 15 May). For these animals we used the number of days from the removal date to 15 May. We assumed that animals removed in 2008 would have occurred for the full 32 days in 2009.

Having predicted the number of days an animal would have been present had it not been removed, we multiplied this by an estimate of daily energy requirement (kg/d) based on the bioenergetics model in Wright (2007). We assumed a 100% salmonid diet and used the weight-at-removal as the mass input. Lastly, we converted total energy requirements to number of salmonids by dividing it by 6.6 kgs, the average weight of Chinook salmon found in a recent study of salmon passage at the dam (personal communication, Christopher Peery, University of Idaho, 10/11/2006).

As an alternative approach, we also predicted the amount of predation 25 California sea lions might consume by bootstrapping USACE observation data. As above, we first extracted all candidate animals from the USACE database and deleted observations for the 25 animals removed during the spring chinook run in 2008-2009. We next took a random sample of n=11 observed predation values from the set of all candidate animals and all years, and multiplied this by 0.5 to represent the number of salmon saved in 2008 by the removal of the 11 sea lions in that year. We then added this to another sample of n=11 (not multiplied by 0.5) to represent the number of salmon saved in 2009 by the removal of the 11 animals in 2008 (assuming 100% of the animals removed in 2008 would be back in 2009). Finally we added this to a sample of n=14 animals (multiplied by 0.5) to represent the number of salmonids saved in 2009 by the removal of the 14 sea lions in that year (note that the animal removed on 8/24/09 was not included as it will not result in saved salmon until 2010). We repeated this procedure 10,000 times to arrive at a mean and 95% confidence interval for the predicted number of salmonids saved due to the 25 removals over the 2008-2009 periods.

RESULTS

Boat-based deterrent activities

Boat-based pinniped hazing crews from ODFW, WDFW, and/or CRITFC hazed sea lions on 57 days (78 boat-days) from 1/13/09-5/15/09 (Table 1). Severe weather (snow, ice, high winds) often prevented safe boat operation in January and February. Hazing resulted in a total of 612 and 427 "takes" of California sea lions and Steller sea lions, respectively. A total of 10,227 cracker shells, 1,627 seal bombs, and 168 rubber buckshot rounds were used during deterrent activities.

The majority of hazing events started in the BRZ (Figures 1 and 2). Of those starting in the BRZ, 20 percent of California sea lion and 50 percent of the Steller sea lions hazing events resulted in animals being driven below the BRZ boundary (Figure 2). At the start of hazing events most pinnipeds (82%) were observed either stationary or moving upstream (Table 2). At the end of the hazing events the majority (68%) of the pinnipeds were moving downstream (Table 2). Boat-based pinniped hazing events generally lasted less than 30 minutes (Figure 3).

Based on their observations of our hazing efforts, IMATA provided a letter to the States outlining a number of ideas on how our use of non-lethal deterrents might be modified to increase their effectiveness (Appendix 3). We are currently reviewing their recommendations and discussing how they might be implemented in the future.

Trapping

A total of 21 California sea lions were captured in 2009 (Table 3): four of the sea lions that were listed for removal were transferred into permanent captivity (two to the Shedd Aquarium and two to the Gladys Porter Zoo); eleven of the listed animals were chemically euthanized; and six sea lions not on the removal list were instrumented, branded (if they were not already marked), and released on site.

One male Steller sea lion was trapped on 3/18/09 along with one known predatory California sea lion. Both sea lions were successfully removed from the trap within an hour without incident. The Steller sea lion was released at the trap site.

On 10/1/09, a sea lion trap was moved above the dam and placed in the forebay in an attempt to trap an animal (C697) that had locked above the dam on 5/16/09 and subsequently spent the summer from Bonneville Dam to The Dalles Dam. This sea lion was repeatedly observed by USACE staff consuming salmonids at the fish ladder exit in the forebay area near the navigation lock. As of 10/22/09 it had not yet been caught and had recently been reported just above Bonneville Dam in the entrance to ODFW's Eagle Creek Salmon Hatchery.

Acoustic telemetry

Six California sea lions were tagged with acoustic transmitters (Figures 4 and 5). Duration of tracking ranged from 6 to 44 days. Range testing results were highly variable and were

inconsistent within and between receivers, particularly within the BRZ. Detection distances ranged from tens-of-meters to over a kilometer. Nevertheless, detection at each "passage gate" appeared to be quite high, which gave us confidence in our ability to detect animals as they moved upriver and downriver.

Of the four animals with relatively long datasets, three foraged almost exclusively in the BRZ and Tanner Creek area (Figs. 5A, 5C, and 5D), while the fourth made daily foraging trips of approximately 5 miles downriver from the BRZ near Marker 85 (Fig. 5B). This relative use of the river is further summarized in Figure 6, which shows the frequency of detections in each of three areas: the BRZ, Tanner Creek to Skamania Island and St. Helens to the mouth of the river. Detection data showed that approximately 90% of the detections of these animals occurred during the day and twilight hours (Figure 7). These animals spent approximately 10 of 106 nights away from the favored haul-out site in the PH2 tailrace during their stay at Bonneville Dam. All four of these animals made at least one trip to Astoria and back to Bonneville subsequent to tagging and prior to the end of May. One animal (C697) made two such trips.

Three of the instrumented California sea lions were opportunistically detected by other researchers using acoustic arrays located near Cascade Head, Oregon (~82 miles south of the mouth of the Columbia River). These detections occurred on 5/21/09, (C935; Fig. 5F), 5/22/09 (C927; Fig. 5C), and 5/30/09 (C934; Fig. 5E). Travel times from Bonneville Dam to this site (~230 miles) ranged from 4 to 15 days.

Food habits

Undigested remains recovered from sea lion fecal material and gastro-intestinal tracts have been transferred to ODFW for future identification.

Effect of removals

We removed a total of 26 California sea lions from the Columbia River during 2008-2009 (includes accidental deaths, transfer to zoos and aquariums and euthanized animals). Based on the bioenergetics modeling approach, the predicted number of salmonids that would have been consumed had these animals not been removed was approximately 1,655 over the two-year period (Table 4). The alternative method of bootstrapping the observed minimum number of salmonids observed by USACE observers resulted in a mean of 773 salmonids saved over the two-year period (95% confidence interval: 528 to 1,054).

DISCUSSION

Boat-based deterrent activities

Hazing activities in 2009 were conducted (1) in an attempt to disrupt and reduce sea lion predation near the dam (and possibly minimize recruitment of new, naïve predators to the area), and (2) to fulfill requirements of the Section 120 authorization granted to the States for permanent removal of California sea lions at Bonneville Dam. One component of this Section 120 authorization requires sea lions to have been exposed to non-lethal hazing prior to taking

permanent removal actions for individual animals. In general, the response to hazing in 2009 was similar to that seen in previous years. There was no apparent reduction in sea lion activity or predation in response to hazing. There was also no negative reaction, injury or mortality to salmonids or other fish and wildlife species as a result of the pinniped hazing activities. Many hazing events occurred in areas downstream of the BRZ (areas HR, WR, and MC) even though the level of effort in those areas was much less than areas inside the BRZ.

The States and CRITFC have successfully coordinated on hazing efforts below Bonneville Dam for the past three years. In reviewing this cooperative effort and results of hazing overall, we have determined that improvements in efficiency and outcomes can be made. In order to maximize the beneficial results of hazing, trapping and removing predatory sea lions in future years, the States will focus their staff and resources on trapping and removal efforts, while CRITFC will focus on deterrent and sea lion abundance estimation activities. Both the States and CRITFC will work together on further telemetry studies. The level of hazing activities conducted by CRITFC and States' staff on the water, and by USDA Wildlife Services staff on shore, will be more than adequate to meet the objectives of disrupting sea lion foraging behavior in the BRZ and exposing predators to significant deterrent efforts.

Based on the recommendations by IMATA we intend to modify our deterrent techniques by incorporating some of their suggestions into future deterrent methods. We intend to focus boat-based hazing in the area above Tanner Creek and into the BRZ. Once sea lions have been encouraged to begin moving downstream out of the BRZ we will generally not continue to haze them to areas further downriver. We intend to refine and improve on our hazing efforts in a number of ways, including working more closely with CRITFC on more effective boat hazing focusing on the BRZ. Other suggestions made by IMATA are being evaluated at this time and will be considered for use in the following season. A number of the suggestions are not practical to this situation or are not logistically possible to implement. We expect to continue to consult with this group in the future to improve hazing and deterrent techniques as possible.

Trapping and Removal

All candidate California sea lions removed in 2009 were captured on floating traps. During the 2009 season, the States discussed protocols and safety at several meetings with USACE staff and came to an understanding of how firearms would be used. This effort would involve the use of a trained marksman, a biologist experienced with identification of known predatory sea lions and a Safety Officer provided by USACE. Use of firearms would be conducted according to the restrictions identified in the Section 120 Letter of Authority. However, opportunities for use of firearms were extremely limited in 2009 due to sea lion haul-out patterns. Sea lions repeatedly used sections of the apron below the Corner Collector that would not allow use of firearms. Only on one or two occasions were known predatory animals observed in locations and at times where firearms could have been used.

Limiting space on the apron below the Corner Collector used as a haulout area by sea lions could increase the likelihood that animals would more frequently rest on the traps. The need for modification of the apron has been discussed with USACE staff at Bonneville. There is general agreement that this could be beneficial to the predator removal program, but there is currently no

funding identified for a permanent fix for this problem. The States are considering testing temporary methods to block portions of the apron (e.g. with concrete blocks) in 2010. This action will need the approval of the Fish Passage Operations and Maintenance coordination team and USACE.

Modification of the trapping protocols including locking traps open when not in use, installment of remote door release systems, increased monitoring and use remote cameras during the 2009 season proved very successful at preventing unintended capture events. In 2009 we had three traps equipped with these systems and we will add a fourth for the 2010 season.

Health screenings for animals that were captured and could potentially be sent to captive display facilities proved to be costly, time consuming and not always conclusive. The costs for this work was not considered or provided for in initial project budget requests. While it is important to make healthy animals available for facilities that are eligible to receive them, the health screening process put a significant burden on our operations that were not directly supported through existing budgets. Some of these costs including staff and health screening may require additional funding or be supported by the institutions approved by NMFS to receive healthy animals. This same situation applies to institutions seeking legally transferable biological samples. The States do not have necessary funding or staff to conduct full post mortem examinations and tissue collection in every case. Again, those requesting materials should provide their staff and be responsible for covering costs of this work.

Early in the 2009 season there was confusion about how to evaluate the health condition of sea lions that might be appropriate for transfer to captivity. This question has been clarified with NMFS where only conditions (again, other than obvious poor health) identified in the letters of authority to a receiving facility (e.g. size limitations or potential health concerns) will be considered when evaluating an animal for transfer to captivity.

Acoustic telemetry

Two of the objectives of the acoustic telemetry work were to (1) determine whether USACE observers would detect instrumented animals given that the receiver data indicated they were in the BRZ; and (2) determine the extent of nocturnal movements and, presumably, foraging activity. A comparison of the telemetry data (Figs. 5A-5F) with daily USACE observation data revealed that nearly all diurnal activity in the BRZ by instrumented animals was reflected in the USACE observer data. The few exceptions seemed to be occasions on which animals foraged at or below Tanner Creek for most or all of daylight hours. An extreme example of this was animal C697 (Fig. 5B) which foraged almost exclusively five miles downriver from Tanner Creek near Marker 85, only returning to the BRZ at night to haul-out on the corner collector apron. Hauling-out at the corner collector at night was the norm for tagged animals (Figs. 5A-5F), with nocturnal activity only occurring about 10% of the time (Figure 7).

In an attempt to collect more detailed data on hazing effects, we attached an acoustic pinger to the CRITFC hazing boat in an attempt to correlate boat and instrumented sea lion movements as they passed within detection range of the receivers. Unfortunately, noise interference from the boat motor prevented adequate detection of the acoustic tag attached to the boat.

Effect of removals

Predicting how many salmonids were saved by removing sea lions is subject to a number of assumptions and considerable uncertainty. Nevertheless we believe the two approaches we used are reasonable and produced a plausible range of estimates (approximately 800 to 1,700 salmonid saved). Each relied to some extent, however, on USACE observation data which are known to be minimum estimates of predation and residency. We therefore believe that our estimates of salmonids saved likely reflect minimums as well.

Recommendations for 2010

- The Corner Collector apron needs to be modified to limit its use as a haulout in areas near the traps and where use of firearms could be safely carried out. Ultimately USACE should plan, budget and implement a permanent fix. In the meantime, the States will pursue tests of temporary options for modifying this area to change sea lion use patterns.

- We plan to move forward next season with a revised boat-based hazing protocol. This would include incorporation of several of the IMATA suggestions for influencing predator behavior. While the States, USACE, USDA and CRITFC will coordinate directly on all hazing activities, CRITFC will take the lead in boat-based hazing activities in the BRZ with direction and staff assistance from the States.

- The initial results of the acoustic tracking work were very encouraging and could potentially lead to a better understanding of predator foraging patterns in this area. Since the sample size achieved last year was low, we plan to continue deploying tracking tags in 2010 on animals that are not listed for removal.

- In cooperation with USACE, we will continue refining our methods for predicting the number of salmonids saved due to sea lion removals.

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Table 1. Weekly summary of 2009 boat-based hazing activities at and below Bonneville Dam.

		Effort (days/wk)[1]					Take[2]		Munitions used			Observed salmonid predation[3]	
Wk #	Wk of	OR	WA	IT	Total	Boat-days	CSL	SSL	Cracker shells	Seal bombs	Rubber buckshot	Inside tailraces	Outside tailraces
1	01/11/09	2			2	2	10	14	51	33	2		
2	01/18/09	1			1	1	1	9	19	13			
3	01/25/09	2			2	2	4	20	64	12			
4	02/01/09	2			2	2	4	25	148				
5	02/08/09	2			2	2	4	36	172		9	1	
6	02/15/09	1			1	1	1	12	105	39			
7	02/22/09	1			1	1	6	11	182	43			
8	03/01/09												
9	03/08/09		4		4	4	33	32	403	37	4	3	
10	03/15/09		4	3	5	7	46	58	754	149	29	2	2
11	03/22/09		4	3	5	7	34	34	622	104	21	9	2
12	03/29/09		1	3	3	4	58	30	464	95		2	1
13	04/05/09		2	5	5	7	83	33	965	201		9	2
14	04/12/09		3	5	5	8	74	31	1,384	320	16	9	4
15	04/19/09		3	5	5	8	88	27	1,538	208	47	9	7
16	04/26/09		4	5	5	9	89	27	1,572	139	40	12	2
17	05/03/09		4	5	5	9	57	27	1,312	159		11	2
18	05/10/09			4	4	4	20	1	472	75		1	
Total		11	29	38	57	78	612	427	10,227	1,627	168	68	22

[1] OR=ODFW, WA=WDFW, IT=CRITFC; more than one boat may have operated per day (see boat-day column).

[2] Take refers to numbers of animal-harassment events; CSL=California sea lion, SSL=Steller sea lion.

[3] Salmonid predation observed during boat-based hazing inside and outside dam tailraces; observations were anecdotal and should not be used to infer predation rates outside the tailraces.

Table 2. The observed direction that pinnipeds were moving prior to and following boat-based hazing events in 2009.

	Start of hazing event		End of hazing event	
Direction of travel	Number	Proportion	Number	Proportion
Unavailable	2	0.004	5	0.010
Upriver	255	0.489	43	0.083
Stationary	174	0.334	15	0.029
Downriver	76	0.146	354	0.679
Unknown	14	0.027	103	0.198
Multiple directions		0.000	1	0.002
Total	521		521	

Table 3. Summary of 2009 sea lion capture activities in the Columbia River.

Capture Date	Brand	Alt ID	Eligible	Euthanized	Captivity	Tagged/released
3/10/2009	C265	B237	Yes	1		
3/11/2009	C635	B240	Yes	1		
3/17/2009	C643	B242	Yes	1		
3/18/2009*	C507		Yes		1	
	C700	B247	Yes		1	
4/1/2009	C554		Yes	1		
	C578		Yes	1		
	C579		Yes	1		
	C586		Yes		1	
	C657	B127	Yes		1	
	C669	B110	Yes	1		
	C697		No			1
	C926	B278	Yes (09)			1
4/8/2009	C697		No			(Recapture)
	C927		No			1
4/16/2009	C927		No			(Recapture)
	C928		No			1
5/11/2009	C858**		Yes (09)	1		
5/13/2009	C645**		Yes	1		
5/14/2009	C674		Yes	1		
	C934	B300	No			1
	C935		No			1
8/24/09	C928**		Yes	1		
Total				11	4	6

*One male Steller sea lion also trapped and released at the trap site without complication.
** Captured at Astoria trap.

Table 4. Predicted numbers of salmonids saved due to California sea lion removals in the Columbia River, 2008-2009.

	ID	Status	Capture date	Removal weight, lbs (kgs)	Est. energy requirement**, kg/d (fish/d)	Est. 2008 residence time, days	Est. 2009 residence time, days	Est. total salmonids saved
1	C319	Sea World	4/24/2008	1269 (576)	21.91 (3.32)	15	32	156
2	C606	Sea World	4/24/2008	600 (272)	12.46 (1.88)	15	32	88
3	C739	Sea World	4/24/2008	783 (355)	15.24 (2.31)	15	32	109
4	B198	Died under anesthesia	4/28/2008	1454 (660)	24.46 (3.70)	15	32	174
5	B66	Sea World	4/28/2008	992 (450)	18.30 (2.77)	15	32	130
6	C640	Sea World	4/28/2008	935 (424)	17.17 (2.60)	15	32	122
7	C668	Sea World	4/28/2008	980 (445)	17.80 (2.69)	15	32	126
8	B252	Died on trap	5/4/2008	~330 (150)	7.95 (1.20)	11	32	52
9	B275	Died on trap	5/4/2008	~850 (386)	16.19 (2.45)	11	32	105
10	C347	Died on trap	5/4/2008	~900 (408)	16.94 (2.56)	11	32	110
11	C672	Died on trap	5/4/2008	~550 (250)	11.78 (1.78)	11	32	77
12	C265	Euthanized	3/10/2009	~800 (363)	15.63 (2.36)		16	38
13	C635	Euthanized	3/11/2009	~900 (408)	16.94 (2.56)		16	41
14	C643	Euthanized	3/17/2009	788 (357)	15.23 (2.30)		16	37
15	C507	Shedd Aquarium	3/18/2009	684 (310)	14.00 (2.12)		16	34
16	C700	Shedd Aquarium	3/18/2009	611 (277)	12.79 (1.93)		16	31
17	C554	Euthanized	4/1/2009	~600 (272)	12.32 (1.86)		16	30
18	C578	Euthanized	4/1/2009	~700* (317)	14.03 (2.12)		16	34
19	C579	Euthanized	4/1/2009	~800 (363)	15.53 (2.35)		16	38
20	C586	Gladys Porter	4/1/2009	919 (416)	17.33 (2.62)		16	42
21	C657	Gladys Porter	4/1/2009	~700* (317)	14.03 (2.12)		16	34
22	C669	Euthanized	4/1/2009	~600 (272)	12.32 (1.86)		16	30
23	C858	Euthanized (Astoria capture)	5/11/2009	868 (394)	16.39 (2.48)		4	10
24	C645	Euthanized (Astoria capture)	5/13/2009	1006 (456)	18.38 (2.78)		2	6
25	C674	Euthanized	5/14/2009	939 (426)	17.53 (2.65)		1	3
26	C928	Euthanized (Astoria capture)	8/24/09	578 (262)	12.17 (1.84)		0	0
	Total							1655

*Weight not available; average of other animals used.
**Average of 1000 repetitions.

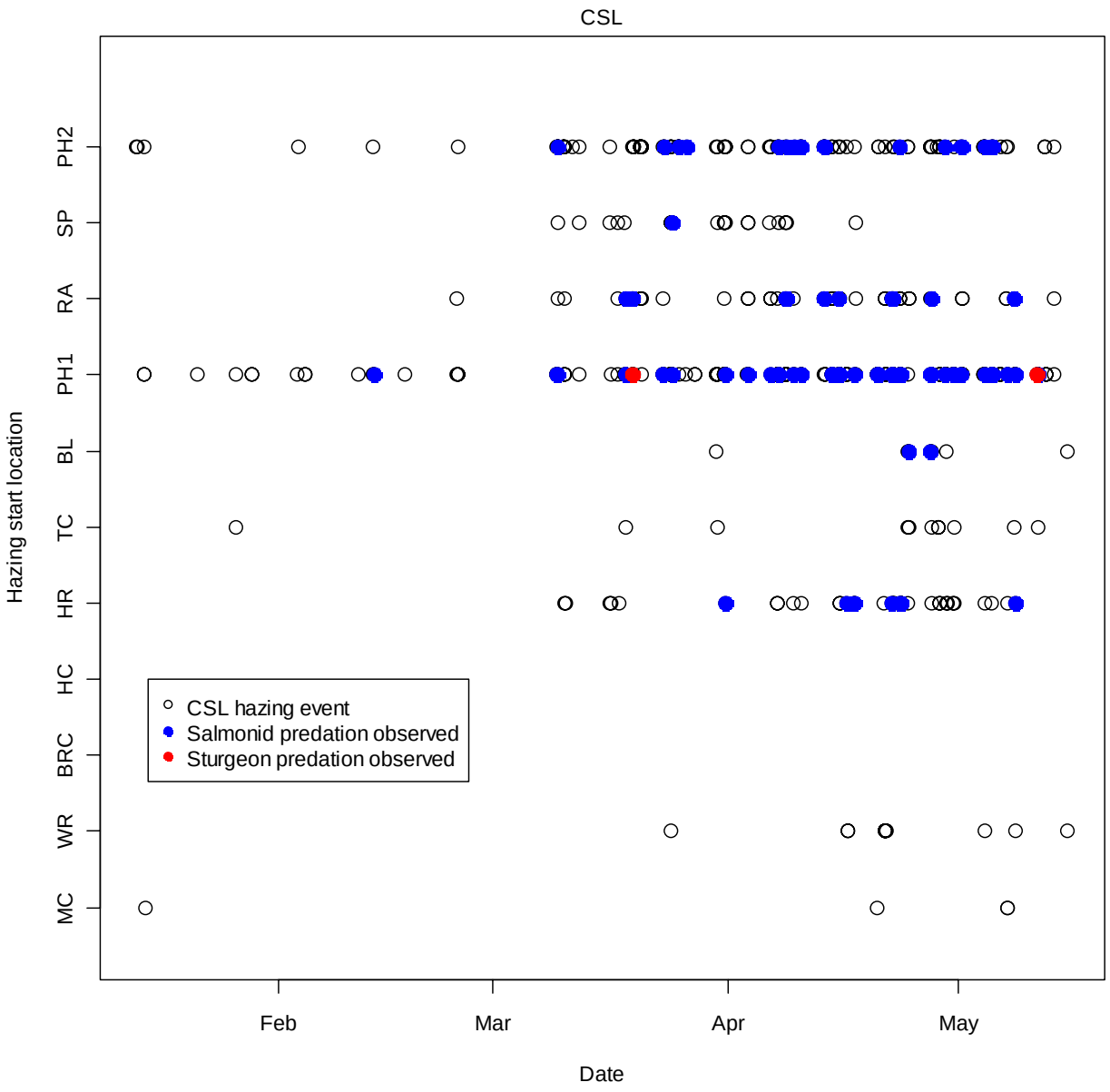


Fig. 1A. California sea lion hazing start locations by date (see Appendix 2 for location map). Symbols denote whether and what type of predation event was observed at the start of the hazing event.

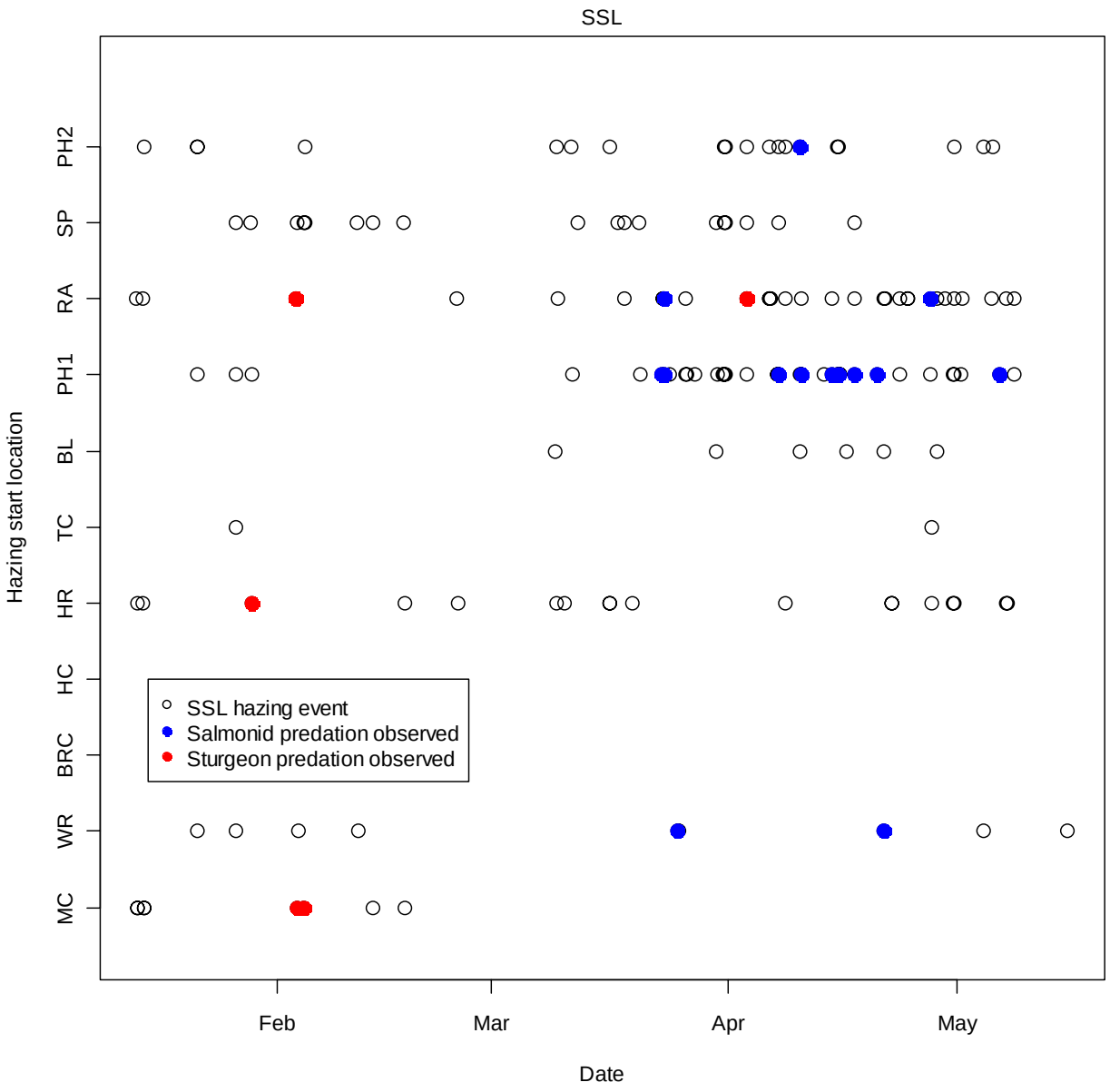


Fig. 1B. Steller sea lion hazing start locations by date (see Appendix 2 for location map). Symbols denote whether and what type of predation event was observed at the start of the hazing event.

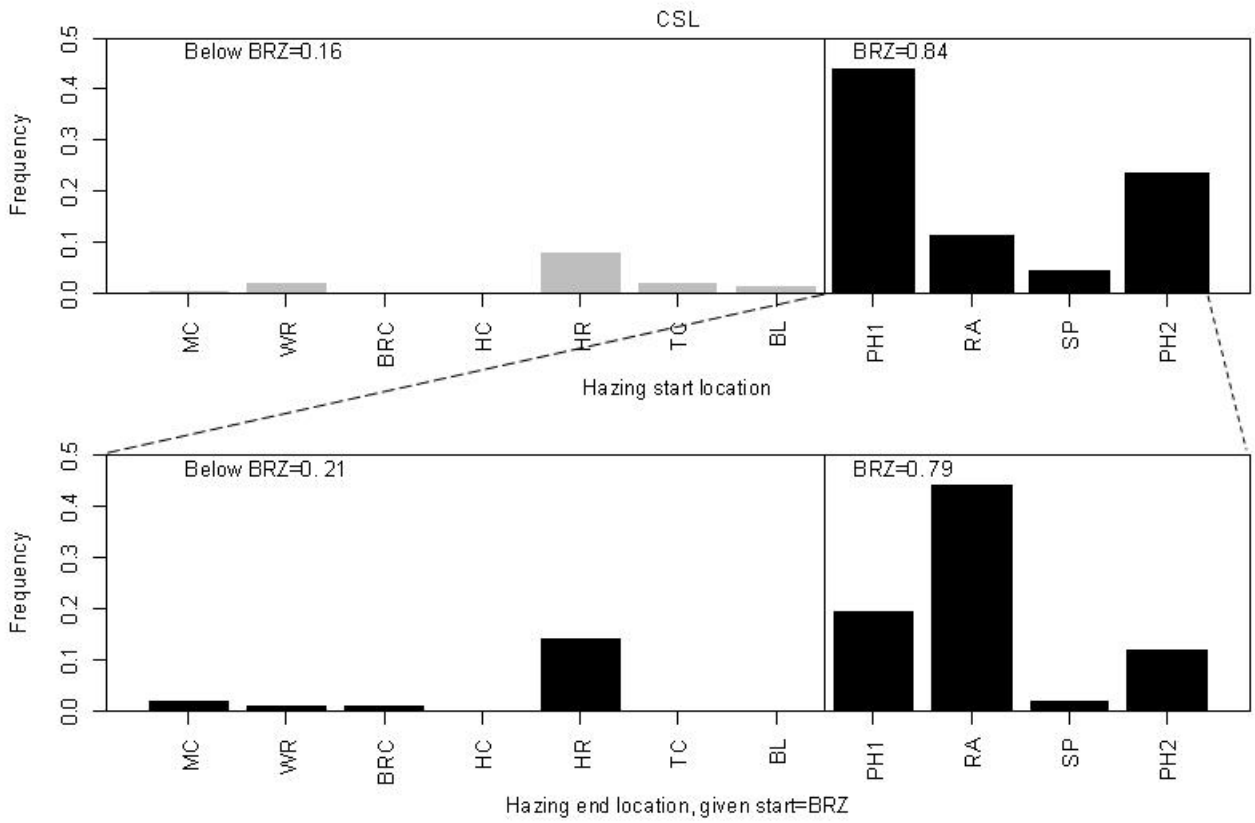


Fig. 2A. California sea lion hazing start (top) and end (bottom) locations (see Appendix 2 for location map). End locations are conditional on having started in the Boat Restricted Zone (black bars).

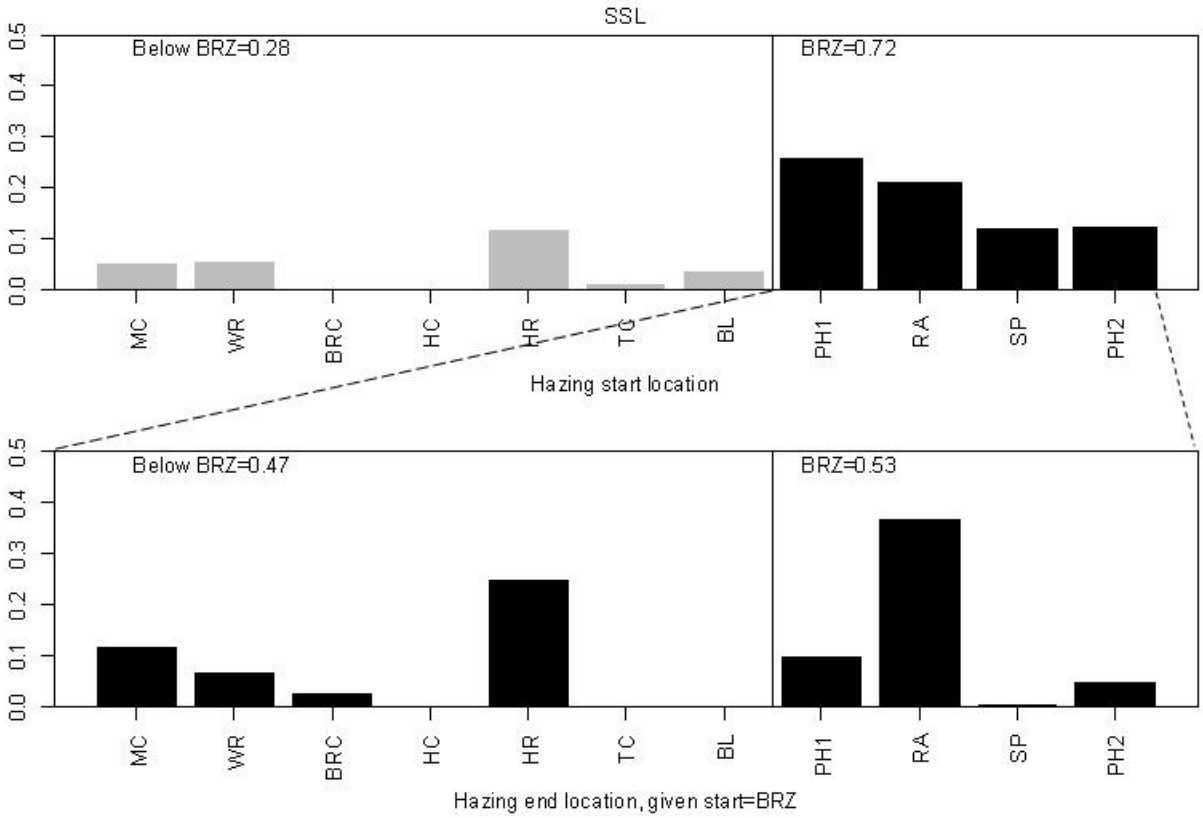


Fig. 2B. Steller sea lion hazing start (top) and end (bottom) locations (see Appendix 2 for location map). End locations are conditional on having started in the Boat Restricted Zone (black bars).

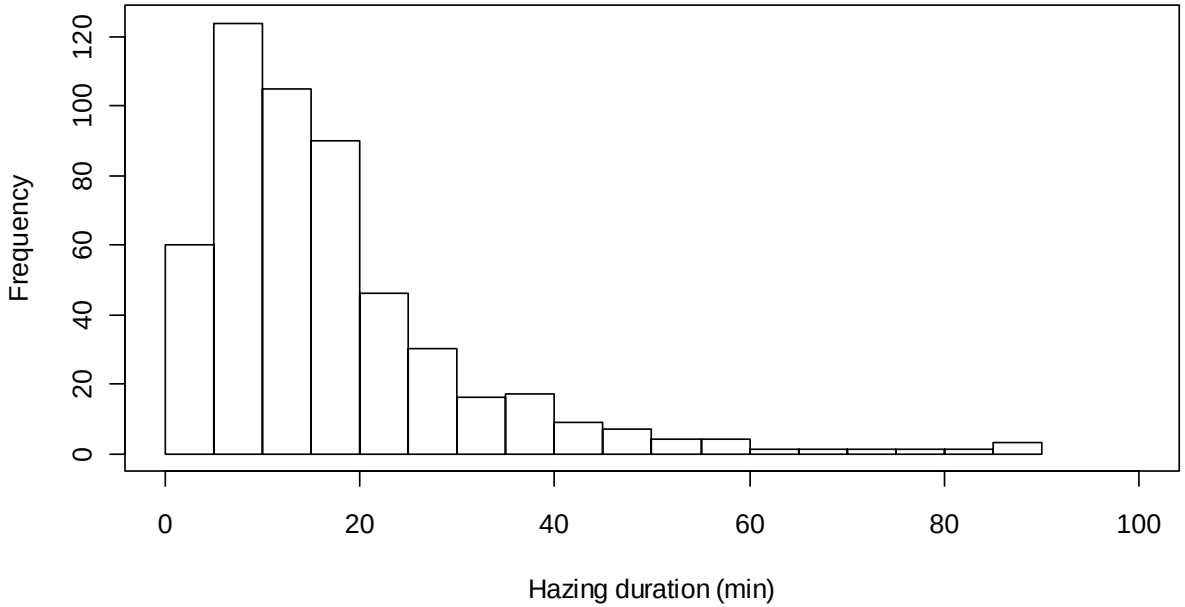


Figure 3. Histogram of hazing event duration, January-May 2009 (n=521 events).

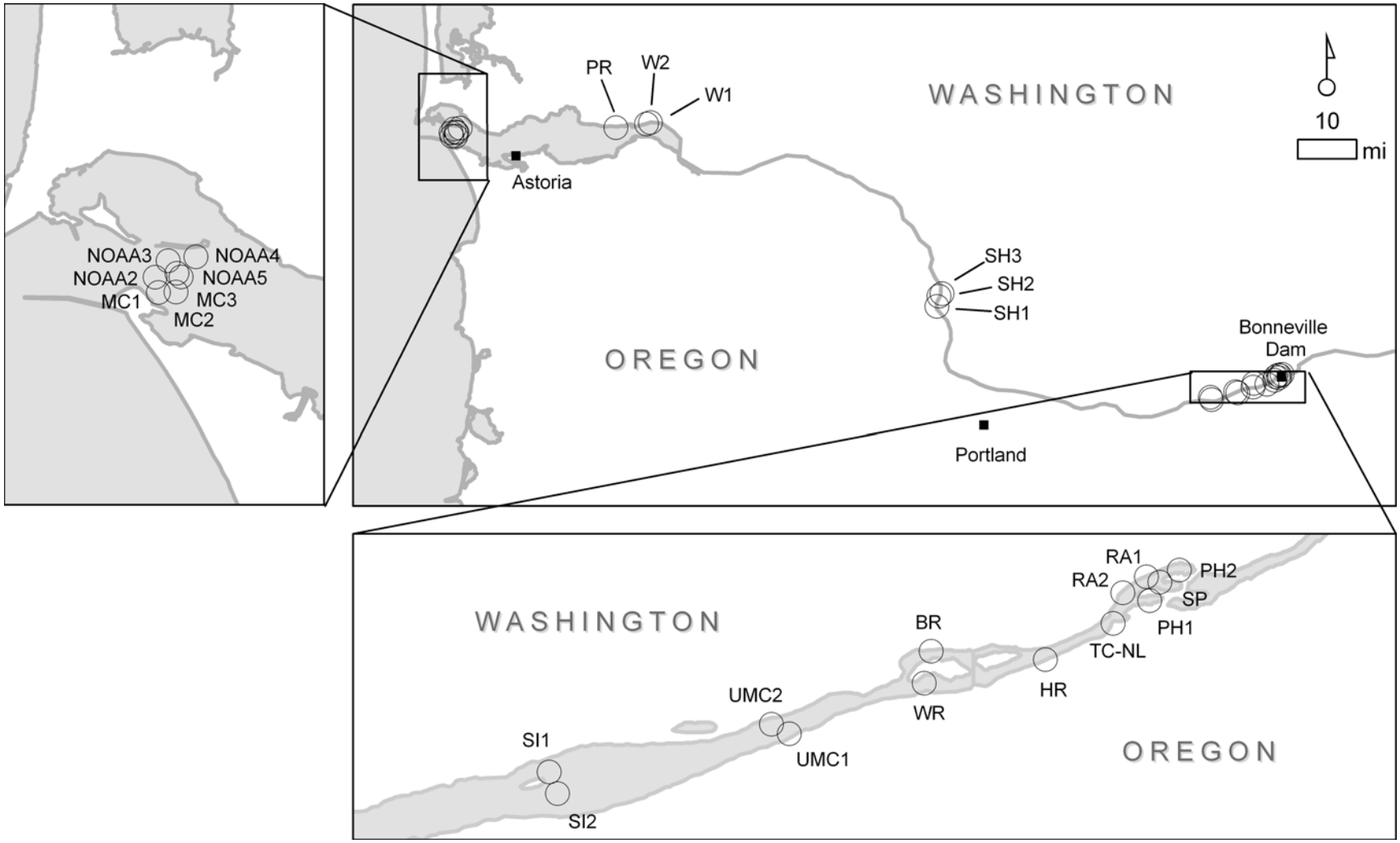


Fig. 4. Hydrophone locations used to track six California sea lions tagged at Bonneville Dam, 2009.

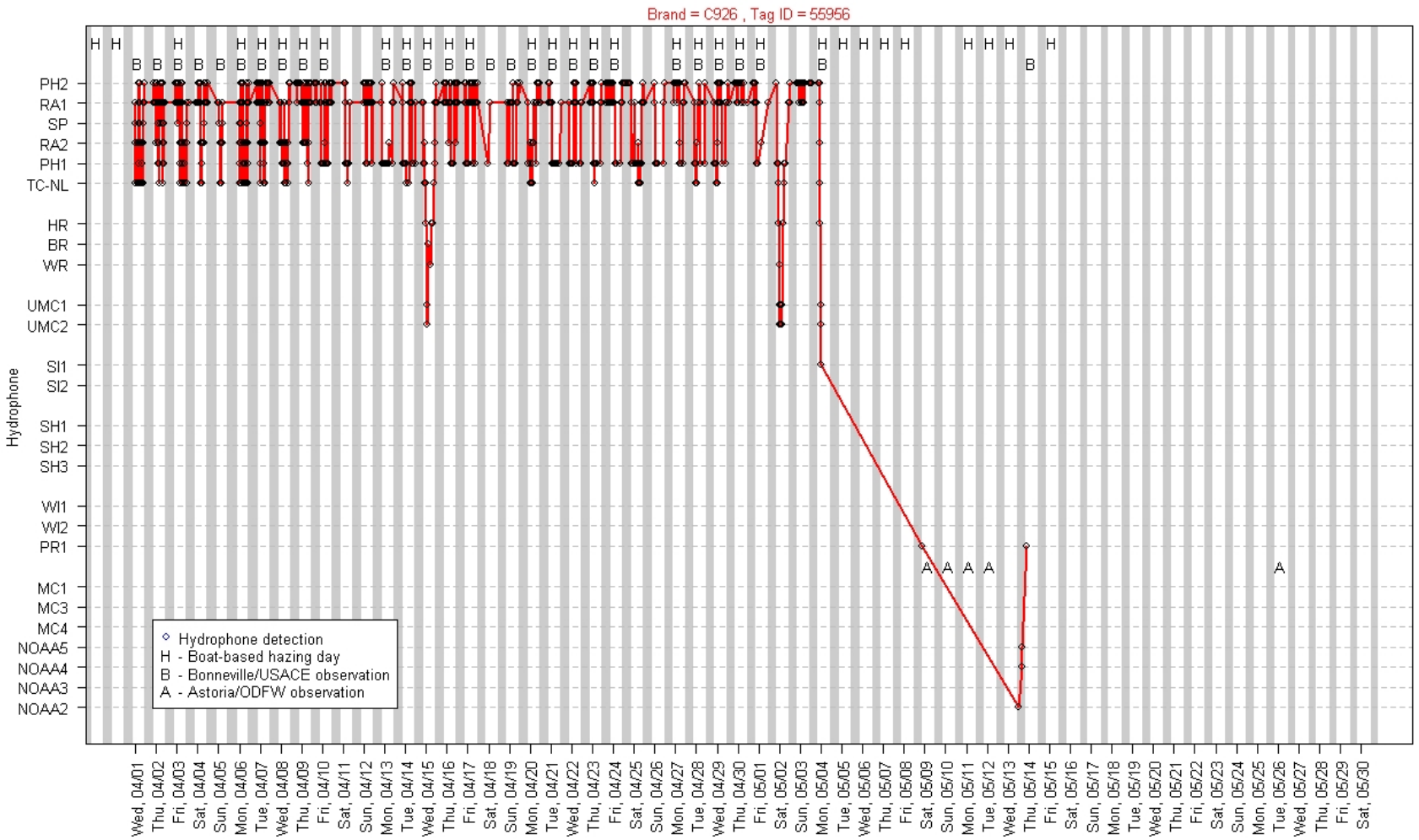


Fig. 5A. Movement profile of C926. See Figure 4 for locations of hydrophones listed on the y-axis.

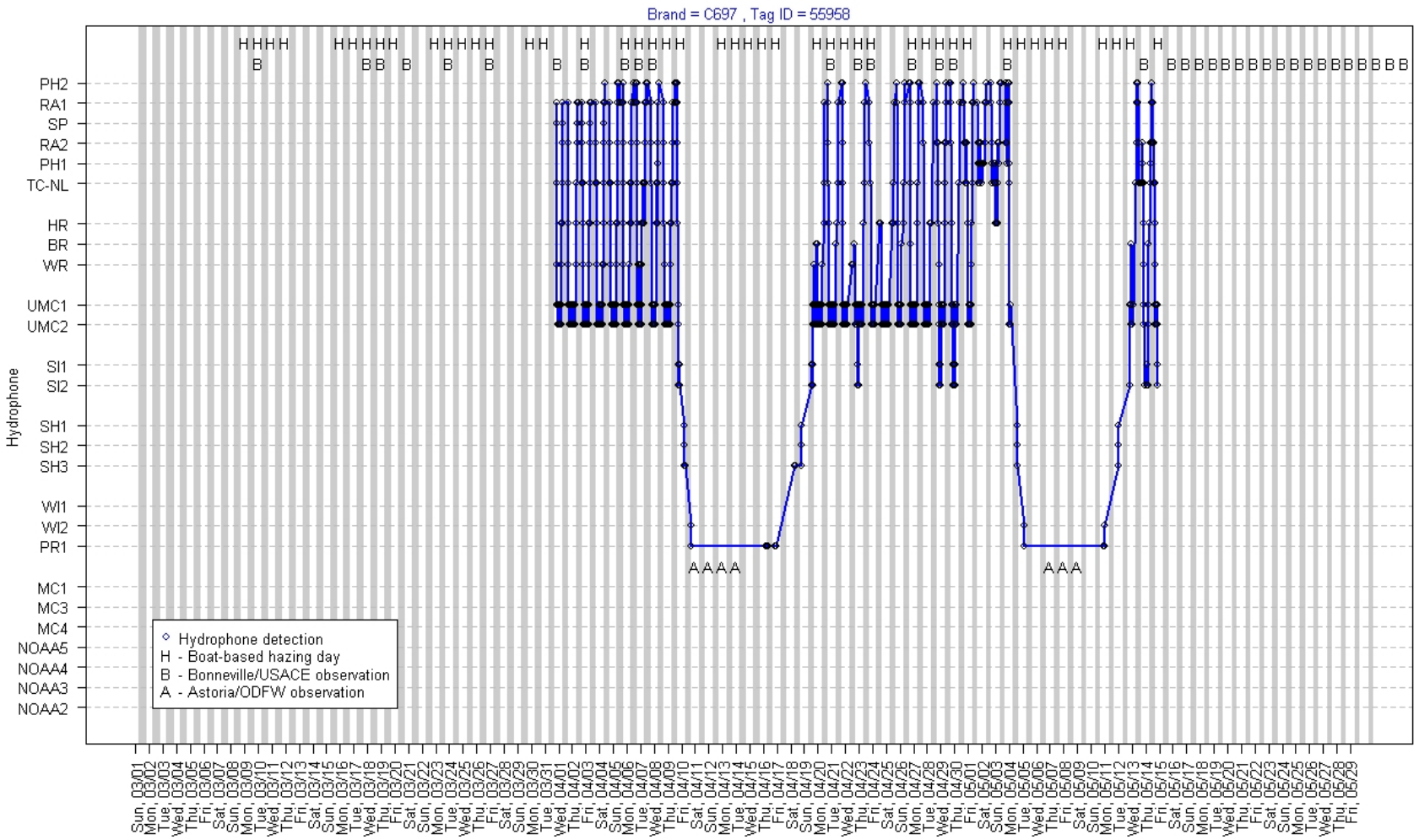


Fig. 5B. Movement profile of C697. See Figure 4 for locations of hydrophones listed on the y-axis.

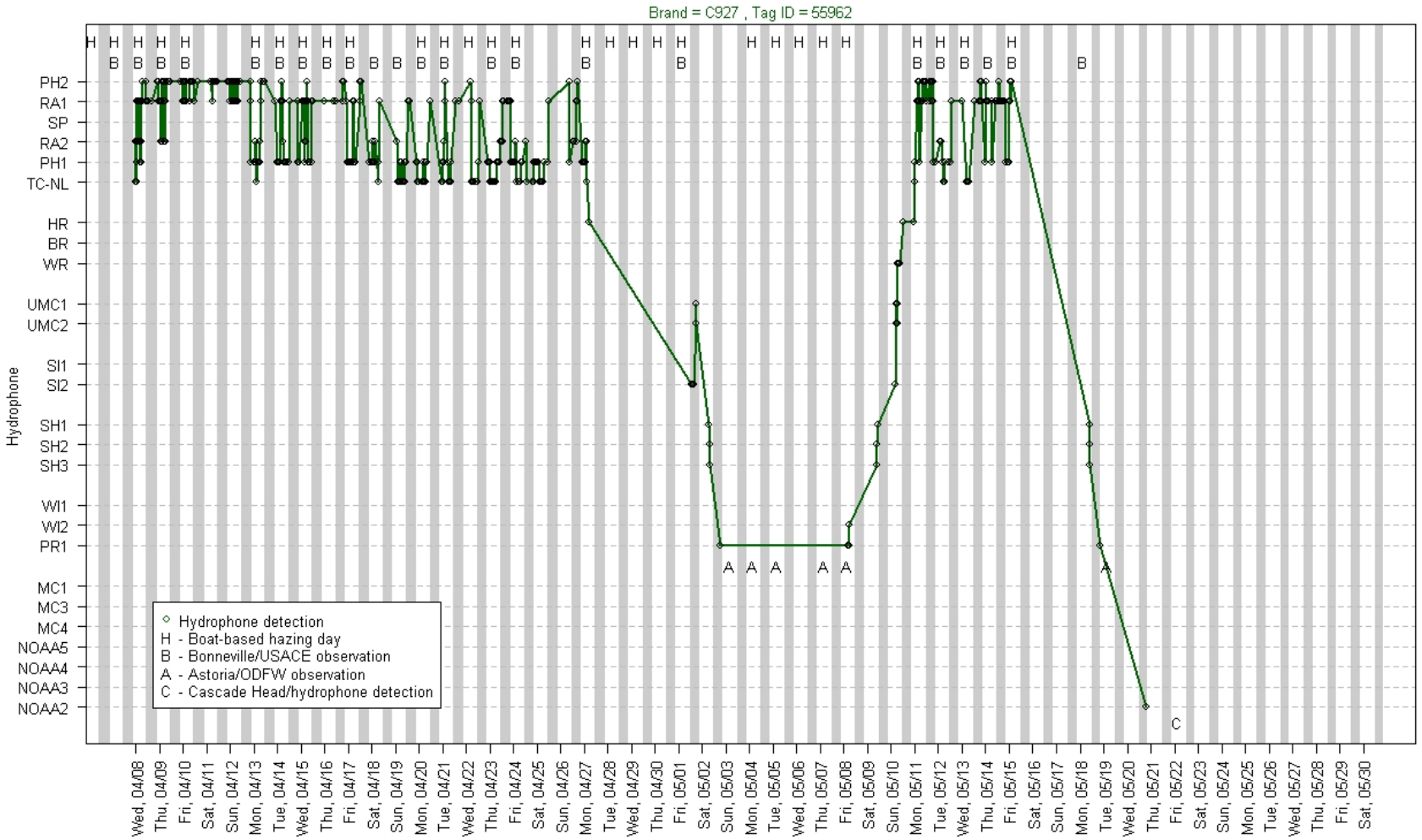


Fig. 5C. Movement profile of C927. See Figure 4 for locations of hydrophones listed on the y-axis. (Note: C927 seen by boat-based hazing crew in PH1 at 9:27 on 5/1/09.)

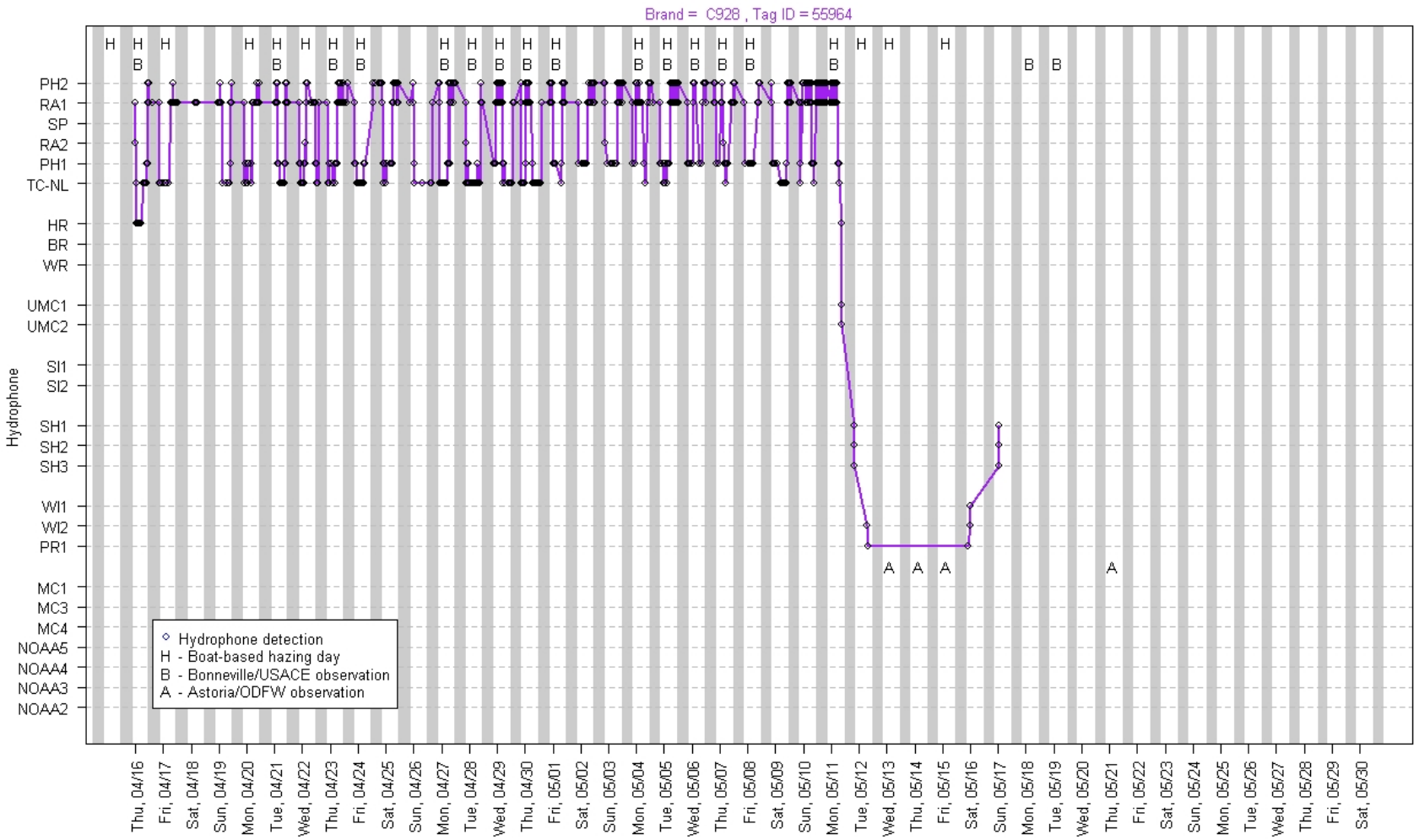


Fig. 5D. Movement profile of C928. See Figure 4 for locations of hydrophones listed on the y-axis.

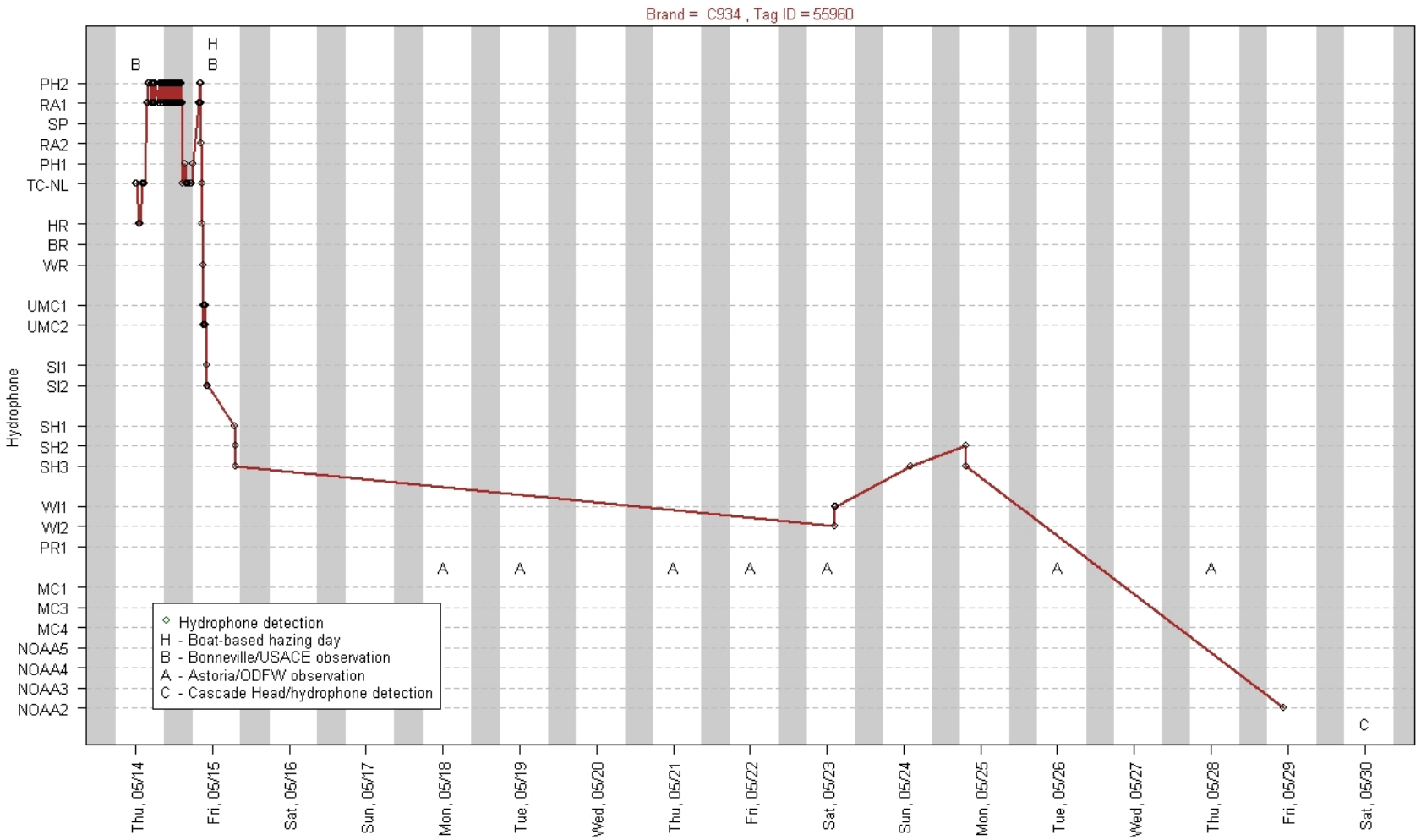


Fig. 5E. Movement profile of C934. See Figure 4 for locations of hydrophones listed on the y-axis.

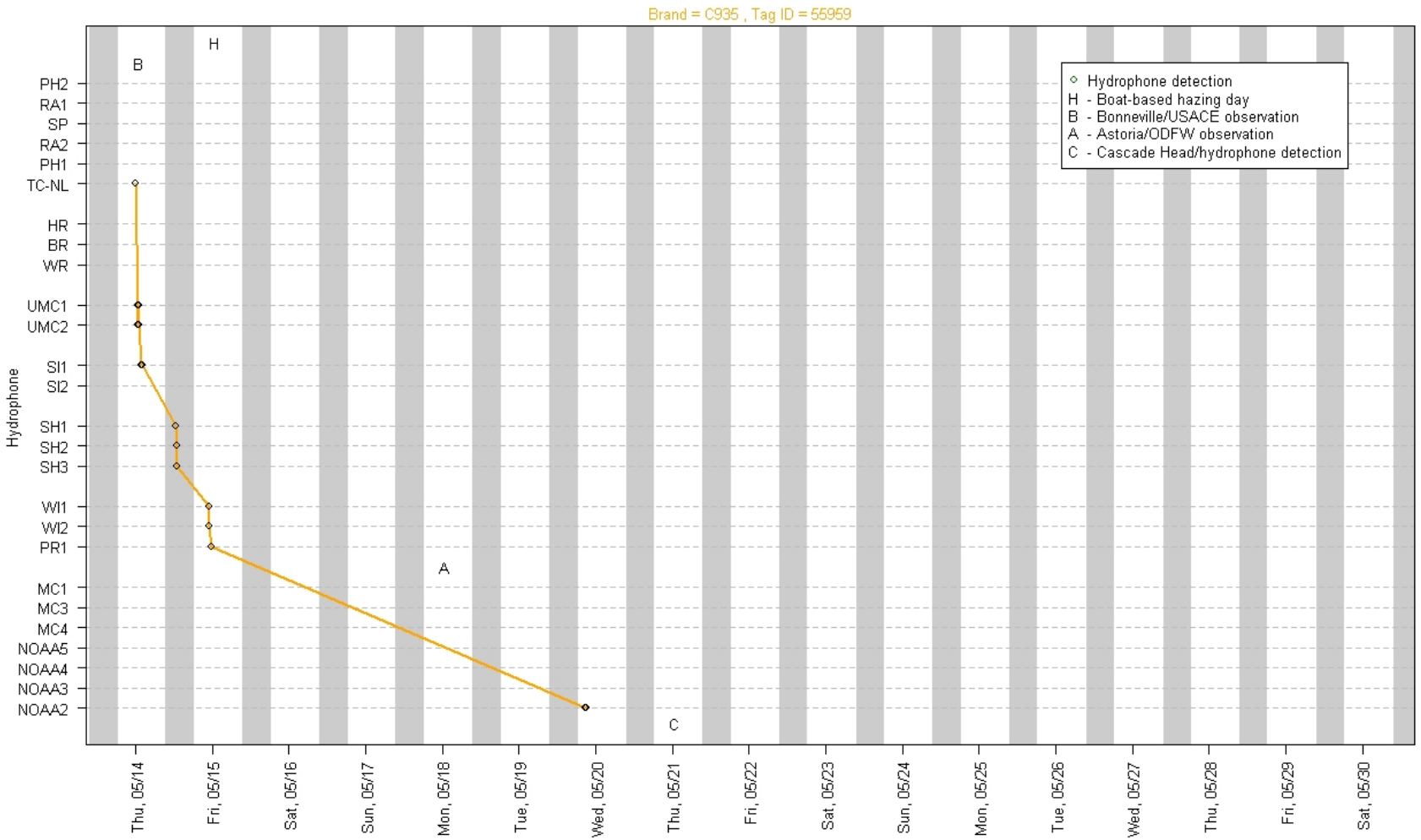


Fig. 5F. Movement profile of C935. See Figure 4 for locations of hydrophones listed on the y-axis.

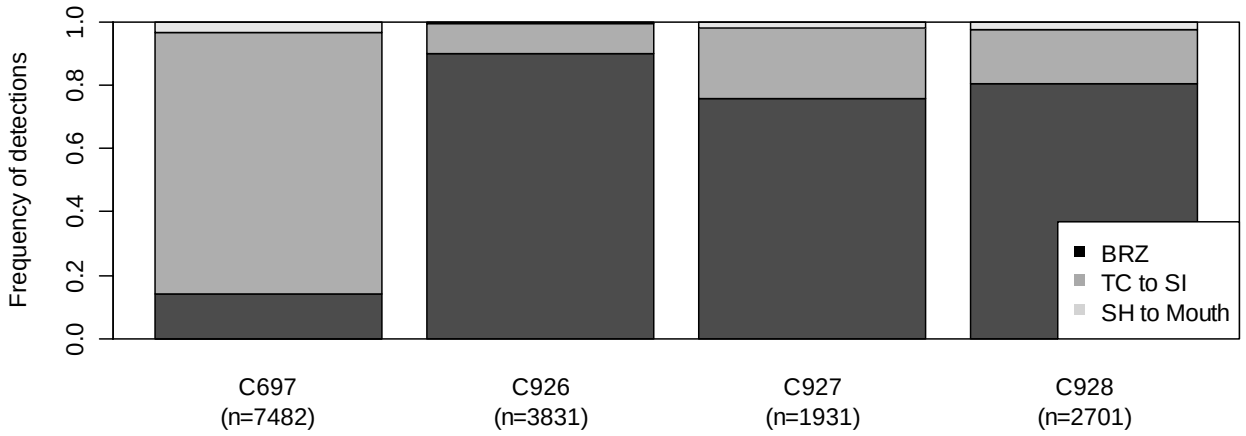


Fig. 6. Relative frequency of acoustic transmitter detections by area. 'BRZ' included hydrophones PH2, RA2, SP, RA1, and PH1 (see Fig. 4); 'TC to SI' included hydrophones TC-NL, HR, BR, WR, UMC1, UMC2, SI1, and SI2; 'SH to Mouth' included the remaining hydrophones from St. Helens to the mouth of the Columbia River. Sample size under each brand indicates the total number of detections across all hydrophones.

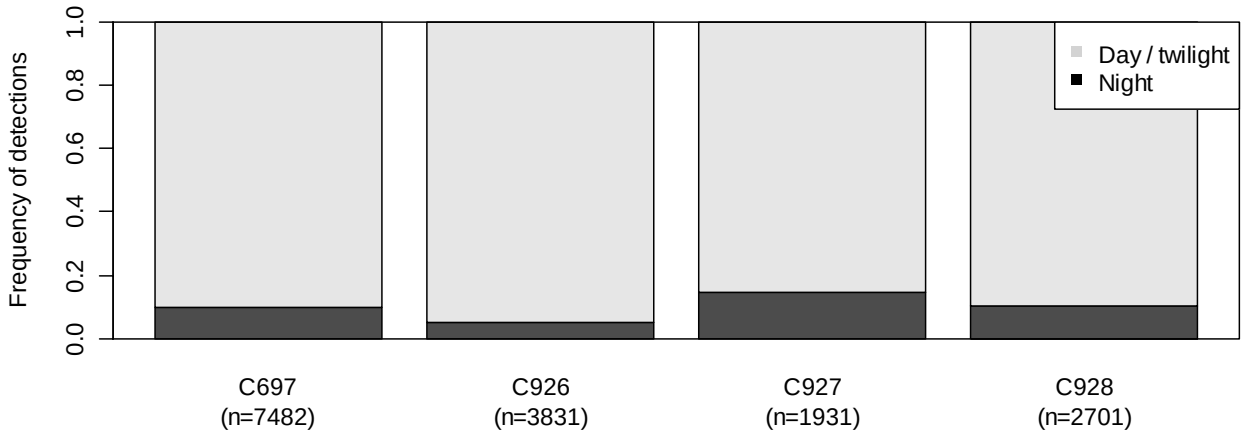


Fig. 7. Relative frequency of acoustic transmitter detections by time of day. 'Day / twilight' included all detections from one hour before sunrise to one hour after sunset; 'Night' included the remainder. Sample size under each brand indicates the total number of detections across all hydrophones.

Appendix 1. Datasheet used to document pinniped hazing events at Bonneville Dam, 2009.

BONNEVILLE PINNIPED HAZING PROJECT

DATE(MM/DD/YY) _____ AGENCY/CREW _____

VISIBILITY (G/F/P) _____ TIME START _____ TIME END _____

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

_____

_____

_____

Enter one record per animal or group hazed*:

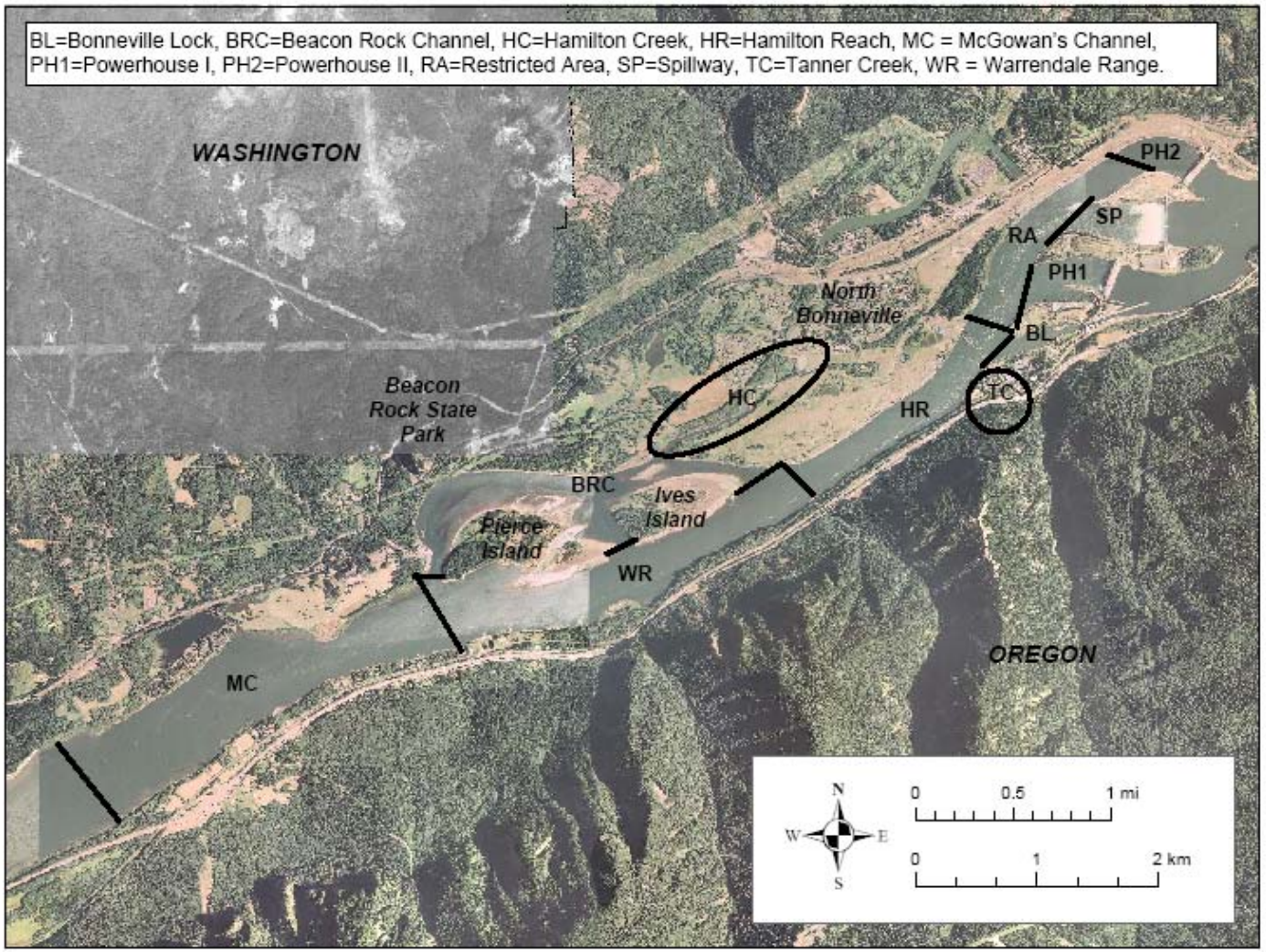
START			SPP. #		METHOD(S) #				END			Fish kill (sp.)	Brand
TIME (24 hr)	AREA (map)	DIR. (↑↓?)	Zc	Ej	CS	SB	SR	RB	TIME (24 hr)	AREA (map)	DIR. (↑↓?)		
NOTES:													
NOTES:													
NOTES:													
NOTES:													
NOTES:													
NOTES:													
NOTES:													
NOTES:													

*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

Appendix 2. Map and location codes used to document pinniped hazing events at Bonneville Dam, 2009.



Appendix 3. Memo from the International Marine Animal Trainer's Association.

IMATA
International Marine Animal Trainers' Association

September 1, 2009

Steven Jeffries
Washington Department of Fish and Wildlife
Marine Mammal Investigations
7801 Phillips Road SW
Lakewood WA 98498

Dear Steve,

On behalf of the members of the International Marine Animal Trainers Association's (IMATA) Bonneville Sea Lion Ad Hoc Committee, I would like to thank you again for allowing our site visit team the opportunity to view the sea lion predation occurring at the Bonneville Dam this past March. Spending two days with you, Robin Brown (ODFW), Robert Stansell and Sean Tackley (USACOE) gave us a unique opportunity to observe and familiarize ourselves with the significant predation behavior occurring at the dam. Additionally, the visit helped us better understand the challenges faced by your agencies in increasing the number of salmon successfully travelling through the dam and fish-ways.

After sharing our observations with the other members of the Ad Hoc Committee, and additional discussion and consultation within the committee and with IMATA's Board of Directors, we submit the following three-part recommendation for your consideration (Enclosure 1). The recommendation includes: 1) an endorsement of the Interagency Working Groups' (IWG) plan to maximize expansion of the sea lion exclusion device (SLED) zone, 2) a request for the IWG to investigate the feasibility of modifying the acoustic deterrent devices (ADDs) to allow for command actuation (i.e., turning the ADDs on/off with the flip of a switch), and 3) an offer by IMATA to train IWG personnel to maximize the effectiveness of the other hazing tools currently in use at the dam by employing them in a manner more consistent with known principles of behavior modification.

The IWG has already characterized both the financial costs and other constraints associated with expanding the SLED zone. Though significant, we believe the expansion of the SLED zone is critical to improving the situation at the dam. In addition, we believe that with minimal effort the IWG can determine whether modifying the ADDs is possible, and are hopeful that it can be accomplished with minimal cost. If so, the ADDs could be readily incorporated into the overall behavior modification plan. Developing such plans, and training others in their use is the expertise that IMATA can contribute to this effort. We are confident that a second, week-long site visit by a two/ three-person IMATA team at the onset of the 2010 season would allow adequate training time for IWG personnel, as well as initial implementation and subsequent fine-tuning of a more behaviorally-sound hazing strategy. However, at this time, IMATA's Board of Directors can not commit to again covering the travel costs of the Ad Hoc Committee members that volunteer their time, and hopes that instead the IWG will consider providing this support.

Both IMATA's members and its Board of Directors remain committed to supporting the IWG in its efforts to reduce the impacts of sea lion predation on salmon at the Bonneville Dam. Please contact me at your earliest convenience to discuss IMATA's recommendation, or any other issues for which we may be of assistance.

Sincerely,

Shelley Ballmann
IMATA Bonneville Sea Lion Ad Hoc Committee Chair

1200 S. Lake Shore Drive | Chicago, Illinois 60605 USA
Phone: (312) 692-3193 | Fax: (312) 939-2216
www.imata.org

IMATA
International Marine Animal Trainers' Association

Enclosure (1)

IMATA Recommendation for Reducing Impact of Sea Lion Predation on Salmon at Bonneville Dam

1. Maximize expansion of SLED zone

    a. Increasing size of SLED zone will create larger refuge for salmon to congregate / mill, and decrease the density of salmon

    b. Decreased salmon density will increase effort required by foraging sea lions, decreasing rate of consumption

2. Command actuation of ADDs

    a. ADDs frequency and sound pressure level make them mild to moderately aversive stimuli

    b. Constant transmission by ADDs maximizes opportunity for sea lions to become habituated

    c. Transmission during successful predation allows for counter conditioning (i.e., ADDs become associated with positive outcome of successful predation)

    d. Command actuation would allow ADDs to be used like any other hazing tool

3. Modified hazing strategy using aversive stimuli

    a. Recognize that only mild to moderately aversive stimuli are available for use (i.e., strong aversive stimuli are not authorized), therefore punishment is not likely to be successful

    b. Exclusively target behavior of foraging in high salmon density areas adjacent to / within SLED zone; allow sea lion to forage low salmon density areas

    c. Use a variety / combination of aversive stimuli

    d. Deliver aversive only while sea lion is foraging in high salmon density area

    e. Allow sea lion to terminate aversive stimuli by leaving high salmon density area (i.e., negative reinforcement)

    f. Do not deliver aversive stimuli once sea lion has successfully captured a salmon (i.e., avoid association of aversive stimuli and positive outcome; avoid shortening interval between foraging bouts)

    g. Maintain log of aversive stimuli delivered, by individual sea lion if possible

    h. Concentrate continued use of aversive stimuli on those individual sea lions for which they are effective

    i. Focus capture efforts on individuals that do not respond to aversive stimuli

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